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(always under construction....)

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Questions and suggestions can be sent to us via our Feedback form.

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Bees and Beekeeping

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Frequently Asked Questions:

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How can I extract honey from a comb without a mechanical extractor?

- **Suggestion A:** Exhibitors of honey samples extract without an extractor all the time. They incline a warm (90 degrees F) comb with open cells -- either carefully uncapped, or just beginning to be capped -- at 60 degrees to the horizontal with the bottom end sitting on a (preferably glass) cookie sheet, and stroke the comb slowly and forcefully with the smooth side of a spoon to force the honey out and down the comb unto the perfectly clean sheet. This way no air or pollen or wax gets incorporated and the sample, if run immediately into a jar that is also perfectly clean and free of odors (check the cardboard on the underside of the lid for *any* odors) , one gets about as perfect a sample as possible (after careful skimming). The comb can be replaced in the hive and is quickly repaired and the remaining honey tidied up.
- **Suggestion B:** Don't boil or heat it. This will destroy your comb and will also destroy the flavor of your honey. Wax melts at approximately 150 degrees F., My understanding is that temperatures above approximately 120 degrees F. will damage honey flavor (those in the know, does this have anything to do with the temperature at which enzymes start breaking down?) Certainly, boiling it will damage it. As for letting it trickle out, you might end up with an increase in the moisture in the honey. Remember, it is a hydroscopic solution (tending to absorb moisture) and will pull in water from the air surrounding it. The bees dehydrate the nectar-honey until it reaches around 17% water and then they cap it - sealing it off from the air. If you left honey on a saucer in your kitchen it would eventually (in a few days perhaps) reach about 25% water, at which point, if there was any yeast about, it would begin to ferment. It's easy to see how mead-making originated, isn't it?

Other Information Sources:

- **Suggestion C:** We have two hives, and decided last year for first time to extract honey. I used a large Rubbermaid tub where I placed a frame in vertically and then scraped the comb down to the foundation with a stainless steel spatula-like the kind used for burger flipping in restaurants. I would *heat* the spatula in a pot of boiling water. I don't think it took more than a couple of minutes per frame, after I quit trying not to damage the foundation. After two frames, I would pour the tub into a colander lined with cheese cloth over another tub. After reading a remark about the best temperature for extracting in one of the Dadant books, (with or without extractor), I turned up the heat in my house to 90F, and the honey flowed like water. (Of course, I chose to extract in the short time of cool weather Southern California has!) It wasted a lot of honey, but I had more than enough to give for Christmas, and several holidays past that. (60+lb.) Last time, I went to the honey-supplier's and bought a plastic Chinese-manufactured extractor. It holds two frames, I cut down on the extracting time, but it skittered on the floor, so it had to be held down with my feet braced on either side, on a damp towel. I also bought an electric uncapping knife-cut myself real good-but between the sanitary conditions, the *cauterization* and the healing power of the raw honey-I healed in a week! I found that the temperature is still important for draining-yes, bought a stainless steel drainer which was slow in cooler weather but not as messy as cheesecloth. It strained into a plastic tub with a gate-beat using a 4-cup cheesecloth-lined funnel! It can be done without the tools; it was amusing until the third day, when you can't quit but are quite sick of wax caps and honey everywhere. As soon as you can, get a stainless steel extractor! The American Bee Journal has ads in their classifieds where people sell used equipment.
- **Suggestion D (tail end of a long story about an old beekeeper):** He heated it just hot enough to melt the wax, and then drew the honey off from the bottom. His tanks were water jacked and heated with adjustable gas burners. His wax was very nice looking and he turned it into hand dipped candles. To this day I would not criticize this bee man for his method of extracting honey, it worked for him and my guess it worked for his dad and his dad's dad. He had no trouble selling his honey and people would come to his home to pick it up, and it sold well in the few stores he marketed it in.
- **Suggestion E:** Here in the UK a major crop is oil seed rape, much favored by the bees. The honey produced from this crop granulates in a few weeks, or less! If it granulates in the comb it is very hard to extract. In the past I have resorted to melting the whole comb and letting the liquid cool. The wax can then be

lifted off and the honey poured. The secret is not to let the mixture get too hot otherwise the honey will be damaged, but it does mean that you can at least get at the stuff. This method is not really to be recommended as it destroys comb, thereby making more work for both bees and beekeeper, and it risks damage to the honey. It also takes a very long time to do properly as the heating rate is slow, it must NOT be boiled, 65C is high enough.

Is it possible to have two queens in a single bee hive?

Normally only one queen is found in each colony of bees. This is because rival queens do not tolerate each other and will generally fight to the death of one (usually the older will be killed by the younger). Worker bees do not care how many queens they have (although they will tend to kill a newly introduced queen as they would any other intruder into the hive). The reason beekeepers may want to have an extra queen in the colony is to increase the number of bees. Bees work more efficiently if their total number is increased. 100,000 bees in one colony produce much more honey than two 50,000 bee colonies. However, it is almost impossible to get that many bees from one queen - she can only lay so many eggs per day, and during the summer months worker bees live only a few weeks.

Briefly, the way it is done is this: In early spring, the brood section of a strong hive is separated by a screen into two parts - one with a queen and one without. Each part has a separate entrance. A queen is purchased or raised by the beekeeper, and carefully installed in the queenless part. The warmth, hive odors, etc., can circulate between the two parts, but the screen prevents the queens from getting at each other. After a week or so, the beekeeper checks to see if the new queen is accepted and laying eggs. If so, the screen is taken away and replaced by a wire mesh device, the "queen excluder", which allows worker bees to circulate through but the mesh openings are too small to allow the queens to pass. Each queen now lays eggs in her own portion of the hive - one above and one below the queen excluder. If all goes as planned, a rapid population explosion ensues and much honey is produced by the hive! Later in the summer, when all those bees are no longer necessary, the queen excluder is removed, and eventually the queens find each other and settle their differences. Thus the hive is naturally returned to the single queen state again.

Can I put a queen excluder at the base of the hive to prevent swarming?

Just like the queen, the drones are too big to pass through the queen

excluder. Putting one at the base of the hive would prevent the drones from escaping, thus interrupting the breeding cycle.

What is the technique for using tobacco smoke to kill braula coeca?

Braula coeca is a member of the braulid family. They are sometimes called "bee lice" and are about the size of a pinhead. They are basically a wingless fly and apparently do little harm to the hive, other than eating some of the produce (from the mouths of the bees).

This technique came off the net, and may be untried, so consider this experimental!

CAUTION: You **may** kill your bees using this method.

WARNING: Use of nicotine in this way may be unlawful in some countries.

1. Make the hive air-proof (except a small hole at the entrance).
2. Put approximately 2 grams of tobacco in your smoker & light it.
3. Put your smoker nozzle into the hole you left in the entrance and puff away until the tobacco has been all used up.
4. Seal the entrance and wait a couple of minutes.
5. Open the entrance.

Some bees may be so affected by the smoke that they will fall to the floor. Some bees may die.

The braula coeca in the hive should fall to the floor dead. If you have a removable floor, you should remove it now and incinerate the debris.

What about using tobacco smoke to kill mites?

- **Suggestion A:** I am a biologist working in a bee research institute in the Netherlands. In the early eighties we did experiments with tobacco smoke and Varroa mites in Greece. At that time we did not have any drugs registered in the Netherlands for the diagnosis of Varroa. Waste tobacco is commonly used in the Netherlands as fuel for smokers. About 50-70% of the mites were killed after smoking of about 3 grams of tobacco into a hive. In 1983 we treated many colonies this way and this was how we detected the first mites in our country. Later the same method was used in England (we had a short publication in Bee World). After the introduction of better acaricides (Folbex VA, Perizin, Apistan), tobacco smoke was not used anymore. Tobacco smoke is not effective enough to use it as a control agent.

Moreover as a non-smoker I did not like to be surrounded by clouds of tobacco smoke.

A lot of research has been done with all kinds of essential oils like menthol and thymol, but nobody has come up with a nice method to use these substances in Varroa control. The best results came from Switzerland (Buehlman) with a mixture containing also eucalyptol (Api-lifevar). We repeated the tests, but the hives (and the honey) keep smelling for months after the treatment.

What causes someone to become allergic to bee stings?

- **Suggestion A:** To the best of our knowledge, no one starts out allergic to bee stings, that develops after one or more stings. Most people seem to go one way or the other, either you get less sensitive or more sensitive. Lots of references will explain this to you. The more interesting aspects to me are the differences seen in individual responses and the work done by one of our Missoula allergists, Dr. Bell, who has some evidence that allergies to bees tend to be more common in the family members of beekeepers than in the general population (even if the family members do not work with the bees).

  In my own case, I am allergic to just about everything except bee stings. As a child growing up on a farm, I couldn't drive past a green alfalfa field without wheezing. Took five years of desensitizing shots (yep, I was one of the earliest test cases for this procedure back in the 50's) before I became halfway functional. However, after 20 years of bee stings, I rarely swell, even if stung on the wrists or eyelid - worst case is a slightly tired looking eye. Most stings do not even hurt, pain ranges from a slight prick to nothing (especially in my forearms), although a direct hit on a nerve ending still hurts like heck.

  On the other extreme is one of my students who I will call R.A. R.A. is a young woman who has worked for me for three years. She is very gentle with the bees and likes to work with them. After 3 or 4 stings spread across an entire summer, R.A. developed one of the worst cases of sensitivity to bee stings that Dr. Bell had seen (at least as evidenced by the skin test). She wanted to keep working bees, so last winter, she took the whole venom de-sensitizing shots. This spring, she went back to work. She keeps an adrenaline kit handy, but hasn't had to use it.

  The reason I mention this is that many doctors and even Justin recommend not getting the shots. Among my colleagues, one

who does field work in remote areas also became hypersensitive, took the shots, and is now okay, although he needs occasional booster shots. On the other hand, one of our beekeepers has two teenagers, both became allergic, both got the shots, one can work bees, the other can't.

The reason for this lengthy discourse is to comment on the people who are allergic but work bees with an adrenaline kit close at hand. Personally, having seen what a severe reaction can do and how fast (and I have experienced them personally, not from bee stings, but from other allergies), I would not take the risk. I don't enjoy bees so much that I would risk my life. On the other hand, I think anyone who wants to work around bees or to enjoy the out-of-doors without fears of stinging insects and who is allergic should seriously consider the de-sensitizing shots. For me, the peace of mind (and the lack of allergy symptoms) is well worth the bother and the expense. And yes, they are expensive, in part because so few people get them (the old supply and demand equation).

Don't skunks get stung when they raid a hive?

- **Suggestion A:** Yes!! Lots of stings, and not just externally, you can find stingers in the mouth and throat and I suspect even farther down the G.I. tract. Doesn't seem to bother them much. They come each night to the same hives, scratch at the entrances, wait till the bees flood out, and start licking them up. Looks like when things get really hot and heavy they move over to the next hive. But maybe they just decide to try some other bees. Worst part is that every evening just about dusk you can count on your skunk to repeat the process. If left unchecked, I have seen a skunk decimate strong hives. You can always tell which are the favorites, scratches on the front of the hive, generally digging in the dirt just in front of the hive, fecal pellets full of bees.

I have drones in November. What is going wrong?

- **Suggestion A:** If you have not placed the Apistan Strips on top of each brood hive body (for example if they are just placed on top of a second story which is completely full of honey), is that the varroasis can proceed to the point where the queen becomes a drone layer, and some small drones start appearing. You know you have problems if any of these drones have deformed wings.
- **Suggestion B:** Generally you would expect drones to be gone by this time of the year. However, in a hive that is apparently

normal, I wouldn't worry about a few drones. I have often seen this in my hives as well, and they over winter perfectly well. If, on the other hand, the hive population is low, with lots of drones, then I would say you might have a problem - probably a failing queen, or queenless and with laying workers. In that case I would go in and check the brood (if any), and probably kill the hive off now rather than let it die out in the winter and attract mice.

What is a good way to sterilize a hive?

- **Suggestion A:** I sterilize my hives with a blow torch. I have a spare set and so I can sterilize that with the torch while inspecting for damage etc. Keep a bucket of water handy because any residual wax can burst into flames.

How can I tell if my wood preservative or paint will be safe for the bees?

- **Suggestion A:** I use an experiment when selecting a wood preservative or paint for my hive. I paint a small piece of wood and allow it to dry for 2-3 days. I place it in a jar with about 10 fruit flies which I had captured (not as easy as it seems). In a second jar I set up a control with no wood. I place some porridge (cooked) in each jar and let them get on with it. I observe them every day for about a week after which time I judge that it was safe to paint the spare hive, if the fruit flies were doing fine. Once I paint the hive pieces, I allow about a week for the paint to dry and any fumes to evaporate before putting the pieces into use.

  I guess that the points to look out for are:

  1. Not to paint the hive while it is occupied, as they try to help and will get their feet stuck!
  2. To allow a week or so for the paint to dry
  3. Test the paint on some volunteers first, and a few fruit flies are cheaper than a hive of bees.

How is lactic acid used to control mites?

- **Suggestion A:** Lactic acid is available in powder form, not expensive, and is applied to the bees during routine inspections. It is shaken on from a home made pepper pot, a honey jar with small holes in the lid. The theory is that it caused the mites to lose their grip and fall to the floor. They are not killed so must be trapped by a sticky paper insert. I tape the paper to a stiff backing

sheet to avoid buckling and coat the paper with a thin film of cooking oil, cheap and non-toxic. When dusting hold the combs at around forty five degrees, not horizontal, to avoid the dust falling into open brood. This treatment only affects the mites on the adult bees but it is non-toxic so can be applied when Apistan is not allowed. Used in conjunction with drone cell traps it helps keep down mite numbers during the active season. It is time consuming so not practical on a commercial basis, However, for the amateur with few stocks and time to spare it is an additional aid.

Do varroa mites carry bee viruses?

- **Suggestion A:** I have personally seen the tremendous and rapid devastation associated with the varroa mite. Dead bees carpet the surrounding area, up to an inch and a half thick! The brood dies, looking suspiciously like AFB but without the ropiness of the dead brood. Before that the queen rapidly fails, and very little new brood is produced anyway. The colony is destroyed in about six weeks. How can the mite do this alone? I remember reading an article in Apis, I believe it was one of the summer '94 issues, in which the possibility of viral transmission by varroa was discussed.
- **Suggestion B:** I think that virus infections carried by or triggered by varroa is now pretty firmly established. Recent work in the UK has been plotting the rise of virus mortality against mite infestation with interesting results. In the UK, the researchers are seeing mortality due to Slow Paralysis Virus (which I understand was a surprise). In the Europe mainland Acute Paralysis Virus is more usual. Other viruses are also frequently observed. As I understand it, it is the virus that causes death of the bees and hence demise of the colony, not the *direct* effects of varroa itself.

What is the proper way to dispose of Apistan Strips?

- **Suggestion A:** Pesticide disposal instructions are on the box/container. Apistan is rather mild considering most others. "May be disposed of on site or at an approved disposal facility". In other words, put it in with your normal trash.

Can you use the same Apistan Strips for multiple seasons?

- **Suggestion A:** My understanding is that reuse of Apistan is not an approved practice, unless the strips have only been briefly used for testing for mite presence. After use of the strips for mite

treatment, the chemical content of the strips is naturally reduced and reuse will kill only the most susceptible mites, leaving the more resistant ones alive to reproduce and pass on fluvalinate resistance. Doing this will hasten the day when Apistan will no longer be effective, a condition we are already hearing about in Europe.

What is an alternative to using an uncapping knife?

- **Suggestion A:** Get a wide uncapping fork from a bee supply house. Mine is about 2 1/2 inches wide with tines every 1/8 inch or so. Scratch the cappings of the comb with it before you extract. If you extract cool (70 degrees or so,) you get very little wax off the combs, but it opens the cells enough to sling the honey out. If you extract when it is warmer, (like Augusts are here,) the fork will take off a little more wax, but the combs are definitely reusable.

  I leave the emptied combs outside "away" from the hives, for the bees to clean out the remainder and recycle it into the hive. Don't leave them open near the hives or they will start robbing each other!

My bee hive died off. What do I need to do to prepare it for a new package of bees?

- **Suggestion A:** All you need to do is remove the dead bees from the hive. Make sure not to mess up the comb. If there is bees in the comb leave them the new bees in the spring will clean them out. Store the hive in a cool place and block off all passages with a screen to allow air flow and to keep out unwanted pests (ants, other insets, and mice). The new package in the spring will use the old comb. This will save them time from building comb and will allow them to start producing honey quicker.
- **Suggestion B:** I'd clean it out now if you can get to it. If you leave the dead bees on the combs until late spring, you might find that mother nature has not only taken the lives of your bees, but also left you with quite a nice batch of mold in their place. Carefully transport the supers to a place where you can break them down (preferably warm!) gently brush off the dead bees, don't bother to try to remove any that have died inside the cells, your package will do a much better job of that. I would then put the complete colony back outside in a protected location, or store in an unheated garage, carefully screening any opening greater than 1/4" to keep the furry four footers out. If you store the

supers inside without benefit of para-dichloro-benzine you might find that the wax moth has vacationed in your colony for the winter. Storing outside (using the magic word "assuming") assuming you live in the colder climes, will postpone the arrival of the wax moth until you can re-populate with fresh package bees. Remember; cold combs are as fragile as glass, handle with care, and let them warm up above 55 to 60F before trying to remove them from the supers. If you still have any honey or pollen in the combs, you cannot use para-dichloro-benzine. The resulting odor will be taken up by the honey and render it useless to your future bees.

Is it a bad idea to have multiple races of bees in a single yard?

- **Suggestion A:** I've got a single hive with mixed races. It's a colony I transferred from somebody's squirrel-house last summer. The queen is Italian and about 75% of the bees are Italian but the other 25% are dark grey (Carnolian?). They seem to behave pretty much like my other Italian colonies. I figure the queen must have mated wild and been pretty wild about her mating.
- **Suggestion B:** Not at all. Plus you will get to notice the differences in behavior between them which can be interesting. I've been amazed at the work the Buckfasts can do. (And they have been fairly consistent.) Caucasians tend to be very gentle, but the ones I have tried used so much propolis the hives were hard to get apart. Not all are so bad.

Does the Steve Tuttle 'Mite Solution' really control varroa mites?

- **Suggestion A:** 'Mite Solution' is an herbal-mineral oil combination, advertised in 'Bee culture', developed by Steve Tuttle, a bee keeper in Washington state. I do not know for sure which oils are used, but I am assuming it is related to the experiments for varroa control which use thymol and eucalyptus oils. I assume this just because of having read, also in 'Bee culture' a short note about such research. I'd have to look through back issues to give references. It is usually applied on a 1/4" screen at the front entrance, but since I had rather severe varroa mite problems (lost 23 of 30 hives summer '94) I wanted to apply it a bit heavier. So, since in a phone conversation, Steve said they had found no ill results from heavier applications, I mixed it with my Crisco patties which I had been using for several years anyway, following recommendations of Roger Morse and

others.(reportedly good for tracheal mite control).

- **Suggestion B:** I began using it this past summer and fall, with positive results so far. I mixed it in with Crisco-sugar patties, and placed it in the hive.
- **Suggestion C:** I tried this mite solution in six of my hives with sticky paper in the bottom to detect mite fall. I found no mites on the paper after 24 hours. The following week I inserted Apistan strips and found medium to heavy mite falls. I knew I had mites but with the "mite solution" I could not even detect that I had mites. I spread the solution along the entrance and across the top bars in the middle of the cluster to make sure the bees came in contact with it. Maybe it just takes longer to work, but one would think I'd have seen something in 24 hours. I am not going to trust my hives to this "mite solution".

How can I keep my bees from dying in the winter?

- **Suggestion A:** All of my hives have been started from package bees. I have found that a large number of dead bees outside the hive isn't necessarily something to be worried about; the bees seem to clean house and carry out the dead ones only when it is warm enough. Since bees die naturally all winter long, it is not unusual for them to carry out lots of dead ones which have been accumulating during cold weather as soon as it warms up.

  Here is what has worked for me in wintering bees (Western Washington State):

  1. Enough surplus honey; two deep hive bodies, one with 10 full frames (top) and one with at least four outside full frames, brood nest in center (bottom).
  2. Treatment for both kinds of mites (Apistan and menthol) in the fall.
  3. Proper ventilation (entrance reducer at the bottom for small opening), 3/4" hole in the top box for moisture release through venting. Keep the bottom entrance clear of dead bees, other debris, and snow. Check it every few days.
  4. Mouse guard at the bottom entrance.
  5. Hive wrapping temporarily (roofing paper) during spells of excessive cold. Some beekeepers here add a third super on top full of fiberglass insulation and with a piece of plywood nailed to the bottom to keep the glass away from the bees. Do this before cold weather sets in; never open the hive in the cold.

6. Treatment for nosema (fumidil) in fall and/or spring.
7. Hive painted a dark color so that heat from natural light is absorbed into the hive. This permits a looser cluster and allows the bees to reach honey on outside frames. They gradually move up in the hive through the winter to reach more. If it is too cold inside the hive, they will starve even though there is plenty of food, because the cluster is too tight to reach it. Make sure the winter winds do not hit the hive directly.
8. Young bees need plenty of pollen. Without it, their ability to produce wax is inhibited. Brood rearing to gear up for spring starts early, late January or February depending on your climate. Feeding a pollen substitute as soon as it is warm enough to safely open the hive is a good bit of added insurance. Also, use an interior feeder during early spring if honey reserves are running low.
9. Use a metal outer cover to prevent moisture from entering the hive. I like the telescoping variety with a masonite inner cover underneath.
10. I never open my hives unless it is warm out; 60 degrees F is an absolute minimum for me; 65 or warmer is better. Bees and brood can get sick if chilled.
11. My hives are slanted slightly forward, they are 1" lower at the front than at the back. This causes any moisture which collects on the floor to run out instead of evaporating in the hive. I also keep a cinder block on top so that the cover cannot blow off.

I hope this helps. I'm sorry it's not very well organized. One thing which really helped me was a book by Mark Winston called the Biology of the Honeybee if memory serves. There is a chapter which describes their wintering habits in great detail. The book as a whole was very educational for me and provided much insight into making beekeeping decisions. It really helps to have an idea of how the bees work when you are trying to figure out what to do or what to not do.

How can I move one of my hives just a short distance from where it is currently sitting?

- **Suggestion A:** Move the hive to a new location (at night when all foragers are home). Make sure the location is say 3 or more miles away. Then another night after a week or so move the colony to the preferred location. They will re-orient and not return to the original site. It should be pretty easy to find a spot to put them temporarily -- try a relative or friend's place. This method is easy and reliable.

How can I use bees to pollinate inside my greenhouse?

- **Suggestion A:** Place a hive against the side of the greenhouse, with the entrance facing outside. Turn one of the supers around so its entrance faces into the greenhouse. Cut a hole in the plastic sheeting of the greenhouse to match up with the second super entrance. Staple the plastic back on the box so it is tight and wait.

How do you locate a wild bee colony?

- **Suggestion A:** What is done is to trap several bees off the flowers, then release one bee at a time, and track the bees back to the feral nest. You will need some bee trapping boxes. You would be surprised at how elaborate the bee catching boxes are.

Related web pages:

- APIS -- Florida Extension Beekeeping Newsletter
- B Eye see the world through the eyes of a honeybee
- Bee Alert using bees to assess environmental hazards
- Beekeeping: The Beekeeper's Home Page Beekeeping, the honey bee, and honey production are shown with news updated monthly; lots of photos; notices of meetings. Canadian and North American content.
- Bees and Pollination: USDA-ARS Carl Hayden Bee Research Center GEARS
- British Isles Bee Breeders Association
- E.H. Thorne (Beehives) Ltd. Wragby, Lincoln, UK
- The Pollination Scene practical pollination tips and info
- The Pollination Home Page Aids fruit and vegetable growers and beekeepers to manage pollination for better crops.

Commercial suppliers:

-

Electronic mailing lists:

- **BEE-L: Bee Biology Discussion List**

  BEE-L is for the discussion of research and information concerning the biology of bees. This includes honey bees and other bees (and maybe even wasps). We communicate about sociobiology, behavior, ecology, adaptation, evolution, genetics, taxonomy, physiology, pollination, and flower nectar and pollen production of bees.

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- Beekeeping : A Practical Guide for the Novice Beekeeper - by Werner Melzer - List: $6.95 - Publication date: March 1, 1989
- The ABC and Xyz of Bee Culture : An Encyclopedia of Beekeeping - by Roger Morse - List: $30.00 - Publication date: June 1990
- The New Complete Guide to Beekeeping - by Roger A. Morse - Publication Date: November 1, 1994 - List: $15.00

Periodicals:

- Bees For Development (Magazine); Dr. Nicola Bradbear, ed.; Bees For Development, Troy, Monmouth, NP5 4AB, UK; (F) +44 1600 716167; email: 100410.2631@compuserve.com
- Australasian Beekeeper, Pender Beekeeping Supplies Pty Ltd, P.M.B. Maitland, NSW 2320, Australia. price 1 year $A36.00
- American Bee Journal, Hamilton Illinois, 62341, United States of America. price per annum: $US 23.12

This page was last updated on November 15, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

How can I extract honey from a comb without a mechanical extractor?

- **Suggestion A:** Exhibitors of honey samples extract without an extractor all the time. They incline a warm (90 degrees F) comb with open cells -- either carefully uncapped, or just beginning to be capped -- at 60 degrees to the horizontal with the bottom end sitting on a (preferably glass) cookie sheet, and stroke the comb slowly and forcefully with the smooth side of a spoon to force the honey out and down the comb unto the perfectly clean sheet. This way no air or pollen or wax gets incorporated and the sample, if run immediately into a jar that is also perfectly clean and free of odors (check the cardboard on the underside of the lid for *any* odors) , one gets about as perfect a sample as possible (after careful skimming). The comb can be replaced in the hive and is quickly repaired and the remaining honey tidied up.
- **Suggestion B:** Don't boil or heat it. This will destroy your comb and will also destroy the flavor of your honey. Wax melts at approximately 150 degrees F., My understanding is that temperatures above approximately 120 degrees F. will damage honey flavor (those in the know, does this have anything to do with the temperature at which enzymes start breaking down?) Certainly, boiling it will damage it. As for letting it trickle out, you might end up with an increase in the moisture in the honey. Remember, it is a hydroscopic solution (tending to absorb moisture) and will pull in water from the air surrounding it. The bees dehydrate the nectar-honey until it reaches around 17% water and then they cap it - sealing it off from the air. If you left honey on a saucer in your kitchen it would eventually (in a few days perhaps) reach about 25% water, at which point, if there was any yeast about, it would begin to ferment. It's easy to see how mead-making originated, isn't it?
- **Suggestion C:** We have two hives, and decided last year for first time to extract honey. I used a large Rubbermaid tub where I placed a frame in vertically and then scraped the comb down to the foundation with a stainless steel spatula-like the kind used for burger flipping in restaurants. I would *heat* the spatula in a pot of boiling water. I don't think it took more than a couple of minutes per frame, after I quit trying not to damage the foundation. After two frames, I would pour the tub into a colander lined with cheese cloth over another tub. After reading a remark about the best temperature for extracting in one of the Dadant books, (with or without extractor), I turned up the heat in my house to 90F, and the honey flowed like water. (Of course, I chose to extract in the short time of cool weather Southern California has!) It wasted a lot of honey, but I had more than enough to give for Christmas, and several holidays past that. (60+lb.) Last time, I went to the honey-supplier's and bought a plastic Chinese-manufactured extractor. It holds two frames, I cut down on the extracting time, but it skittered on the floor, so it had to be held down with my feet braced on either side, on a damp towel. I also bought an electric uncapping knife-cut myself real good-but

between the sanitary conditions, the *cauterization* and the healing power of the raw honey-I healed in a week! I found that the temperature is still important for draining-yes, bought a stainless steel drainer which was slow in cooler weather but not as messy as cheesecloth. It strained into a plastic tub with a gate-beat using a 4-cup cheesecloth-lined funnel! It can be done without the tools; it was amusing until the third day, when you can't quit but are quite sick of wax caps and honey everywhere. As soon as you can, get a stainless steel extractor! The American Bee Journal has ads in their classifieds where people sell used equipment.

- **Suggestion D (tail end of a long story about an old beekeeper):** He heated it just hot enough to melt the wax, and then drew the honey off from the bottom. His tanks were water jacked and heated with adjustable gas burners. His wax was very nice looking and he turned it into hand dipped candles. To this day I would not criticize this bee man for his method of extracting honey, it worked for him and my guess it worked for his dad and his dad's dad. He had no trouble selling his honey and people would come to his home to pick it up, and it sold well in the few stores he marketed it in.
- **Suggestion E:** Here in the UK a major crop is oil seed rape, much favored by the bees. The honey produced from this crop granulates in a few weeks, or less! If it granulates in the comb it is very hard to extract. In the past I have resorted to melting the whole comb and letting the liquid cool. The wax can then be lifted off and the honey poured. The secret is not to let the mixture get too hot otherwise the honey will be damaged, but it does mean that you can at least get at the stuff. This method is not really to be recommended as it destroys comb, thereby making more work for both bees and beekeeper, and it risks damage to the honey. It also takes a very long time to do properly as the heating rate is slow, it must NOT be boiled, 65C is high enough.

Is it possible to have two queens in a single bee hive?

Normally only one queen is found in each colony of bees. This is because rival queens do not tolerate each other and will generally fight to the death of one (usually the older will be killed by the younger). Worker bees do not care how many queens they have (although they will tend to kill a newly introduced queen as they would any other intruder into the hive). The reason beekeepers may want to have an extra queen in the colony is to increase the number of bees. Bees work more efficiently if their total number is increased. 100,000 bees in one colony produce much more honey than two 50,000 bee colonies. However, it is almost impossible to get that many bees from one queen - she can only lay so many eggs per day, and during the summer months worker bees live only a few weeks.

Briefly, the way it is done is this: In early spring, the brood section of a strong hive is separated by a screen into two parts - one with a queen and one without. Each part has a separate entrance. A queen is purchased or raised by the beekeeper, and carefully installed in the queenless part. The warmth, hive odors, etc., can circulate between the two parts, but the screen prevents the queens from getting at each other. After a week or so, the beekeeper checks to see if the new queen is accepted and laying eggs. If so, the screen is taken away and replaced by a wire mesh device, the "queen excluder", which allows worker bees to circulate through but the mesh openings are too small to allow the queens to pass. Each queen now lays eggs in her own portion of the hive - one

above and one below the queen excluder. If all goes as planned, a rapid population explosion ensues and much honey is produced by the hive! Later in the summer, when all those bees are no longer necessary, the queen excluder is removed, and eventually the queens find each other and settle their differences. Thus the hive is naturally returned to the single queen state again.

Can I put a queen excluder at the base of the hive to prevent swarming?

Just like the queen, the drones are too big to pass through the queen excluder. Putting one at the base of the hive would prevent the drones from escaping, thus interrupting the breeding cycle.

What is the technique for using tobacco smoke to kill braula coeca?

Braula coeca is a member of the braulid family. They are sometimes called "bee lice" and are about the size of a pinhead. They are basically a wingless fly and apparently do little harm to the hive, other than eating some of the produce (from the mouths of the bees).

This technique came off the net, and may be untried, so consider this experimental!

CAUTION: You **may** kill your bees using this method.

WARNING: Use of nicotine in this way may be unlawful in some countries.

1. Make the hive air-proof (except a small hole at the entrance).
2. Put approximately 2 grams of tobacco in your smoker & light it.
3. Put your smoker nozzle into the hole you left in the entrance and puff away until the tobacco has been all used up.
4. Seal the entrance and wait a couple of minutes.
5. Open the entrance.

Some bees may be so affected by the smoke that they will fall to the floor. Some bees may die.

The braula coeca in the hive should fall to the floor dead. If you have a removable floor, you should remove it now and incinerate the debris.

What about using tobacco smoke to kill mites?

- **Suggestion A:** I am a biologist working in a bee research institute in the Netherlands. In the early eighties we did experiments with tobacco smoke and Varroa mites in Greece. At that time we did not have any drugs registered in the Netherlands for the diagnosis of Varroa. Waste tobacco is commonly used in the Netherlands as fuel for smokers. About 50-70% of the mites were killed after smoking of about 3 grams of tobacco into a hive. In 1983 we treated many colonies this way and this was how we detected the first mites in our country. Later the same method was used in England (we had a short publication in Bee World). After the introduction of better acaricides (Folbex VA, Perizin, Apistan), tobacco smoke was not used anymore. Tobacco smoke is not effective enough to use it as a control agent.

Moreover as a non-smoker I did not like to be surrounded by clouds of tobacco smoke.

A lot of research has been done with all kinds of essential oils like menthol and thymol, but nobody has come up with a nice method to use these substances in Varroa control. The best results came from Switzerland (Buehlman) with a mixture containing also eucalyptol (Api-lifevar). We repeated the tests, but the hives (and the honey) keep smelling for months after the treatment.

What causes someone to become allergic to bee stings?

- **Suggestion A:** To the best of our knowledge, no one starts out allergic to bee stings, that develops after one or more stings. Most people seem to go one way or the other, either you get less sensitive or more sensitive. Lots of references will explain this to you. The more interesting aspects to me are the differences seen in individual responses and the work done by one of our Missoula allergists, Dr. Bell, who has some evidence that allergies to bees tend to be more common in the family members of beekeepers than in the general population (even if the family members do not work with the bees).

  In my own case, I am allergic to just about everything except bee stings. As a child growing up on a farm, I couldn't drive past a green alfalfa field without wheezing. Took five years of desensitizing shots (yep, I was one of the earliest test cases for this procedure back in the 50's) before I became halfway functional. However, after 20 years of bee stings, I rarely swell, even if stung on the wrists or eyelid - worst case is a slightly tired looking eye. Most stings do not even hurt, pain ranges from a slight prick to nothing (especially in my forearms), although a direct hit on a nerve ending still hurts like heck.

  On the other extreme is one of my students who I will call R.A. R.A. is a young woman who has worked for me for three years. She is very gentle with the bees and likes to work with them. After 3 or 4 stings spread across an entire summer, R.A. developed one of the worst cases of sensitivity to bee stings that Dr. Bell had seen (at least as evidenced by the skin test). She wanted to keep working bees, so last winter, she took the whole venom de-sensitizing shots. This spring, she went back to work. She keeps an adrenaline kit handy, but hasn't had to use it.

  The reason I mention this is that many doctors and even Justin recommend not getting the shots. Among my colleagues, one who does field work in remote areas also became hypersensitive, took the shots, and is now okay, although he needs occasional booster shots. On the other hand, one of our beekeepers has two teenagers, both became allergic, both got the shots, one can work bees, the other can't.

  The reason for this lengthy discourse is to comment on the people who are allergic but work bees with an adrenaline kit close at hand. Personally, having seen what a severe reaction can do and how fast (and I have experienced them personally, not from bee stings, but from other allergies), I would not take the risk. I don't enjoy bees so much that I would risk my life. On the other hand, I think anyone who wants to work around bees or to enjoy the

out-of-doors without fears of stinging insects and who is allergic should seriously consider the de-sensitizing shots. For me, the peace of mind (and the lack of allergy symptoms) is well worth the bother and the expense. And yes, they are expensive, in part because so few people get them (the old supply and demand equation).

Don't skunks get stung when they raid a hive?

- **Suggestion A:** Yes!! Lots of stings, and not just externally, you can find stingers in the mouth and throat and I suspect even farther down the G.I. tract. Doesn't seem to bother them much. They come each night to the same hives, scratch at the entrances, wait till the bees flood out, and start licking them up. Looks like when things get really hot and heavy they move over to the next hive. But maybe they just decide to try some other bees. Worst part is that every evening just about dusk you can count on your skunk to repeat the process. If left unchecked, I have seen a skunk decimate strong hives. You can always tell which are the favorites, scratches on the front of the hive, generally digging in the dirt just in front of the hive, fecal pellets full of bees.

I have drones in November. What is going wrong?

- **Suggestion A:** If you have not placed the Apistan Strips on top of each brood hive body (for example if they are just placed on top of a second story which is completely full of honey), is that the varroasis can proceed to the point where the queen becomes a drone layer, and some small drones start appearing. You know you have problems if any of these drones have deformed wings.
- **Suggestion B:** Generally you would expect drones to be gone by this time of the year. However, in a hive that is apparently normal, I wouldn't worry about a few drones. I have often seen this in my hives as well, and they over winter perfectly well. If, on the other hand, the hive population is low, with lots of drones, then I would say you might have a problem - probably a failing queen, or queenless and with laying workers. In that case I would go in and check the brood (if any), and probably kill the hive off now rather than let it die out in the winter and attract mice.

What is a good way to sterilize a hive?

- **Suggestion A:** I sterilize my hives with a blow torch. I have a spare set and so I can sterilize that with the torch while inspecting for damage etc. Keep a bucket of water handy because any residual wax can burst into flames.

How can I tell if my wood preservative or paint will be safe for the bees?

- **Suggestion A:** I use an experiment when selecting a wood preservative or paint for my hive. I paint a small piece of wood and allow it to dry for 2-3 days. I place it in a jar with about 10 fruit flies which I had captured (not as easy as it seems). In a second jar I set up a control

with no wood. I place some porridge (cooked) in each jar and let them get on with it. I observe them every day for about a week after which time I judge that it was safe to paint the spare hive, if the fruit flies were doing fine. Once I paint the hive pieces, I allow about a week for the paint to dry and any fumes to evaporate before putting the pieces into use.

I guess that the points to look out for are:

1. Not to paint the hive while it is occupied, as they try to help and will get their feet stuck!
2. To allow a week or so for the paint to dry
3. Test the paint on some volunteers first, and a few fruit flies are cheaper than a hive of bees.

How is lactic acid used to control mites?

- **Suggestion A:** Lactic acid is available in powder form, not expensive, and is applied to the bees during routine inspections. It is shaken on from a home made pepper pot, a honey jar with small holes in the lid. The theory is that it caused the mites to lose their grip and fall to the floor. They are not killed so must be trapped by a sticky paper insert. I tape the paper to a stiff backing sheet to avoid buckling and coat the paper with a thin film of cooking oil, cheap and non-toxic. When dusting hold the combs at around forty five degrees, not horizontal, to avoid the dust falling into open brood. This treatment only affects the mites on the adult bees but it is non-toxic so can be applied when Apistan is not allowed. Used in conjunction with drone cell traps it helps keep down mite numbers during the active season. It is time consuming so not practical on a commercial basis, However, for the amateur with few stocks and time to spare it is an additional aid.

Do varroa mites carry bee viruses?

- **Suggestion A:** I have personally seen the tremendous and rapid devastation associated with the varroa mite. Dead bees carpet the surrounding area, up to an inch and a half thick! The brood dies, looking suspiciously like AFB but without the ropiness of the dead brood. Before that the queen rapidly fails, and very little new brood is produced anyway. The colony is destroyed in about six weeks. How can the mite do this alone? I remember reading an article in Apis, I believe it was one of the summer '94 issues, in which the possibility of viral transmission by varroa was discussed.
- **Suggestion B:** I think that virus infections carried by or triggered by varroa is now pretty firmly established. Recent work in the UK has been plotting the rise of virus mortality against mite infestation with interesting results. In the UK, the researchers are seeing mortality due to Slow Paralysis Virus (which I understand was a surprise). In the Europe mainland Acute Paralysis Virus is more usual. Other viruses are also frequently observed. As I understand it, it is the virus that causes death of the bees and hence demise of the colony, not the *direct* effects of varroa itself.

What is the proper way to dispose of Apistan Strips?

- **Suggestion A:** Pesticide disposal instructions are on the box/container. Apistan is rather mild considering most others. "May be disposed of on site or at an approved disposal facility". In other words, put it in with your normal trash.

Can you use the same Apistan Strips for multiple seasons?

- **Suggestion A:** My understanding is that reuse of Apistan is not an approved practice, unless the strips have only been briefly used for testing for mite presence. After use of the strips for mite treatment, the chemical content of the strips is naturally reduced and reuse will kill only the most susceptible mites, leaving the more resistant ones alive to reproduce and pass on fluvalinate resistance. Doing this will hasten the day when Apistan will no longer be effective, a condition we are already hearing about in Europe.

What is an alternative to using an uncapping knife?

- **Suggestion A:** Get a wide uncapping fork from a bee supply house. Mine is about 2 1/2 inches wide with tines every 1/8 inch or so. Scratch the cappings of the comb with it before you extract. If you extract cool (70 degrees or so,) you get very little wax off the combs, but it opens the cells enough to sling the honey out. If you extract when it is warmer, (like Augusts are here,) the fork will take off a little more wax, but the combs are definitely reusable.

  I leave the emptied combs outside "away" from the hives, for the bees to clean out the remainder and recycle it into the hive. Don't leave them open near the hives or they will start robbing each other!

My bee hive died off. What do I need to do to prepare it for a new package of bees?

- **Suggestion A:** All you need to do is remove the dead bees from the hive. Make sure not to mess up the comb. If there is bees in the comb leave them the new bees in the spring will clean them out. Store the hive in a cool place and block off all passages with a screen to allow air flow and to keep out unwanted pests (ants, other insets, and mice). The new package in the spring will use the old comb. This will save them time from building comb and will allow them to start producing honey quicker.
- **Suggestion B:** I'd clean it out now if you can get to it. If you leave the dead bees on the combs until late spring, you might find that mother nature has not only taken the lives of your bees, but also left you with quite a nice batch of mold in their place. Carefully transport the supers to a place where you can break them down (preferably warm!) gently brush off the dead bees, don't bother to try to remove any that have died inside the cells, your package will do a much better job of that. I would then put the complete colony back outside in a protected location, or store in an unheated garage, carefully screening any opening greater

than 1/4" to keep the furry four footers out. If you store the supers inside without benefit of para-dichloro-benzine you might find that the wax moth has vacationed in your colony for the winter. Storing outside (using the magic word "assuming") assuming you live in the colder climes, will postpone the arrival of the wax moth until you can re-populate with fresh package bees. Remember; cold combs are as fragile as glass, handle with care, and let them warm up above 55 to 60F before trying to remove them from the supers. If you still have any honey or pollen in the combs, you cannot use para-dichloro-benzine. The resulting odor will be taken up by the honey and render it useless to your future bees.

Is it a bad idea to have multiple races of bees in a single yard?

- **Suggestion A:** I've got a single hive with mixed races. It's a colony I transferred from somebody's squirrel-house last summer. The queen is Italian and about 75% of the bees are Italian but the other 25% are dark grey (Carnolian?). They seem to behave pretty much like my other Italian colonies. I figure the queen must have mated wild and been pretty wild about her mating.
- **Suggestion B:** Not at all. Plus you will get to notice the differences in behavior between them which can be interesting. I've been amazed at the work the Buckfasts can do. (And they have been fairly consistent.) Caucasians tend to be very gentle, but the ones I have tried used so much propolis the hives were hard to get apart. Not all are so bad.

Does the Steve Tuttle 'Mite Solution' really control varroa mites?

- **Suggestion A:** 'Mite Solution' is an herbal-mineral oil combination, advertised in 'Bee culture', developed by Steve Tuttle, a bee keeper in Washington state. I do not know for sure which oils are used, but I am assuming it is related to the experiments for varroa control which use thymol and eucalyptus oils. I assume this just because of having read, also in 'Bee culture' a short note about such research. I'd have to look through back issues to give references. It is usually applied on a 1/4" screen at the front entrance, but since I had rather severe varroa mite problems (lost 23 of 30 hives summer '94) I wanted to apply it a bit heavier. So, since in a phone conversation, Steve said they had found no ill results from heavier applications, I mixed it with my Crisco patties which I had been using for several years anyway, following recommendations of Roger Morse and others.(reportedly good for tracheal mite control).
- **Suggestion B:** I began using it this past summer and fall, with positive results so far. I mixed it in with Crisco-sugar patties, and placed it in the hive.
- **Suggestion C:** I tried this mite solution in six of my hives with sticky paper in the bottom to detect mite fall. I found no mites on the paper after 24 hours. The following week I inserted Apistan strips and found medium to heavy mite falls. I knew I had mites but with the "mite solution" I could not even detect that I had mites. I spread the solution along the entrance and across the top bars in the middle of the cluster to make sure the bees came in contact with it. Maybe it just takes longer to work, but one would think I'd have seen something in 24 hours. I am not going to trust my hives to this "mite solution".

How can I keep my bees from dying in the winter?

- **Suggestion A:** All of my hives have been started from package bees. I have found that a large number of dead bees outside the hive isn't necessarily something to be worried about; the bees seem to clean house and carry out the dead ones only when it is warm enough. Since bees die naturally all winter long, it is not unusual for them to carry out lots of dead ones which have been accumulating during cold weather as soon as it warms up.

  Here is what has worked for me in wintering bees (Western Washington State):

  1. Enough surplus honey; two deep hive bodies, one with 10 full frames (top) and one with at least four outside full frames, brood nest in center (bottom).
  2. Treatment for both kinds of mites (Apistan and menthol) in the fall.
  3. Proper ventilation (entrance reducer at the bottom for small opening), 3/4" hole in the top box for moisture release through venting. Keep the bottom entrance clear of dead bees, other debris, and snow. Check it every few days.
  4. Mouse guard at the bottom entrance.
  5. Hive wrapping temporarily (roofing paper) during spells of excessive cold. Some beekeepers here add a third super on top full of fiberglass insulation and with a piece of plywood nailed to the bottom to keep the glass away from the bees. Do this before cold weather sets in; never open the hive in the cold.
  6. Treatment for nosema (fumidil) in fall and/or spring.
  7. Hive painted a dark color so that heat from natural light is absorbed into the hive. This permits a looser cluster and allows the bees to reach honey on outside frames. They gradually move up in the hive through the winter to reach more. If it is too cold inside the hive, they will starve even though there is plenty of food, because the cluster is too tight to reach it. Make sure the winter winds do not hit the hive directly.
  8. Young bees need plenty of pollen. Without it, their ability to produce wax is inhibited. Brood rearing to gear up for spring starts early, late January or February depending on your climate. Feeding a pollen substitute as soon as it is warm enough to safely open the hive is a good bit of added insurance. Also, use an interior feeder during early spring if honey reserves are running low.
  9. Use a metal outer cover to prevent moisture from entering the hive. I like the telescoping variety with a masonite inner cover underneath.
  10. I never open my hives unless it is warm out; 60 degrees F is an absolute minimum for me; 65 or warmer is better. Bees and brood can get sick if chilled.
  11. My hives are slanted slightly forward, they are 1" lower at the front than at the back. This causes any moisture which collects on the floor to run out instead of evaporating in the hive. I also keep a cinder block on top so that the cover cannot blow off.

  I hope this helps. I'm sorry it's not very well organized. One thing which really helped

me was a book by Mark Winston called the Biology of the Honeybee if memory serves. There is a chapter which describes their wintering habits in great detail. The book as a whole was very educational for me and provided much insight into making beekeeping decisions. It really helps to have an idea of how the bees work when you are trying to figure out what to do or what to not do.

How can I move one of my hives just a short distance from where it is currently sitting?

- **Suggestion A:** Move the hive to a new location (at night when all foragers are home). Make sure the location is say 3 or more miles away. Then another night after a week or so move the colony to the preferred location. They will re-orient and not return to the original site. It should be pretty easy to find a spot to put them temporarily -- try a relative or friend's place. This method is easy and reliable.

How can I use bees to pollinate inside my greenhouse?

- **Suggestion A:** Place a hive against the side of the greenhouse, with the entrance facing outside. Turn one of the supers around so its entrance faces into the greenhouse. Cut a hole in the plastic sheeting of the greenhouse to match up with the second super entrance. Staple the plastic back on the box so it is tight and wait.

How do you locate a wild bee colony?

- **Suggestion A:** What is done is to trap several bees off the flowers, then release one bee at a time, and track the bees back to the feral nest. You will need some bee trapping boxes. You would be surprised at how elaborate the bee catching boxes are.

Related web pages:

- APIS -- Florida Extension Beekeeping Newsletter
- B Eye see the world through the eyes of a honeybee
- Bee Alert using bees to assess environmental hazards
- Beekeeping: The Beekeeper's Home Page Beekeeping, the honey bee, and honey production are shown with news updated monthly; lots of photos; notices of meetings. Canadian and North American content.
- Bees and Pollination: USDA-ARS Carl Hayden Bee Research Center GEARS
- British Isles Bee Breeders Association
- E.H. Thorne (Beehives) Ltd. Wragby, Lincoln, UK
- The Pollination Scene practical pollination tips and info

- The Pollination Home Page Aids fruit and vegetable growers and beekeepers to manage pollination for better crops.

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- American Bee Journal, Hamilton Illinois, 62341, United States of America. price per annum: $US 23.12

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Raising Bumble Bees

Frequently Asked Questions Other Information Sources Return to Bees & Beekeeping

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Why would I want to raise bumble bees?

Due to mite infestations, most of the wild bee hives in the United States have died off. Unless you are fortunate enough to have a commercial beekeeper operating hives near you, you may not get your plants pollinated. Bumble bees do perform pollination, and seem to be unaffected by the mites infesting bee hives.

About bumble bees

Bumble bees are big, fuzzy insects recognized by almost everyone by their robust shape and black and yellow coloration. The common species are 3/4 inch in length or more. Like honey bees, bumble bees live in a colony where the adults care for the young (larvae) produced by a single queen. Bumble bee nests are small compared to honey bees, as each nest contains only a few hundred individuals. Also unlike honey bees, a bumble bee nest is annual and is used only one year and then abandoned.

Bumble bees usually nest in the ground in a deserted mouse nest or bird nest. Occasionally they nest in cavities within a wall or even in the clothes drier vent.

In the spring, the queen selects a nest site and starts the colony by lining an existing cavity with dry grass or moss. Then she collects a mass of pollen and moistens this with nectar to produce a stored food called "bee bread." Her first brood of offspring, numbering 5 to 20, will all be workers (daughters) who take over the colony responsibilities of nest enlargement, food gathering and storage, and feeding and caring for the larvae. The queen continues to lay eggs throughout the summer. By late summer, reproductive males and females are produced. These mate on the wing and the fertilized females move to hibernation sites in the shelter of loose bark, hollow trees or other dry, protected places to lie

dormant through the winter. The males and workers still in the colony die with frost or the first hard freeze.

Along with the honey bees, bumble bees are very important pollinators of flowers. Certain plants are better pollinated by bumble bees because of their very long tongues.

If the vicinity of a bumble bee nest can be avoided, then leaving them alone and waiting for them to die in the fall would be the preferred "management" option. However, bumble bee nests are often found in yards, flowers beds, wood piles, or walls in high traffic places where the threat of being stung is great.

Trapping bumble bees is not practical and exclusion techniques may not solve the problem. When controlling bumble bees is necessary, using insecticides to poison bee colonies is the control method of choice.

Bumble bees, honey bees and yellowjackets are all controlled the same way. After determining the nest location and nest entrance during the day, wait until night to treat if possible. Wear long-sleeved shirt and trousers and tie sleeves and pants legs shut or pull your socks out over your pant cuffs.

Apply insecticide through the entrance hole. Dust formulations of insecticides are preferred (e.g., Sevin dust). Use a duster or "fling" insecticide into the hole off an old plastic spoon. Sprays and ready-to-use "wasp and hornet" aerosol sprays can also be used, but often with less satisfactory results.

Do not plug the entrance hole until all activity has stopped. Be prepared to repeat the treatment if necessary. Finally, seal shut, caulk and paint all openings in the vicinity of the old entrance.

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What Are They?

Orchard mason bees are native North American bees. They live all across the United States and Southern Canada, but are particularly common in the Pacific Northwest, especially in the Puget Sound area and western Cascade Mountains. They are also called "blue orchard bees" and scientists know them as *Osmia lignaria*. They are beautiful insects, about 1/3 inch long and blue black with a metallic sheen. Unfortunately, they are sometimes mistaken for large flies (look closely - they have 2 pairs of wings and are not interested in garbage!). The females are somewhat larger than the males and the males have a white hairy face. Like all bees, mason bees collect flower pollen as a protein source for their young and get their energy from flower nectar. In shopping for groceries, they carry pollen from flower to flower, achieving pollination.

A number of things set mason bees apart from other bees:

- **Solitary:** They are solitary. Each female bee builds a nest by herself, lays eggs, seals the nest, and goes about her business. She receives no help from other bees, so there is no colony or "hive" as in honey bees or bumble bees.
- **Live Together:** Mason bees are attracted to each other. They like to build their nests in aggregations.
- **Safe:** As with other solitary bees, mason bees are gentle and shy. They have a stinger (actually it is an egg guide), but they use it only when they are in serious danger, as when they are purposely caught in the hand. They do not attack to defend their nest or arouse each other in alarm.
- **Specialized Pollinators:** Mason bees prefer to forage on flowers in the apple family, including many varieties of apples, cherries, plums, peaches, and similar "stone fruits". Because they

specialize on these plants, they are exceptionally good pollinators of them. They will forage on other flowers as well.

- **Hard Working:** Orchard mason bees are adapted to a cool climate and can fly in chilly, even drizzly weather. Thus, they are often busy pollinating when honey bees remain inside the hive.
- **Build With Bricks:** Like the wisest little pig, orchard mason bees build their nests with bricks (sort of). Each egg chamber in the nest is sealed with a partition of ordinary mud. The entire nest is also sealed with a hardened mud capping. This is why they are called "mason" bees.

The above features make orchard mason bees the *perfect pollinator* for those who have a small number of fruit trees, but may not want to manage honey bee hives. They are also a *fascinating* wild creature that can be easily encouraged to colonize the backyard garden environment, to the benefit of the gardener, orchardist, homeowner, and nature lover. Mason bees are *totally safe*, even around children and pets.

Keeping

Female mason bees make their nests in hollow cavities. In nature, these are found in the fissured bark of trees or in the emergence holes of tree-eating grubs. Mason bees can be attracted to you yard. They may already be in your neighborhood, especially if you live in the Puget Sound region. To make mason bees a part of your home life, simply provide them with nest holes and make sure they have plenty of flowers to feed on. The ideal nest hole is 5/16 to 11/32 inches in diameter and 4 to 8 inches deep. The bees will nest in a wide variety of such cavities. Straws and holes drilled in boards are commonly used. But to produce happy and healthy bees and to avoid disease build-up, you should give the bees quality housing.

Problems

Orchard mason bees have problems, just like all creatures. They have certain requirements in nest placement, preferring a warm, dry situation. They must have adequate flowers to raise their brood. And finally, they are subject to diseases, parasites, and predators. These include fungal diseases of the developing bees, various types of mites, which compete with the larval bees for foodor parasitize them, and predatory insects or larger predatory animals like woodpeckers. The most serious of these problems are the diseases and parasites.

Straw Systems

Bare wood holes are acceptable to mason bees, but over time the become fouled with debris and germs. If not cleaned, the hole loses its attractiveness as a subsequent nest cavity. Mason bees tend to "go away" from such nest blocks after the first year or two. Diseases and parasites may build up in unhygenic nest blocks. The best nest system for orchard bees is a smooth wood hole with a porous insert or liner (straw) which can be replaced each season.

The concept of straw inserts was developed by USDA scientists in studying mason bees. With a straw system, the filled nests can be removed in the fall, and replaced with new inserts in the spring. The new bees in the nests can be safely stored in a cool environment until it is time for them to begin the nesting cycle and pollinate. Then, simply place the nests near the nest blocks and allow the bees to emerge and re-nest in the new inserts.

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Forage Crops

Return to the Small Farm Resource

- Alfalfa
- Birdsfoot Trefoil
- Brassica Crops
- Chicory
- Field Corn
- Hay
- Kentucky Bluegrass
- Orchardgrass
- Prairie Grass
- Red Clover
- Reed Canarygrass
- Ryegrass
- Sorghum & Sudangrass
- Smooth Bromegrass
- Tall Fescue
- Timothy
- Warm Season Grasses
- White Clover

If you have a question, we will post the question in the appropriate contents page to get suggestions from our site visitors.

Questions and suggestions can be sent to us via our Feedback form.

Visitor Questions:

Go to Other Crops

Go to Orchard/Fruit Crops

General crops related links and mailing lists

Growing Alfalfa

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Alfalfa Establishment

Seed alfalfa or alfalfa-grass mixtures only on well-drained soils. Seeding alfalfa following old alfalfa stands is not recommended, as this practice has led to stand establishment problems, which are thought to result in part from insect and disease buildup.

Alfalfa or alfalfa-grass mixtures may be seeded using conventional seeding equipment such as a cultipacker seeder or grain drill on a firm, well- prepared seedbed; or they may be seeded directly into corn stalk or small grain stubble using a special no-till seeder. No-till establishment requires special attention to weed and insect control, but if properly done it results in excellent stands with little or no soil losses. Plant as soon as a good seedbed can be prepared in spring or, for a mid- to late-summer seeding, in early- to mid-August. Late summer seedings need at least 8 weeks of growth before the first killing frost.

Band seeding no deeper than .25 inch is an excellent method of seeding. When band seeding or when using the no-till seeder, you may reduce recommended alfalfa seeding rates by one-third. Press wheels used in conjunction with conventional band seeding provide additional stand insurance. To ensure a firm seedbed, if seedbed is dry and press wheels are not used, cultipack before and after seeding in the same direction as band seeding. If annual crops such as oats or peas and triticale are used as a nurse crop, reduce the seeding rate of the companion crop by 30%, and harvest when the small grain is in the boot or early heading stage for silage, hay, or greenchop. Do not apply additional nitrogen for the nurse crop.

Fluid seeding-distributing seed in a carrier of water or fertilizer solution- is a new technique generally limited to forage legumes. Because fluid seeding requires special equipment for good seed suspension and distribution, custom application is recommended. Fluid seeding is a broadcast method, so for best results prepare the seedbed as

in conventional seeding and cultipack after seeding.

Seeding rates necessary for successful stands are related to the condition of the seedbed and method of seeding.

Use preinoculated seed or treat seed with proper inoculant. If seed is preinoculated, look for the expiration date on the tag to see if reinoculation is necessary. This may occur if seed is not used soon after purchase or stored improperly.

Seed already treated with Apron (metalaxyl) fungicide is available to give protection against Phytophthora and Pythium. These fungal diseases can cause serious establishment problems in poorly drained fields or following extended periods of heavy rainfall. Apron fungicide is also available for self-treatment of seeds. The fungicide Ridomil is also available for soil application to protect against these same diseases.

Alfalfa Hay Harvest Management

Seeding Year - When alfalfa is spring seeded, the first cutting can be made 60 days after emergence if one cutting during the seeding year is allowed to reach early bloom before it is harvested. Normally up to two to three harvests may be made in the year of a spring seeding, depending on the length of the growing season.

Established Stands - Cutting management is an important tool in achieving high quality, high yields, and stand persistence. It also can be effective in reducing the impact of weed, insect, and disease pests. Harvest schedules depend somewhat on the quality goals of the producer. Progressive dairy farmers have recognized the economic importance of producing high-quality forage and often cut early in order to obtain greater than 20% crude protein, less than 30% acid detergent fiber, and less than 40% neutral detergent fiber. Such high-quality forage has the potential to increase forage dry matter intake and milk production while decreasing the requirement for grain.

For high-quality alfalfa, make the first cutting at mid- to full bud stage, so long as:

1. Better adapted varieties with multiple pest resistance are used.
2. Adequate levels of lime, phosphorus, and potassium are maintained.
3. Insect pests are monitored and controlled.

Cutting pre- or early bud alfalfa is not recommended because there is a higher risk of losing the stand. Also, fiber levels may be undesirably low when cut extremely early. If an alfalfa stand has been weakened by winter stress, make the first cutting at the early- to midbloom stage.

Generally, summer cuttings are permitted to reach early bloom

(approximately 35 days between cuttings). In Pennsylvania, the average cutting intervals between first and second cuts and second and third cuts, for producers who make four or more cuts per year, is 37 and 33 days, respectively.

In the past, it has been recommended that producers avoid cutting alfalfa during the critical 6-week period prior to the average hard frost date (generally between early September and mid-October). This should still be considered if the stand is weak due to such factors as low soil fertility, disease, or extreme climatic conditions (such as water-saturated soils). However, it has more recently been recognized that alfalfa can be cut even during this critical period as long as:

1. Better adapted varieties with multiple pest resistant are used.
2. Adequate levels of lime, phosphorus, and potassium are maintained.
3. There are at least 45 days of regrowth prior to cutting.

If harvests are delayed until mid-October, leave a 4- to 6-inch stubble to protect the crown and to catch snow for added insulation over winter.

Harvest schedules for alfalfa-grass mixtures should be based on the growth stage of the alfalfa as it relates to the species of grass used in the mix. Because orchardgrass, perennial ryegrass, reed canarygrass, and tall fescue can tolerate more frequent cuttings without jeopardizing the grass stand, they are more compatible with frequently cut alfalfa. Stands of timothy or smooth bromegrass mixed with alfalfa should not be cut until the grass is in the early head-emergence stage, and cannot tolerate frequently cut alfalfa; therefore, they are more compatible with less intensely managed alfalfa (three cuts or less per year).

Alfalfa Grazing Management

Rotational grazing is a "must" for optimum returns in an alfalfa or alfalfa-grass grazing system. Rotational grazing is more labor intensive than continuous grazing because of the need to provide and maintain electric fencing and to move animals from one paddock to another on a carefully planned and executed schedule. Care also must be given to avoid damaging the alfalfa stand, because comparatively high numbers of animals graze on a relatively small area of alfalfa. However, the rewards can offset the extra effort.

There is no set rule on number of paddocks required or on paddock size. Most recommendations call for fields to be divided into a minimum of six to eight paddocks for most effective management. Paddock size depends on the number and size of animals being grazed. However, there should be enough animals in a paddock to harvest the available forage in less than four days.

As an example of a rotational grazing practice, a recent demonstration successfully grazing 24-beef cattle on a four-acre alfalfa plot. The field was subdivided into eight half-acre paddocks. After four days grazing on each paddock, the cattle were rotated. After all eight paddocks had been grazed, cattle were returned to the first paddock, which had recovered and was ready for another round of grazing.

Determining the number of animals that each acre of alfalfa will support in a grazing system is a difficult process. The number of animals per acre can be increased as alfalfa becomes more productive beyond the first year of stand life and as the management skills of the farm operator improve. A conservative suggested is 2 to 3 dairy cows or 3 to 5 stockers per acre during the early part of the grazing season.

The number of animals per acre is normally reduced when alfalfa production declines, such as during the typical mid-summer slump period. It is very important to closely monitor grazing to prevent overgrazing. Overgrazing can force animals to consume more supplement, if one is supplied, increasing production costs. Overgrazing also may force animals to eat the basal stems which are not very nutritious, thus limiting animal gain. Severe overgrazing also could damage the crowns of the alfalfa plants.

Undergrazing, on the other hand, can lead to uneven grazing. When unevenly grazed, the remaining plants become larger and less palatable. When the field is grazed again, the animals once more will favor the young tender plants. This in effect reduces the productive acreage unless the older, larger plants are clipped periodically.

One or more "sacrifice" paddocks also enhance a grazing program where alfalfa is the main forage. A sacrifice paddock is an area, preferably with grass sod, that can be used to hold animals during wet weather or to allow adequate regrowth of the alfalfa paddocks. Hay may be fed in sacrifice paddocks to keep pasture growing at an optimum rate.

Alfalfa Fertility

Before Planting -Information on adjusting soil nutrient levels before seeding is available.

During Establishment - Have a soil test taken to determine lime and fertilizer needs for alfalfa establishment. Fields to be seeded to alfalfa should be limed to pH 6.5 to 7.0. Needed lime should be applied at least 6 months to a year before seeding to allow the lime time to react with the soil and minimize triazine herbicide carryover. For maximum

production, seed only in soils that are already at a pH of 6.2. Generally, for soils below this pH, lime should be applied but seeding delayed. Starter fertilizer applications of up to 20-60-20 per acre are desirable at seeding time. Band placement is highly recommended. Plant nutrients recommended in excess of this amount should be incorporated into the seedbed before seeding. If soil test recommendations are followed at planting, additional applications of fertilizer in the fall of the seeding year are not necessary.

Established Stands - High levels of phosphorus and potassium must be maintained in the soil for high crop yields and long-lived alfalfa stands. Determine lime and fertilizer needs by soil test. High alfalfa yields can reduce plant nutrient levels in soil rapidly. Thus, for top production and stand persistence, annual soil testing is recommended.

When a soil test indicates the need for fertilizer, topdress after first and/or last cutting. Split applications, one-half in fall and one-half after first cutting, may result in more efficient use of fertilizer, especially potash. Recent research suggests that, based on nutrient removal, a 0-1-4 ratio of N-P2O5-K20 is best when high yields are anticipated. If the soil test is 1 part per million (ppm) or less of boron (B), or plant tissue has 25 ppm or less B, then topdress with a fertilizer containing at least 2 pounds of B per acre.

At present, there is no evidence to indicate a general need for other fertilizer nutrients. Recent research does suggest that in certain isolated cases small responses from sulfur may be obtained.

Managing Weeds in Legumes

Managing weeds in forages requires a different approach than weed management in row crops. Over 95% of the weed control in a healthy forage crop comes from the competition provided by the forage. However, to maintain a relatively weed-free forage, proper fertilization, cutting management, insect control, the use of disease-resistant varieties, and selective herbicide use are necessary to keep the forage stand competitive.

If weeds become a problem, they can compete or interfere for light, nutrients, water, and space, directly influencing yield and standability. Common chickweed infestations in alfalfa have been reported to reduce forage stand by more than 30%. Common chickweed emerges in the fall and winter and early in spring develops a thick lush mat that can compete with the first forage cutting. Once the chickweed dies in early summer, summer annual weeds such as foxtails, lambsquarters, and pigweed or perennial weeds such as dandelion can replace the dead or dying winter annual weeds and continue to reduce forage yield and quality.

Unlike most grain or fiber crops from which weeds are separated at harvest, weeds are often harvested along with the forage crop, potentially reducing quality. Reductions in quality are often in the form of lower protein content and feed digestibility. Although weeds do have some feed value, this value differs among species. Dandelions come close to equaling alfalfa in protein and total digestible nutrients (TDN). Control of dandelion may not necessarily improve the quality of hay, but it may be of some value in reducing the time necessary to dry the hay, since dandelion dries more slowly than alfalfa. Increased drying time may mean greater harvest losses due to untimely rainfall.

Grassy weed quality can be similar to that of the forage. In general, weedy grasses have about 75% of the quality of alfalfa. However, controlling quackgrass in alfalfa can increase forage protein levels 4% to 7%. Weeds with woody stems or flower stalks, such as yellow rocket, white cockle, rough fleabane, curly dock, and broadleaved dock, have lower protein levels (about 50% of the quality of alfalfa), so controlling them is even more important.

When weeds are present or persist in spite of good management, herbicides can help improve yield and quality. Weed control at establishment or in the seedling year is most critical for maintaining a healthy forage stand. When weeds are controlled the seedling year, the forage crop seldom requires additional herbicide treatments for at least the first two years of the stand.

Weed management in forages can be divided into two phases: control in the establishment or seedling year and control in an established stand.

Control before and during establishment

Managing weeds in forages begins long before crop establishment. Certain types of weeds are potentially serious problems for forages, so it is important to eliminate them in advance. In particular, perennial broadleafs and grasses such as dandelion, curly dock, Canada thistle, and quackgrass are much easier to manage prior to planting a forage crop. In addition, biennial weeds including musk thistle and burdock should be eliminated before establishing forage. If these weeds are not removed before the seeding is made, they commonly persist throughout the life of the forage. The cost of controlling weeds before or at the time of seeding should be considered an investment that will be returned for the life of the stand.

Below are some general rules for managing weeds at establishment or in the seedling year:

1. Weeds that emerge with the crop are generally more destructive.
2. Maintain the forage relatively weed-free for the first 60 days.
3. Weeds that emerge beyond 60 days will not influence that year's

forage yield.

4. Later-emerging weeds may still influence forage quality.
5. Winter annual weed competition in early spring is most damaging to forages.
6. Broadleaved or dicotyledonous weeds are generally more competitive against legumes than grassy weeds.

Herbicides are needed most often during establishment, and several options exist for managing weeds in pure legume seedings. In no-till seedings, adequately controlling the existing vegetation is very important, especially perennials. Weed control is also very important while the forage is young and prone to competition from invading species.

Control in an established stand

The best weed control in an established forage stand is achieved by maintaining a dense healthy stand through proper fertilization, cutting management, and insect control. Controlling weeds in established forages is normally of greatest benefit in the first cutting. Weeds generally contribute much less to yield in the second and succeeding harvests. Before using a herbicide in established stands, evaluate the forage to ensure it is worth the cost of the herbicide.

Below are some general rules to follow before using a herbicide in established forage stands:

1. Thin or irregular stands will not thicken once weeds are removed. Be sure there are sufficient desirable species to fill in the gaps. A minimum of five alfalfa plants per square foot should be present.
2. Weeds tolerant of the herbicide may invade the space left by susceptible species, ultimately creating a more severe weed problem.
3. Only well-established vigorous stands should be treated with herbicides.
4. If the forage stand is at least two years old and 25% to 30% are weeds, removing them with an herbicide application is of questionable value.
5. If 50% or greater of the stand are weeds, it is time to rotate to a different crop.

If weeds become a problem in established forages, several herbicide options are available. Chemical control in established forage legumes is often limited to late fall or early spring applications. Also, many products have harvesting, feeding, or grazing restrictions following their use.

Managing Legume Insects

Management of forage insect pests is aimed primarily at the alfalfa weevil and the potato leafhopper in alfalfa. Other insect pests of forages are minor in comparison and must be dealt with on a field-by-field basis. Economic injury levels for the potato leafhopper and the alfalfa weevil are fairly well established. The economic injury level is the value of crop loss caused by the pests that is equal to the cost of a spray application. Thus, unless the value for the crop loss caused by the pests exceeds the cost of controlling them, it is not profitable to spray. On the other hand, some insect losses could have been avoided if a spray had been applied at the proper time.

A good pest management program requires proper identification of the pest species causing the damage, and determination if the economic threshold has been exceeded.

Alfalfa blotch leafminer can be found in practically all alfalfa fields in the state (Pennsylvania). However, damage will always appear worse than it actually is. The second cutting is usually most severely infested. Control may be justifiable if 30% or more of the leaflets have a mine present.

The adult fly is about .13 inch long and resembles a common housefly. The larvae (maggots) are pale yellow, soft-bodied, shortened, and thickened. At least three generations per year occur in Pennsylvania. Adult females emerge in the spring, cut shallow holes through the lower leaf surface, and deposit eggs under the leaf epidermis. A female lays one to three eggs per leaflet. To feed, the female cuts a hole in the leaf with her oviposter and laps up exposed sap and tissue, forming conspicuous pinholes in the leaves. After the eggs hatch, the larvae tunnel within the leaf, feeding on leaf tissue. The larval stage lasts approximately two weeks. Larval mining causes conspicuous white blotches on the leaflets, which are typically comma-shaped. Blotches and punctures can cause deterioration of foliage quality, loss of photosynthetic area, and defoliation.

Alfalfa weevil is primarily a problem in the first cutting of alfalfa in April and May. Larvae feed within the growing tips, on the upper leaves as they open, and later on the lower leaves. Plants become skeletonized from weevil feeding and the leaves dry, giving the field a frosted appearance. After cutting, the larvae may feed on the new emerging shoots, severely retarding alfalfa regrowth. Adults also feed on the alfalfa plant. Conditions that favor pest development are excessive pesticide use (which destroys biological control agents), mild winters, and warm dry spring weather. Several species of parasitic wasp and a fungus help maintain alfalfa weevil populations.

Black cutworms can cause extensive damage to new seedings in late

May early June.

Pea aphid control is sometimes needed, but natural controls are usually all that is needed to keep aphid populations in check. Control may be warranted if populations reach 30 aphids per sweep of an insect net.

Pea aphids are small, green, long-legged insects about .19 inch long. They can be winged or wingless. Like other aphids, the pea aphid damages the plant by removing sap with its sucking mouth parts and possibly by poisoning the plant.

The insect overwinters on alfalfa, clovers, and other perennial plants in either the egg stage or as adult females. In the spring, populations increase on the winter host and begin migrating to other hosts about May 1. Winged females start colonies on new plants by giving birth to live young, which are ready to reproduce in 12 days. A female commonly produces 6 to 7 young per day. There are 7 to 20 generations per year. Pea aphids may be found in forage fields during June and July.

Potato leafhoppers are the most destructive insect pest on new seedings of alfalfa in the state. Stress to alfalfa seedlings caused by this pest can affect the vigor and later performance of the plants and influence stand longevity. New spring seedings are especially vulnerable to attack by leafhoppers. Regrowth of second and third cuttings of established stands is also frequently damaged.

It is essential to use sound control measures for this pest on new seedings in order to obtain optimum stands, yields, and quality. In most years, leafhopper populations are high enough in some fields to cause appreciable losses to newly established stands.

There are several ways to reduce leafhopper damage to the first cutting of new seedings:

1. leafhopper populations can be monitored by periodical sweepings and applying an insecticide accordingly;
2. Furadan (carbofuran) 4F can be broadcast and incorporated prior to seeding;
3. Lorsban (Chloropyrifos) 4E can be broadcast and incorporated prior to seeding. Furadan 4F may be used at seeding time by mixing 2 to 4 pints of Furadan 4F in 15 to 40 gallons of water and spraying on the soil surface; then incorporating. If a herbicide is being used, mix it with Furadan 4F and apply both materials in the same operation. Lorsban 4E can be broadcast and incorporated prior to seeding.

At the time alfalfa is typically seeded in the spring there are no insect pests that will influence yield, with the possible exception of cutworms. Clover root curculio do not lay eggs in spring-seeded alfalfa, because they have already moved into established stands when new seedings are

seeded. The same is true of alfalfa weevil, which migrate into established stands to lay their eggs in late March and early April. Furadan and Lorsban cannot be expected to provide adequate leafhopper control on alfalfa seeded before early May.

The effects of Furadan and Lorsban will not last much longer than 45 to 50 days; therefore, their effectiveness will be minimal by the time the leafhoppers arrive, usually in early June. Even when Furadan or Lorsban is used at planting, spray protection may still be needed before harvest, depending on the buildup of leafhoppers in the field.

Regrowth after the first cut must be monitored closely for insects, starting when the regrowth is 2 to 3 inches tall.

Currently, the only control method for potato leafhoppers on seedling alfalfa established in spring grains such as oats is malathion. However, this compound has a very short residual and application requires driving over the alfalfa and small grain.

Leafhopper populations often vary considerably from one field to the next. For this reason, it is advisable to make leafhopper checks with an insect net in each alfalfa field. Start checking new seedings in early June, and check the regrowth of established stands when the plants are about 3 inches high. Adult potato leafhoppers are yellowish green and about .13 inch long and .03 inch wide. The nymphs are similar in appearance but lack wings. Damaging populations may be more likely when temperatures are between 70 and 90 degrees F, harvest is delayed, or alfalfa is strip-cut or cut in blocks.

Meadow spittlebug damage is most likely on legumes seeded in small-grain stubble. Spray applications are not profitable unless there are one or more spittle masses per stem by mid-May.

The adult spittlebug is .25 to .38 inch long and resembles a frog; its head is short and blunt with large eyes. Adults vary in color and marking, ranging form light grey to dark brown, with spots, strips, or bands on the wing covers. Adults walk with their front four legs and drag their back legs. The nymphal stage is found within the frothy spittle mass that they secrete. They are about .03 inch long and orange. As they develop, they become greenish yellow and then green.

Eggs are laid during August and September in small-grain stubble, alfalfa, or weeds where they overwinter. They begin to hatch during April in Pennsylvania. The nymphal stage lasts approximately 5 to 8 weeks. Adults appear in late May and early June to lay the next year's eggs.

Managing Legume Diseases

The following management practices will help minimize disease losses in alfalfa. Most of these recommendations apply to other legumes as well.

1. Use the best-adapted, disease-resistant varieties.
2. Do not plant alfalfa in fields that are poorly drained. Red clover, birdsfoot trefoil, or a grass is a better choice. In fields that are moderate to poorly drained, Phytophthora-resistant varieties should be used along with a fungicide seed or soil treatment.
3. Use a cereal, corn, or grass crop for at least 2 years in rotation with alfalfa.
4. Keep soil pH, phosphorus, and potassium at optimal levels for crop growth.
5. Control leafhoppers, as they interact with diseases.
6. Clean all equipment of plant debris before storing for the winter, as some pathogens that do not survive well in the field survive well on equipment under shelter.
7. Mow youngest stands first. This reduces the spread of pathogens by machinery from older, more diseased stands into healthier, younger stands. Mow after the dew has dried, as pathogens are easily spread in water films.
8. Mow a few days earlier than usual when stands are hit hard by leaf spots, in order to retain more leaves and reduce inoculum in the field.
9. Maintain a cutting schedule that ensures the recharging of root carbohydrates both during the growing season and prior to fall dormancy.

Wilt diseases can cause severe stand losses in Pennsylvania. Bacterial, Fusarium, and Verticillium wilts occur statewide, with Fusarium wilt worse in the southern counties and Verticillium wilt worse in the northern counties. Resistance to all these wilts is available in current varieties and is needed to obtain maximum production.

Anthracnose is a fungus disease that occurs statewide and is particularly severe in southeastern Pennsylvania. The causal fungus often cannot overwinter in the field, but it does so in infected plant debris on equipment in storage. Therefore, cleaning equipment before storing for the winter helps delay the introduction of this pathogen into young seedlings in spring. Resistant varieties are available and should be used statewide.

Phytophthora root rot can devastate young stands of alfalfa and can cause serious plant loss in older stands. Soils saturated with water for three or more days can trigger a disease outbreak. In perennially wet sites, the use of alternative crops is recommended. The use of resistant varieties, seed treatment with Apron fungicide, or soil treatment with

Ridomil fungicide are effective control measures.

Crown and root rot complex, caused by Fusarium spp. plus other fungi and bacteria, is common in alfalfa. Resistant varieties are not available; therefore, growers must depend on proper crop management practices to minimize stress on the plants, which slows down the rate of root rot development. Root-rotting fungi "team up" with root-feeding insects, and root deterioration progresses with increasing stand age.

Aphanomyces root rot is a new disease that is causing establishment problems in other areas. As yet, no outbreaks of the disease have been reported in Pennsylvania, although both strains of the pathogen are known to exist in Pennsylvania soils. This disease is likely to occur under the same wet soil conditions as does Phytophthora, so it is possible that losses caused by this fungus have been occurring but have been attributed to Phytophthora. The fungicide treatments available against Pythium spp. and Phytophthora spp. are not effective against Aphanomyces spp.; however, resistance to one of the strains of the fungus is available in some newer varieties.

Foliar diseases are common in Pennsylvania throughout most of the growing season and can cause significant quality and yield loss through defoliation. When foliar diseases are severe, early mowing helps in leaf retention and reduces inoculum in the field. Some of the current varieties have improved levels of resistance, but all become diseased if favorable moisture and temperatures prevail.

Spring and summer blackstem occur in Pennsylvania, with spring blackstem usually more severe. Leaves, petioles, and stems are attacked, with the spring blackstem fungus also causing crown and root rot. As with other foliar diseases, early harvesting of severely diseased stands can increase leaf retention and reduce inoculum in the field. A few current varieties have improved levels of resistance, but all will become severely diseased if extended moist periods occur.

Nematodes generally do not cause serious problems on alfalfa in Pennsylvania, as long as rotations with corn, cereal, or grass crops are used.

Sclerotinia crown and stem blight can cause seeding failures. Late-summer or early-fall seedings using conservation tillage favor disease development. The infective stage for this disease usually occurs in October, and fall-seeded plants are very susceptible at this time. Because conservation tillage does not bury the fungus, disease severity is often much more severe than in seedings done with conventional tillage. Infected seedlings often survive until spring when the plants die and entire stands may be lost. Spring plantings, because of the plants' increased maturity in the fall, are not as likely to be devastated. Resistant varieties are not available.

Virus diseases are not considered serious on alfalfa in Pennsylvania. Viruses may be present, however, without causing obvious symptoms, and it is possible that viruses contribute to premature stand decline. No resistant varieties are available.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Alternative Agriculture: Committee of the Role of Alternative Farming Methods in Modern Production Agriculture - by National Research Council - List: $30.25 - Publication Date: September 1989
  Book News, Inc., 01/01/90:
  Eleven case studies explore how alternative farming systems have been adopted--and with what economic results--on farms of various sizes producing different crops across the country. Annotation copyright Book News, Inc. Portland, Or.

- Making Hay - by Verlyn Klinkenborg - Publication Date: October 1997 - List: $14.95
  The New York Times Book Review, Christopher Lehmann-Haupt :
  Mr. Klinkenborg has achieved a terse idiom that amounts almost to Middle Western rural poetry.... what is most admirable about Making Hay is that it memorializes a way of life we take for granted. Its language celebrates both the changes and permanence of modern farming, its earthiness and ethereality.

- Biodiversity and Wheat Improvement - by A.B. Damania (Editor) - Publication Date: March 1994 - List: $165.00
  The publisher, John Wiley & Sons :
  A multidisciplinary group of leading scientists present articles regarding research in areas crucial to the conservation, evaluation and utilization of biodiversity in wild relatives and old forms of wheat. The recommendations and conclusions will prove useful to further research on a topic which is rapidly gaining importance in the efforts to meet the growing demands for increased food production.

- Crop Production : Evolution, History, and Technology - by C. Wayne Smith - Publication Date: November 1995 - List: $71.50
  The publisher, John Wiley & Sons :
  One of the nation's leading agronomists presents an outstanding resource that deals with the agronomy of the eight major grain, fiber and oilseed row crops produced in the U.S. Each crop listed includes a structured discussion of the types of cultivars: its history, uses and processing, how to plant and grow the crop, pests and other problems and the harvesting, grading and marketing processes.

- Acid Soil and Acid Rain (Research Studies in Botany and Related Applied Fields, No. 10) - by Ivan R. Kennedy - Publication Date: May 1992 - List: $165.00
  The publisher, John Wiley & Sons :
  Examines the basic chemical processes involved in acidification in order to better assess their long-term effects on the status of soils, the health of plants and other living species that depend on them. Discusses acidity, pH and protons--their significance in bioenergetics and the consequent role of autotrophic organisms in acidifying ecosystems. The Second Edition incorporates and integrates recent findings that render more explanations of the causes of the environmental impacts of acidity, especially in forests and lakes. Also explores current research into acid rain and soil in order to devise appropriate measures for their amelioration. Features numerous case studies and a bibliography that has doubled in size.

- Australian Sodic Soils; Distribution, Properties and Management - by R. Naidu - Publication Date: 1995 - List: $120.00
  Card catalog description
  Sodic soils cover almost a third of the total land in Australia and are represented to some extent on all continents except Antarctica. They can occur naturally, as in Australia, or may

develop as a result of the removal of salts from saline soils. Sodicity impacts adversely on many soil properties and interferes with the proper functioning of the soil and of the plants grown in it. Problems arise as a result of the deterioration in soil structure, decreased retention and availability of water, decreased nutrient availability and impaired biological activity. Sodic soils are easily eroded and this causes severe land degradation and pollution of water resources. The management of sodic soils is often difficult and challenging. Because they are so widespread in Australia, their impact on productivity is immense. Australian Sodic Soils: Distribution, Properties and Management brings together for the first time the results of scientific studies carried out in Australia and presented at the first national conference on Australian sodic soils.

- Fundamentals of Soil Science - by Henry D. Foth - Publication Date: January 1991 - List: $87.95

- Reducing Soil Water Evaporation With Tillage and Straw Mulching - by S. K. Jalota, S. S. Prihar - Publication Date: October 1997 - List: $64.95

- Slash/Mulch Systems : Sustainable Methods for Tropical Agriculture - by H. David Thurston - Publication Date: January 1997 - List: $59.00

- Sustainable Dryland Farming : Combining Farmer Innovation and Medic Pasture in a Mediterranean Climate - by Lynne Chatterton, Brian Chatterton - Publication Date: March 1996 - List: $90.00

- Corn : It's Origin, Evolution and Improvement - by Paul C. Mangelsdorf - Publication Date: June 1974 - List: $33.00

- Grass Varieties in the United States - by James Alderson, W. Curtis Sharp - Publication Date: June 1995 - List: $45.00
  Booknews, Inc. , 08/01/96:
  Previously published as Agriculture Handbook, no. 170 (revised 1994), Soil Conservation Service, US Department of Agriculture. This handbook is a working guide to the status of named and experimental grasses available for use in the US. No attempt has been made to appraise the relative merits of included varieties, nor to verify the adaptation information provided by the preparer. Descriptions, with some exceptions are those reported by developers. They include brief descriptive text and

information on source, method of breeding, intended use, and sources of seed and stock and further information. Annotation c. by Book News, Inc., Portland, Or.

- Grazing Management : Science into Practice (Longman Handbooks in Agriculture) - by John G. Hodgson - Publication Date: November 1990 - List: $59.95
  The publisher, John Wiley & Sons :
  This text considers grazing management from the viewpoint of the ecology of grazing systems and focuses on the interrelationships between plant and animal populations which affect the stability of such systems, and the output of animal products from them. Relates the steps in the production process to the grassy surface characteristics that influence plant and animal behavior and uses these relationships to create a practical framework for management decisions.

- Legumes of Africa - by J.M. Lock - Publication Date: December 1989 - List: $45.00

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Alfalfa Establishment

Seed alfalfa or alfalfa-grass mixtures only on well-drained soils. Seeding alfalfa following old alfalfa stands is not recommended, as this practice has led to stand establishment problems, which are thought to result in part from insect and disease buildup.

Alfalfa or alfalfa-grass mixtures may be seeded using conventional seeding equipment such as a cultipacker seeder or grain drill on a firm, well- prepared seedbed; or they may be seeded directly into corn stalk or small grain stubble using a special no-till seeder. No-till establishment requires special attention to weed and insect control, but if properly done it results in excellent stands with little or no soil losses. Plant as soon as a good seedbed can be prepared in spring or, for a mid- to late-summer seeding, in early- to mid-August. Late summer seedings need at least 8 weeks of growth before the first killing frost.

Band seeding no deeper than .25 inch is an excellent method of seeding. When band seeding or when using the no-till seeder, you may reduce recommended alfalfa seeding rates by one-third. Press wheels used in conjunction with conventional band seeding provide additional stand insurance. To ensure a firm seedbed, if seedbed is dry and press wheels are not used, cultipack before and after seeding in the same direction as band seeding. If annual crops such as oats or peas and triticale are used as a nurse crop, reduce the seeding rate of the companion crop by 30%, and harvest when the small grain is in the boot or early heading stage for silage, hay, or greenchop. Do not apply additional nitrogen for the nurse crop.

Fluid seeding-distributing seed in a carrier of water or fertilizer solution- is a new technique generally limited to forage legumes. Because fluid seeding requires special equipment for good seed suspension and distribution, custom application is recommended. Fluid seeding is a broadcast method, so for best results prepare the seedbed as in conventional seeding and cultipack after seeding.

Seeding rates necessary for successful stands are related to the condition of the seedbed and method of seeding.

Use preinoculated seed or treat seed with proper inoculant. If seed is preinoculated, look for the expiration date on the tag to see if reinoculation is necessary. This may occur if seed is not used soon after purchase or stored improperly.

Seed already treated with Apron (metalaxyl) fungicide is available to give protection against Phytophthora and Pythium. These fungal diseases can cause serious establishment problems in poorly drained fields or following extended periods of heavy rainfall. Apron fungicide is also available for self-treatment of seeds. The fungicide Ridomil is also available for soil application to protect against these same diseases.

Alfalfa Hay Harvest Management

Seeding Year - When alfalfa is spring seeded, the first cutting can be made 60 days after emergence if one cutting during the seeding year is allowed to reach early bloom before it is harvested. Normally up to two to three harvests may be made in the year of a spring seeding, depending on the length of the growing season.

Established Stands - Cutting management is an important tool in achieving high quality, high yields, and stand persistence. It also can be effective in reducing the impact of weed, insect, and disease pests. Harvest schedules depend somewhat on the quality goals of the producer. Progressive dairy farmers have recognized the economic importance of producing high-quality forage and often cut early in order to obtain greater than 20% crude protein, less than 30% acid detergent fiber, and less than 40% neutral detergent fiber. Such high-quality forage has the potential to increase forage dry matter intake and milk production while decreasing the requirement for grain.

For high-quality alfalfa, make the first cutting at mid- to full bud stage, so long as:

1. Better adapted varieties with multiple pest resistance are used.
2. Adequate levels of lime, phosphorus, and potassium are maintained.
3. Insect pests are monitored and controlled.

Cutting pre- or early bud alfalfa is not recommended because there is a higher risk of losing the stand. Also, fiber levels may be undesirably low when cut extremely early. If an alfalfa stand has been weakened by winter stress, make the first cutting at the early- to midbloom stage.

Generally, summer cuttings are permitted to reach early bloom (approximately 35 days between cuttings). In Pennsylvania, the average cutting intervals between first and second cuts and second and third cuts, for producers who make four or more cuts per year, is 37 and 33 days, respectively.

In the past, it has been recommended that producers avoid cutting alfalfa during the critical 6-week period prior to the average hard frost date (generally between early September and mid-October). This should still be considered if the stand is weak due to such factors as low soil fertility, disease, or extreme climatic conditions (such as water-saturated soils). However, it has more recently been recognized that alfalfa can be cut even during this critical period as long as:

1. Better adapted varieties with multiple pest resistant are used.
2. Adequate levels of lime, phosphorus, and potassium are maintained.
3. There are at least 45 days of regrowth prior to cutting.

If harvests are delayed until mid-October, leave a 4- to 6-inch stubble to protect the crown and to catch snow for added insulation over winter.

Harvest schedules for alfalfa-grass mixtures should be based on the growth stage of the alfalfa as it relates to the species of grass used in the mix. Because orchardgrass, perennial ryegrass, reed canarygrass, and tall fescue can tolerate more frequent cuttings without jeopardizing the grass stand, they are more compatible with frequently cut alfalfa. Stands of timothy or smooth bromegrass mixed with alfalfa should not be cut until the grass is in the early head-emergence

stage, and cannot tolerate frequently cut alfalfa; therefore, they are more compatible with less intensely managed alfalfa (three cuts or less per year).

Alfalfa Grazing Management

Rotational grazing is a "must" for optimum returns in an alfalfa or alfalfa-grass grazing system. Rotational grazing is more labor intensive than continuous grazing because of the need to provide and maintain electric fencing and to move animals from one paddock to another on a carefully planned and executed schedule. Care also must be given to avoid damaging the alfalfa stand, because comparatively high numbers of animals graze on a relatively small area of alfalfa. However, the rewards can offset the extra effort.

There is no set rule on number of paddocks required or on paddock size. Most recommendations call for fields to be divided into a minimum of six to eight paddocks for most effective management. Paddock size depends on the number and size of animals being grazed. However, there should be enough animals in a paddock to harvest the available forage in less than four days.

As an example of a rotational grazing practice, a recent demonstration successfully grazing 24-beef cattle on a four-acre alfalfa plot. The field was subdivided into eight half-acre paddocks. After four days grazing on each paddock, the cattle were rotated. After all eight paddocks had been grazed, cattle were returned to the first paddock, which had recovered and was ready for another round of grazing.

Determining the number of animals that each acre of alfalfa will support in a grazing system is a difficult process. The number of animals per acre can be increased as alfalfa becomes more productive beyond the first year of stand life and as the management skills of the farm operator improve. A conservative suggested is 2 to 3 dairy cows or 3 to 5 stockers per acre during the early part of the grazing season.

The number of animals per acre is normally reduced when alfalfa production declines, such as during the typical mid-summer slump period. It is very important to closely monitor grazing to prevent overgrazing. Overgrazing can force animals to consume more supplement, if one is supplied, increasing production costs. Overgrazing also may force animals to eat the basal stems which are not very nutritious, thus limiting animal gain. Severe overgrazing also could damage the crowns of the alfalfa plants.

Undergrazing, on the other hand, can lead to uneven grazing. When unevenly grazed, the remaining plants become larger and less palatable. When the field is grazed again, the animals once more will favor the young tender plants. This in effect reduces the productive acreage unless the older, larger plants are clipped periodically.

One or more "sacrifice" paddocks also enhance a grazing program where alfalfa is the main forage. A sacrifice paddock is an area, preferably with grass sod, that can be used to hold animals during wet weather or to allow adequate regrowth of the alfalfa paddocks. Hay may be fed in sacrifice paddocks to keep pasture growing at an optimum rate.

Alfalfa Fertility

Before Planting -Information on adjusting soil nutrient levels before seeding is available.

During Establishment - Have a soil test taken to determine lime and fertilizer needs for alfalfa establishment. Fields to be seeded to alfalfa should be limed to pH 6.5 to 7.0. Needed lime should be applied at least 6 months to a year before seeding to allow the lime time to react with the soil and minimize triazine herbicide carryover. For maximum production, seed only in soils that are already at a pH of 6.2. Generally, for soils below this pH, lime should be applied but seeding delayed. Starter fertilizer applications of up to 20-60-20 per acre are desirable at seeding time. Band placement is highly recommended. Plant nutrients recommended in excess of this amount should be incorporated into the seedbed before seeding. If soil test recommendations are followed at planting, additional applications of fertilizer in the fall of the seeding year are not necessary.

Established Stands - High levels of phosphorus and potassium must be maintained in the soil for high crop yields and long-lived alfalfa stands. Determine lime and fertilizer needs by soil test. High alfalfa yields can reduce plant nutrient levels in soil rapidly. Thus, for top production and stand persistence, annual soil testing is recommended.

When a soil test indicates the need for fertilizer, topdress after first and/or last cutting. Split applications, one-half in fall and one-half after first cutting, may result in more efficient use of fertilizer, especially potash. Recent research suggests that, based on nutrient removal, a 0-1-4 ratio of N-P2O5-K20 is best when high yields are anticipated. If the soil test is 1 part per million (ppm) or less of boron (B), or plant tissue has 25 ppm or less B, then topdress with a fertilizer containing at least 2 pounds of B per acre.

At present, there is no evidence to indicate a general need for other fertilizer nutrients. Recent research does suggest that in certain isolated cases small responses from sulfur may be obtained.

Managing Weeds in Legumes

Managing weeds in forages requires a different approach than weed management in row crops. Over 95% of the weed control in a healthy forage crop comes from the competition provided by the forage. However, to maintain a relatively weed-free forage, proper fertilization, cutting management, insect control, the use of disease-resistant varieties, and selective herbicide use are necessary to keep the forage stand competitive.

If weeds become a problem, they can compete or interfere for light, nutrients, water, and space, directly influencing yield and standability. Common chickweed infestations in alfalfa have been reported to reduce forage stand by more than 30%. Common chickweed emerges in the fall and winter and early in spring develops a thick lush mat that can compete with the first forage cutting. Once the chickweed dies in early summer, summer annual weeds such as foxtails, lambsquarters, and pigweed or perennial weeds such as dandelion can replace the dead or dying winter annual weeds and continue to reduce forage yield and quality.

Unlike most grain or fiber crops from which weeds are separated at harvest, weeds are often

harvested along with the forage crop, potentially reducing quality. Reductions in quality are often in the form of lower protein content and feed digestibility. Although weeds do have some feed value, this value differs among species. Dandelions come close to equaling alfalfa in protein and total digestible nutrients (TDN). Control of dandelion may not necessarily improve the quality of hay, but it may be of some value in reducing the time necessary to dry the hay, since dandelion dries more slowly than alfalfa. Increased drying time may mean greater harvest losses due to untimely rainfall.

Grassy weed quality can be similar to that of the forage. In general, weedy grasses have about 75% of the quality of alfalfa. However, controlling quackgrass in alfalfa can increase forage protein levels 4% to 7%. Weeds with woody stems or flower stalks, such as yellow rocket, white cockle, rough fleabane, curly dock, and broadleaved dock, have lower protein levels (about 50% of the quality of alfalfa), so controlling them is even more important.

When weeds are present or persist in spite of good management, herbicides can help improve yield and quality. Weed control at establishment or in the seedling year is most critical for maintaining a healthy forage stand. When weeds are controlled the seedling year, the forage crop seldom requires additional herbicide treatments for at least the first two years of the stand.

Weed management in forages can be divided into two phases: control in the establishment or seedling year and control in an established stand.

Control before and during establishment

Managing weeds in forages begins long before crop establishment. Certain types of weeds are potentially serious problems for forages, so it is important to eliminate them in advance. In particular, perennial broadleafs and grasses such as dandelion, curly dock, Canada thistle, and quackgrass are much easier to manage prior to planting a forage crop. In addition, biennial weeds including musk thistle and burdock should be eliminated before establishing forage. If these weeds are not removed before the seeding is made, they commonly persist throughout the life of the forage. The cost of controlling weeds before or at the time of seeding should be considered an investment that will be returned for the life of the stand.

Below are some general rules for managing weeds at establishment or in the seedling year:

1. Weeds that emerge with the crop are generally more destructive.
2. Maintain the forage relatively weed-free for the first 60 days.
3. Weeds that emerge beyond 60 days will not influence that year's forage yield.
4. Later-emerging weeds may still influence forage quality.
5. Winter annual weed competition in early spring is most damaging to forages.
6. Broadleaved or dicotyledonous weeds are generally more competitive against legumes than grassy weeds.

Herbicides are needed most often during establishment, and several options exist for managing weeds in pure legume seedings. In no-till seedings, adequately controlling the existing vegetation is very important, especially perennials. Weed control is also very important while the forage is young and prone to competition from invading species.

Control in an established stand

The best weed control in an established forage stand is achieved by maintaining a dense healthy stand through proper fertilization, cutting management, and insect control. Controlling weeds in established forages is normally of greatest benefit in the first cutting. Weeds generally contribute much less to yield in the second and succeeding harvests. Before using a herbicide in established stands, evaluate the forage to ensure it is worth the cost of the herbicide.

Below are some general rules to follow before using a herbicide in established forage stands:

1. Thin or irregular stands will not thicken once weeds are removed. Be sure there are sufficient desirable species to fill in the gaps. A minimum of five alfalfa plants per square foot should be present.
2. Weeds tolerant of the herbicide may invade the space left by susceptible species, ultimately creating a more severe weed problem.
3. Only well-established vigorous stands should be treated with herbicides.
4. If the forage stand is at least two years old and 25% to 30% are weeds, removing them with an herbicide application is of questionable value.
5. If 50% or greater of the stand are weeds, it is time to rotate to a different crop.

If weeds become a problem in established forages, several herbicide options are available. Chemical control in established forage legumes is often limited to late fall or early spring applications. Also, many products have harvesting, feeding, or grazing restrictions following their use.

Managing Legume Insects

Management of forage insect pests is aimed primarily at the alfalfa weevil and the potato leafhopper in alfalfa. Other insect pests of forages are minor in comparison and must be dealt with on a field-by-field basis. Economic injury levels for the potato leafhopper and the alfalfa weevil are fairly well established. The economic injury level is the value of crop loss caused by the pests that is equal to the cost of a spray application. Thus, unless the value for the crop loss caused by the pests exceeds the cost of controlling them, it is not profitable to spray. On the other hand, some insect losses could have been avoided if a spray had been applied at the proper time.

A good pest management program requires proper identification of the pest species causing the damage, and determination if the economic threshold has been exceeded.

Alfalfa blotch leafminer can be found in practically all alfalfa fields in the state (Pennsylvania). However, damage will always appear worse than it actually is. The second cutting is usually most severely infested. Control may be justifiable if 30% or more of the leaflets have a mine present.

The adult fly is about .13 inch long and resembles a common housefly. The larvae (maggots) are pale yellow, soft-bodied, shortened, and thickened. At least three generations per year occur in Pennsylvania. Adult females emerge in the spring, cut shallow holes through the lower leaf surface, and deposit eggs under the leaf epidermis. A female lays one to three eggs per leaflet. To feed, the female cuts a hole in the leaf with her oviposter and laps up exposed sap and tissue,

forming conspicuous pinholes in the leaves. After the eggs hatch, the larvae tunnel within the leaf, feeding on leaf tissue. The larval stage lasts approximately two weeks. Larval mining causes conspicuous white blotches on the leaflets, which are typically comma-shaped. Blotches and punctures can cause deterioration of foliage quality, loss of photosynthetic area, and defoliation.

Alfalfa weevil is primarily a problem in the first cutting of alfalfa in April and May. Larvae feed within the growing tips, on the upper leaves as they open, and later on the lower leaves. Plants become skeletonized from weevil feeding and the leaves dry, giving the field a frosted appearance. After cutting, the larvae may feed on the new emerging shoots, severely retarding alfalfa regrowth. Adults also feed on the alfalfa plant. Conditions that favor pest development are excessive pesticide use (which destroys biological control agents), mild winters, and warm dry spring weather. Several species of parasitic wasp and a fungus help maintain alfalfa weevil populations.

Black cutworms can cause extensive damage to new seedings in late May early June.

Pea aphid control is sometimes needed, but natural controls are usually all that is needed to keep aphid populations in check. Control may be warranted if populations reach 30 aphids per sweep of an insect net.

Pea aphids are small, green, long-legged insects about .19 inch long. They can be winged or wingless. Like other aphids, the pea aphid damages the plant by removing sap with its sucking mouth parts and possibly by poisoning the plant.

The insect overwinters on alfalfa, clovers, and other perennial plants in either the egg stage or as adult females. In the spring, populations increase on the winter host and begin migrating to other hosts about May 1. Winged females start colonies on new plants by giving birth to live young, which are ready to reproduce in 12 days. A female commonly produces 6 to 7 young per day. There are 7 to 20 generations per year. Pea aphids may be found in forage fields during June and July.

Potato leafhoppers are the most destructive insect pest on new seedings of alfalfa in the state. Stress to alfalfa seedlings caused by this pest can affect the vigor and later performance of the plants and influence stand longevity. New spring seedings are especially vulnerable to attack by leafhoppers. Regrowth of second and third cuttings of established stands is also frequently damaged.

It is essential to use sound control measures for this pest on new seedings in order to obtain optimum stands, yields, and quality. In most years, leafhopper populations are high enough in some fields to cause appreciable losses to newly established stands.

There are several ways to reduce leafhopper damage to the first cutting of new seedings:

1. leafhopper populations can be monitored by periodical sweepings and applying an insecticide accordingly;
2. Furadan (carbofuran) 4F can be broadcast and incorporated prior to seeding;
3. Lorsban (Chloropyrifos) 4E can be broadcast and incorporated prior to seeding. Furadan 4F may be used at seeding time by mixing 2 to 4 pints of Furadan 4F in 15 to 40 gallons of water and spraying on the soil surface; then incorporating. If a herbicide is being used, mix it with Furadan 4F and apply both materials in the same operation. Lorsban 4E can be

broadcast and incorporated prior to seeding.

At the time alfalfa is typically seeded in the spring there are no insect pests that will influence yield, with the possible exception of cutworms. Clover root curculio do not lay eggs in spring-seeded alfalfa, because they have already moved into established stands when new seedings are seeded. The same is true of alfalfa weevil, which migrate into established stands to lay their eggs in late March and early April. Furadan and Lorsban cannot be expected to provide adequate leafhopper control on alfalfa seeded before early May.

The effects of Furadan and Lorsban will not last much longer than 45 to 50 days; therefore, their effectiveness will be minimal by the time the leafhoppers arrive, usually in early June. Even when Furadan or Lorsban is used at planting, spray protection may still be needed before harvest, depending on the buildup of leafhoppers in the field.

Regrowth after the first cut must be monitored closely for insects, starting when the regrowth is 2 to 3 inches tall.

Currently, the only control method for potato leafhoppers on seedling alfalfa established in spring grains such as oats is malathion. However, this compound has a very short residual and application requires driving over the alfalfa and small grain.

Leafhopper populations often vary considerably from one field to the next. For this reason, it is advisable to make leafhopper checks with an insect net in each alfalfa field. Start checking new seedings in early June, and check the regrowth of established stands when the plants are about 3 inches high. Adult potato leafhoppers are yellowish green and about .13 inch long and .03 inch wide. The nymphs are similar in appearance but lack wings. Damaging populations may be more likely when temperatures are between 70 and 90 degrees F, harvest is delayed, or alfalfa is strip-cut or cut in blocks.

Meadow spittlebug damage is most likely on legumes seeded in small-grain stubble. Spray applications are not profitable unless there are one or more spittle masses per stem by mid-May.

The adult spittlebug is .25 to .38 inch long and resembles a frog; its head is short and blunt with large eyes. Adults vary in color and marking, ranging form light grey to dark brown, with spots, strips, or bands on the wing covers. Adults walk with their front four legs and drag their back legs. The nymphal stage is found within the frothy spittle mass that they secrete. They are about .03 inch long and orange. As they develop, they become greenish yellow and then green.

Eggs are laid during August and September in small-grain stubble, alfalfa, or weeds where they overwinter. They begin to hatch during April in Pennsylvania. The nymphal stage lasts approximately 5 to 8 weeks. Adults appear in late May and early June to lay the next year's eggs.

Managing Legume Diseases

The following management practices will help minimize disease losses in alfalfa. Most of these recommendations apply to other legumes as well.

1. Use the best-adapted, disease-resistant varieties.
2. Do not plant alfalfa in fields that are poorly drained. Red clover, birdsfoot trefoil, or a grass

is a better choice. In fields that are moderate to poorly drained, Phytophthora-resistant varieties should be used along with a fungicide seed or soil treatment.

3. Use a cereal, corn, or grass crop for at least 2 years in rotation with alfalfa.
4. Keep soil pH, phosphorus, and potassium at optimal levels for crop growth.
5. Control leafhoppers, as they interact with diseases.
6. Clean all equipment of plant debris before storing for the winter, as some pathogens that do not survive well in the field survive well on equipment under shelter.
7. Mow youngest stands first. This reduces the spread of pathogens by machinery from older, more diseased stands into healthier, younger stands. Mow after the dew has dried, as pathogens are easily spread in water films.
8. Mow a few days earlier than usual when stands are hit hard by leaf spots, in order to retain more leaves and reduce inoculum in the field.
9. Maintain a cutting schedule that ensures the recharging of root carbohydrates both during the growing season and prior to fall dormancy.

Wilt diseases can cause severe stand losses in Pennsylvania. Bacterial, Fusarium, and Verticillium wilts occur statewide, with Fusarium wilt worse in the southern counties and Verticillium wilt worse in the northern counties. Resistance to all these wilts is available in current varieties and is needed to obtain maximum production.

Anthracnose is a fungus disease that occurs statewide and is particularly severe in southeastern Pennsylvania. The causal fungus often cannot overwinter in the field, but it does so in infected plant debris on equipment in storage. Therefore, cleaning equipment before storing for the winter helps delay the introduction of this pathogen into young seedlings in spring. Resistant varieties are available and should be used statewide.

Phytophthora root rot can devastate young stands of alfalfa and can cause serious plant loss in older stands. Soils saturated with water for three or more days can trigger a disease outbreak. In perennially wet sites, the use of alternative crops is recommended. The use of resistant varieties, seed treatment with Apron fungicide, or soil treatment with Ridomil fungicide are effective control measures.

Crown and root rot complex, caused by Fusarium spp. plus other fungi and bacteria, is common in alfalfa. Resistant varieties are not available; therefore, growers must depend on proper crop management practices to minimize stress on the plants, which slows down the rate of root rot development. Root-rotting fungi "team up" with root-feeding insects, and root deterioration progresses with increasing stand age.

Aphanomyces root rot is a new disease that is causing establishment problems in other areas. As yet, no outbreaks of the disease have been reported in Pennsylvania, although both strains of the pathogen are known to exist in Pennsylvania soils. This disease is likely to occur under the same wet soil conditions as does Phytophthora, so it is possible that losses caused by this fungus have been occurring but have been attributed to Phytophthora. The fungicide treatments available against Pythium spp. and Phytophthora spp. are not effective against Aphanomyces spp.; however, resistance to one of the strains of the fungus is available in some newer varieties.

Foliar diseases are common in Pennsylvania throughout most of the growing season and can cause significant quality and yield loss through defoliation. When foliar diseases are severe, early mowing helps in leaf retention and reduces inoculum in the field. Some of the current varieties have improved levels of resistance, but all become diseased if favorable moisture and temperatures prevail.

Spring and summer blackstem occur in Pennsylvania, with spring blackstem usually more severe. Leaves, petioles, and stems are attacked, with the spring blackstem fungus also causing crown and root rot. As with other foliar diseases, early harvesting of severely diseased stands can increase leaf retention and reduce inoculum in the field. A few current varieties have improved levels of resistance, but all will become severely diseased if extended moist periods occur.

Nematodes generally do not cause serious problems on alfalfa in Pennsylvania, as long as rotations with corn, cereal, or grass crops are used.

Sclerotinia crown and stem blight can cause seeding failures. Late- summer or early-fall seedings using conservation tillage favor disease development. The infective stage for this disease usually occurs in October, and fall-seeded plants are very susceptible at this time. Because conservation tillage does not bury the fungus, disease severity is often much more severe than in seedings done with conventional tillage. Infected seedlings often survive until spring when the plants die and entire stands may be lost. Spring plantings, because of the plants' increased maturity in the fall, are not as likely to be devastated. Resistant varieties are not available.

Virus diseases are not considered serious on alfalfa in Pennsylvania. Viruses may be present, however, without causing obvious symptoms, and it is possible that viruses contribute to premature stand decline. No resistant varieties are available.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Alternative Agriculture: Committee of the Role of Alternative Farming Methods in Modern Production Agriculture - by National Research Council - List: $30.25 - Publication Date: September 1989
  Book News, Inc., 01/01/90:
  Eleven case studies explore how alternative farming systems have been adopted--and with what economic results--on farms of various sizes producing different crops across the country. Annotation copyright Book News, Inc. Portland, Or.

- Making Hay - by Verlyn Klinkenborg - Publication Date: October 1997 - List: $14.95
  The New York Times Book Review, Christopher Lehmann-Haupt :
  Mr. Klinkenborg has achieved a terse idiom that amounts almost to Middle Western rural poetry.... what is most admirable about Making Hay is that it memorializes a way of life we take for granted. Its language celebrates both the changes and permanence of modern farming, its earthiness and ethereality.

- Biodiversity and Wheat Improvement - by A.B. Damania (Editor) - Publication Date: March 1994 - List: $165.00
  The publisher, John Wiley & Sons :
  A multidisciplinary group of leading scientists present articles regarding research in areas crucial to the conservation, evaluation and utilization of biodiversity in wild relatives and old forms of wheat. The recommendations and conclusions will prove useful to further research on a topic which is rapidly gaining importance in the efforts to meet the growing demands for increased food production.

- Crop Production : Evolution, History, and Technology - by C. Wayne Smith - Publication Date: November 1995 - List: $71.50
  The publisher, John Wiley & Sons :
  One of the nation's leading agronomists presents an outstanding resource that deals with the agronomy of the eight major grain, fiber and oilseed row crops produced in the U.S. Each crop listed includes a structured discussion of the types of cultivars: its history, uses and processing, how to plant and grow the crop, pests and other problems and the harvesting, grading and marketing processes.

- Acid Soil and Acid Rain (Research Studies in Botany and Related Applied Fields, No. 10) - by Ivan R. Kennedy - Publication Date: May 1992 - List: $165.00
  The publisher, John Wiley & Sons :
  Examines the basic chemical processes involved in acidification in order to better assess their long-term effects on the status of soils, the health of plants and other living species that depend on them. Discusses acidity, pH and protons--their significance in bioenergetics and the consequent role of autotrophic organisms in acidifying ecosystems. The Second Edition

incorporates and integrates recent findings that render more explanations of the causes of the environmental impacts of acidity, especially in forests and lakes. Also explores current research into acid rain and soil in order to devise appropriate measures for their amelioration. Features numerous case studies and a bibliography that has doubled in size.

- Australian Sodic Soils; Distribution, Properties and Management - by R. Naidu - Publication Date: 1995 - List: $120.00
  Card catalog description
  Sodic soils cover almost a third of the total land in Australia and are represented to some extent on all continents except Antarctica. They can occur naturally, as in Australia, or may develop as a result of the removal of salts from saline soils. Sodicity impacts adversely on many soil properties and interferes with the proper functioning of the soil and of the plants grown in it. Problems arise as a result of the deterioration in soil structure, decreased retention and availability of water, decreased nutrient availability and impaired biological activity. Sodic soils are easily eroded and this causes severe land degradation and pollution of water resources. The management of sodic soils is often difficult and challenging. Because they are so widespread in Australia, their impact on productivity is immense. Australian Sodic Soils: Distribution, Properties and Management brings together for the first time the results of scientific studies carried out in Australia and presented at the first national conference on Australian sodic soils.

- Fundamentals of Soil Science - by Henry D. Foth - Publication Date: January 1991 - List: $87.95

- Reducing Soil Water Evaporation With Tillage and Straw Mulching - by S. K. Jalota, S. S. Prihar - Publication Date: October 1997 - List: $64.95

- Slash/Mulch Systems : Sustainable Methods for Tropical Agriculture - by H. David Thurston - Publication Date: January 1997 - List: $59.00

- Sustainable Dryland Farming : Combining Farmer Innovation and Medic Pasture in a Mediterranean Climate - by Lynne Chatterton, Brian Chatterton - Publication Date: March 1996 - List: $90.00

- Corn : It's Origin, Evolution and Improvement - by Paul C. Mangelsdorf - Publication Date: June 1974 - List: $33.00

- Grass Varieties in the United States - by James Alderson, W. Curtis Sharp - Publication Date: June 1995 - List: $45.00
  Booknews, Inc. , 08/01/96:
  Previously published as Agriculture Handbook, no. 170 (revised 1994), Soil Conservation Service, US Department of Agriculture. This handbook is a working guide to the status of named and experimental grasses available for use in the US. No attempt has been made to appraise the relative merits of included varieties, nor to verify the adaptation information

provided by the preparer. Descriptions, with some exceptions are those reported by developers. They include brief descriptive text and information on source, method of breeding, intended use, and sources of seed and stock and further information. Annotation c. by Book News, Inc., Portland, Or.

- Grazing Management : Science into Practice (Longman Handbooks in Agriculture) - by John G. Hodgson - Publication Date: November 1990 - List: $59.95
  The publisher, John Wiley & Sons :
  This text considers grazing management from the viewpoint of the ecology of grazing systems and focuses on the interrelationships between plant and animal populations which affect the stability of such systems, and the output of animal products from them. Relates the steps in the production process to the grassy surface characteristics that influence plant and animal behavior and uses these relationships to create a practical framework for management decisions.

- Legumes of Africa - by J.M. Lock - Publication Date: December 1989 - List: $45.00

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Growing Birdsfoot Trefoil

Frequently Asked Questions Other Information Sources Return to Forage Crops

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Characteristics of Birdsfoot Trefoil

Production of high-quality forage for cattle and sheep has traditionally been difficult on marginal lands in Pennsylvania and New York. Soils with few limitations are generally sown to alfalfa. Soils with low pH, poor drainage, poor native fertility or fragipans prone to heaving are not suited to alfalfa production. Birdsfoot trefoil (Lotus corniculatus L.) is a forage legume that is more tolerant of these adverse production conditions.

Birdsfoot trefoil is a perennial legume that is adapted to production on poorly drained, low pH soils. It can reseed itself, is resistant to Phytophthora root rot and numerous alfalfa insects, responds well to fertilization and does not cause bloat in animals. These characteristics have resulted in its expanded use in the northern United States and southern Canada where production of other forage legumes is limited. Trefoil has traditionally been used in forage grazing systems. Varieties are now available that are suitable for hay production.

Trefoil stems are smaller in diameter and less rigid than alfalfa stems and may grow to a height of 18 to 20 inches. Each yellow flower (4 to 8 per stem) produces one seed pod. Seed pods are at right angles to the flower stalk and resembles a bird's foot, hence its name. Its root system consists of a tap root with numerous lateral branches predominantly located in the upper 15 inches of the soil profile.

As with other forage legumes, trefoil is most productive on fertile, well-drained soils with near neutral pH. However, it has the ability to produce relatively high yields and quality on land that is marginal for alfalfa production. Trefoil can be grown on low pH (5.5) soils and will tolerate short periods of flooding with less yield reduction than alfalfa. It can also tolerate periods of drought, which makes it suited for production on both sandy and clay soils.

In soils that are well drained and have good fertility, birdsfoot trefoil will not yield as well as alfalfa. Yields usually are 50 to 80% that of alfalfa in these soils. Therefore, the site in which trefoil is to be grown should have limitations which make alfalfa production difficult.

Adapted Birdsfoot Trefoil Varieties

About 25 varieties of birdsfoot trefoil are currently available in the United States and Canada. Birdsfoot trefoil varieties are generally characterized by growth habit into two types, Empire and European. Both types are referred to as "broadleaf" trefoils.

Empire-type birdsfoot trefoils are better adapted for use in grazing situations since they have fine stems, prostrate growth and indeterminate growth habit. The Empire types are also slower growing during establishment and regrow more slowly following harvest than the European types. Dawn and Empire are high- yielding Empire types that have performed well in Pennsylvania tests.

European-type birdsfoot trefoils are better adapted to hay production practices since they are more erect, establish faster and regrow faster after harvest. Viking, a European type trefoil, has traditionally been a high-yielding variety when produced for hay in Pennsylvania and New York. Newer varieties Fergus, Norcen and Tretana have production attributes similar to Viking, and also tend to persist better under more vigorous harvest management. This characteristic may allow three cuttings per year in some areas of Pennsylvania and New York.

Birdsfoot Trefoil Establishment

Birdsfoot trefoil requires careful management for successful establishment because of its small seed size and poor seedling vigor. Before seeding, trefoil seed should be inoculated with Rhizobium lupini bacteria, which are specific for birdsfoot trefoil. This will ensure sufficient nodulation of the root system and adequate atmospheric nitrogen fixation.

The small seed of trefoil necessitates that the seed be placed no deeper than 1/4 inch in the soil to achieve maximum stand and yield. A smooth, firm seedbed will greatly facilitate accurate depth placement of the seed. Early spring seedings are generally more successful than late summer seedings.

Firming the soil before and after planting will improve the seeding depth and seed-to-soil contact, which improves moisture uptake by the seed and ultimately enhances germination and emergence. Seeding rates

of 8 to 10 pounds per acre are considered adequate under normal conditions.

The low seedling vigor of trefoil has brought into question the value of a companion or nurse crop when establishing this legume. Small grain companion crops reduce root development, seedling vigor, stand density and yield of trefoil. If a companion crop is used, it should be seeded in 18- inch row spacings and removed early before competition for light becomes too great and before the companion crop begins to lodge. For pure seedings of trefoil, chemical weed control is generally necessary because most weeds grow faster and are more competitive than trefoil.

Trefoil establishment on soils that have a pH less than 5.6 may result in molybdenum (Mo) deficiencies. Molybdenum is an essential nutrient for nitrogen fixation. When needed, Mo can be applied as a seed coating. This method of application should provide sufficient Mo levels for the life of the trefoil stand.

Birdsfoot Trefoil Harvest Management

When harvested as hay, the first cutting of birdsfoot trefoil should be taken at 1/10th bloom and a second cutting in mid to late August. Sufficient time for regrowth between cuttings or grazing is recommended for stand maintenance. Root reserves may not be sufficient to initiate regrowth if the trefoil plant is totally defoliated in midsummer when root reserves are low.

Trefoil is not as resistant as alfalfa to Fusarium-type diseases , therefore, individual trefoil plants will not survive as long as alfalfa. In order to maintain a stand of trefoil, a management system which allows the trefoil to reseed itself is necessary.

Heavy grazing pressure may be needed in the spring to reduce lush growth and allow trefoil to better compete in a grass mixture. Trefoil will compete under continuous grazing better than alfalfa. However, close, continuous grazing is not recommended because trefoil regrowth depends on energy supplied by top growth. Unlike alfalfa, trefoil does not maintain high levels of root reserves during the summer.

Harvesting or grazing between September 1 and the first killing frost is not recommended. This period is needed to allow root reserves to accumulate to improve winter survival and growth the following spring.

Birdsfoot trefoil quality is greater than that of alfalfa because of increased "bypass" protein and smaller stems. Loss of quality with maturity is less pronounced with trefoil than alfalfa. However, leaf loss

during hay making may be greater than alfalfa. When grazed, trefoil is more palatable than alfalfa and produces greater average daily gains and meat yield per acre for heifers and sheep. Unlike alfalfa, grazed trefoil does not cause animals to bloat.

The practice of not harvesting birdsfoot trefoil during the second half of the summer and grazing it in the fall after the first killing frost is known as stockpiling. Trefoil is well suited for stockpiling since it holds its leaves at maturity and after frosts, thus maintaining a relatively high level of quality. Stockpiling also allows root reserves to accumulate during the fall, which improves plant survival and spring growth.

Birdsfoot Trefoil Fertility

Although trefoil seedings will nodulate and fix nitrogen in soil with a pH as low as 4.5, maximum nodulation occurs at pH 6.0 to 6.5. Lime should be applied to low pH soils as recommended by a soil test.

Trefoil will produce better than alfalfa on poor soils, but its fertility requirement for high yields are similar to those for alfalfa. Fertilizer applications at establishment should be based on a soil test. In the absence of a soil test, assuming a medium- fertility soil, plow down 0-45-135 lb per acre and apply 20-60-20 lb per acre in the row at seeding (banded if possible). When fertilizer recommendation exceed this amount, the fertilizer should be incorporated into the seedbed prior to planting.

Soil testing is the best guide for determining fertilizer requirements of established stands of trefoil. When the trefoil makes up more than 30 percent of a mixed trefoil and grass stand, no N fertilizer should be needed. However, if trefoil makes up less than 30% of the mixture, up to 50 lb N per acre will be needed to meet the grass demand for N and to maximize production. Nitrogen fertilization of a trefoil stand with fertilizer N or manure will reduce the N fixing ability of trefoil and increase the competitiveness of the grass or weeds that also may be in the stand.

Birdsfoot Trefoil Summary

Birdsfoot trefoil yields less than alfalfa on well-drained, fertile soils but is superior to alfalfa on soils that have marginal fertility and production capabilities. In areas of New York and Pennsylvania where alfalfa production is not optimal, trefoil may be a viable alternative in forage production systems. Its excellent grazing potential and bloat- free characteristics are ideal for pasture. Poor seedling establishment has been a major complaint of trefoil. Careful management at seeding can reduce this problem considerably. Careful harvest or grazing

management is necessary, but when properly managed, birdsfoot trefoil will persist and remain productive for several years.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

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  Eleven case studies explore how alternative farming systems have been adopted--and with what economic results--on farms of various sizes producing different crops across the country. Annotation copyright Book News, Inc. Portland, Or.

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- Biodiversity and Wheat Improvement - by A.B. Damania

(Editor) - Publication Date: March 1994 - List: $165.00
The publisher, John Wiley & Sons :
A multidisciplinary group of leading scientists present articles regarding research in areas crucial to the conservation, evaluation and utilization of biodiversity in wild relatives and old forms of wheat. The recommendations and conclusions will prove useful to further research on a topic which is rapidly gaining importance in the efforts to meet the growing demands for increased food production.

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with the proper functioning of the soil and of the plants grown in it. Problems arise as a result of the deterioration in soil structure, decreased retention and availability of water, decreased nutrient availability and impaired biological activity. Sodic soils are easily eroded and this causes severe land degradation and pollution of water resources. The management of sodic soils is often difficult and challenging. Because they are so widespread in Australia, their impact on productivity is immense. Australian Sodic Soils: Distribution, Properties and Management brings together for the first time the results of scientific studies carried out in Australia and presented at the first national conference on Australian sodic soils.

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Previously published as Agriculture Handbook, no. 170 (revised 1994), Soil Conservation Service, US Department of Agriculture. This handbook is a working guide to the status of named and experimental grasses available for use in the US. No attempt has been made to appraise the relative merits of included varieties, nor to verify the adaptation information provided by the preparer. Descriptions, with some exceptions are those reported by developers. They include brief descriptive text and information on source, method of breeding, intended use, and sources of seed and stock and further information. Annotation c.

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Periodicals:

- None identified.

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Frequently Asked Questions:

Other Information Sources:

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Characteristics of Birdsfoot Trefoil

Production of high-quality forage for cattle and sheep has traditionally been difficult on marginal lands in Pennsylvania and New York. Soils with few limitations are generally sown to alfalfa. Soils with low pH, poor drainage, poor native fertility or fragipans prone to heaving are not suited to alfalfa production. Birdsfoot trefoil (Lotus corniculatus L.) is a forage legume that is more tolerant of these adverse production conditions.

Birdsfoot trefoil is a perennial legume that is adapted to production on poorly drained, low pH soils. It can reseed itself, is resistant to Phytophthora root rot and numerous alfalfa insects, responds well to fertilization and does not cause bloat in animals. These characteristics have resulted in its expanded use in the northern United States and southern Canada where production of other forage legumes is limited. Trefoil has traditionally been used in forage grazing systems. Varieties are now available that are suitable for hay production.

Trefoil stems are smaller in diameter and less rigid than alfalfa stems and may grow to a height of 18 to 20 inches. Each yellow flower (4 to 8 per stem) produces one seed pod. Seed pods are at right angles to the flower stalk and resembles a bird's foot, hence its name. Its root system consists of a tap root with numerous lateral branches predominantly located in the upper 15 inches of the soil profile.

As with other forage legumes, trefoil is most productive on fertile, well-drained soils with near neutral pH. However, it has the ability to produce relatively high yields and quality on land that is marginal for alfalfa production. Trefoil can be grown on low pH (5.5) soils and will tolerate short periods of flooding with less yield reduction than alfalfa. It can also tolerate periods of drought, which makes it suited for production on both sandy and clay soils.

In soils that are well drained and have good fertility, birdsfoot trefoil will not yield as well as alfalfa. Yields usually are 50 to 80% that of alfalfa in these soils. Therefore, the site in which trefoil is to be grown should have limitations which make alfalfa production difficult.

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About 25 varieties of birdsfoot trefoil are currently available in the United States and Canada. Birdsfoot trefoil varieties are generally characterized by growth habit into two types, Empire and European. Both types are referred to as "broadleaf" trefoils.

Empire-type birdsfoot trefoils are better adapted for use in grazing situations since they have fine stems, prostrate growth and indeterminate growth habit. The Empire types are also slower growing

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Birdsfoot trefoil requires careful management for successful establishment because of its small seed size and poor seedling vigor. Before seeding, trefoil seed should be inoculated with Rhizobium lupini bacteria, which are specific for birdsfoot trefoil. This will ensure sufficient nodulation of the root system and adequate atmospheric nitrogen fixation.

The small seed of trefoil necessitates that the seed be placed no deeper than 1/4 inch in the soil to achieve maximum stand and yield. A smooth, firm seedbed will greatly facilitate accurate depth placement of the seed. Early spring seedings are generally more successful than late summer seedings.

Firming the soil before and after planting will improve the seeding depth and seed-to-soil contact, which improves moisture uptake by the seed and ultimately enhances germination and emergence. Seeding rates of 8 to 10 pounds per acre are considered adequate under normal conditions.

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Heavy grazing pressure may be needed in the spring to reduce lush growth and allow trefoil to better compete in a grass mixture. Trefoil will compete under continuous grazing better than alfalfa. However, close, continuous grazing is not recommended because trefoil regrowth depends on energy supplied by top growth. Unlike alfalfa, trefoil does not maintain high levels of root reserves during the summer.

Harvesting or grazing between September 1 and the first killing frost is not recommended. This period is needed to allow root reserves to accumulate to improve winter survival and growth the following spring.

Birdsfoot trefoil quality is greater than that of alfalfa because of increased "bypass" protein and smaller stems. Loss of quality with maturity is less pronounced with trefoil than alfalfa. However, leaf loss during hay making may be greater than alfalfa. When grazed, trefoil is more palatable than alfalfa and produces greater average daily gains and meat yield per acre for heifers and sheep. Unlike alfalfa, grazed trefoil does not cause animals to bloat.

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Birdsfoot Trefoil Summary

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- None identified.

Commercial suppliers:

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Suggested references:

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Periodicals:

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Growing Brassica Crops

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Characteristics of Brassica Crops

Cool-season perennial grass and grass-legume pastures typically become less productive as the grazing season advances from June to November. Forage brassica crops such as turnip, swede, rape, and kale can be spring-seeded to supplement the perennial cool-season pastures in August and September or summer-seeded to extend the grazing season in November and December. Brassicas are annual crops which are highly productive and digestible and can be grazed 80 to 150 days after seeding, depending on the species. In addition, crude protein levels are high, varying from 15 to 25 percent in the herbage and 8 to 15 percent in the roots depending on the level of nitrogen fertilization and weather conditions.

Adapted Brassica Species & Varieties

Kale (Brassica oleracea L.)

Varieties of kale differ markedly in rate of establishment, stem development, time required to reach maturity, and in winterhardiness. The stemless type kale (e.g. Premier) has a faster rate of establishment than varieties which produce stems. Crop height of the stemless type is approximately 25 inches, whereas that of marrow stem kale is 60 inches with primary stems often 2 inches in diameter. Stemless kale attains maturity in approximately 90 days, allowing two crops/year, whereas varieties that develop stems require 150 to 180 days to attain maximum production. Premier has consistently survived winters in central Pennsylvania, whereas other varieties of kale usually are winter-killed in December.

Rape (Brassica napus L.)

Mature forage rape is one of the best crops available for fattening lambs

and flushing ewes. Rape is a multistemmed crop with fibrous roots. The stems vary in length, diameter, and in palatability to livestock. Forage yields of spring- planted rape increase until plants become physiologically mature. Growth slows or ceases at maturity and yields plateau until leaves senesce and die. Varieties differ in when this occurs, however, Rangi rape retains its leaves longer than most varieties. Generally, yields of rape varieties in Pennsylvania are maximized with two , 90-day growth periods. However, performance of Emerald and Winfred rape varieties, is best with one 180-day growth period, and yields of rape hybrids were greatest with 60 days of growth before the first harvest and a 30-day growth period before the second harvest.

Swede (Brassica napus L.)

Like turnip, swedes produce a large edible root. Yields are higher than those of turnip, but they grow slower and require 150 to 180 days to reach maximum production. Swedes usually produce a short stem (neck), but can have stems 2 1/2 feet long when grown with tall crops which shade the swede. Unfortunately, stem elongation is at the expense of root development. The variety Calder was found to be cold hardy in central Pennsylvania and thus ideal for stockpiling and late fall or early winter grazing. In general, all swede varieties are recommended for late fall grazing.

Turnip (Brassica rapa L.) or **Turnip Hybrids**

These crops grow very fast, reaching near maximum production levels in 80 to 90 days. Studies in southwestern Pennsylvania showed that turnip can accumulate dry matter in October as fast as field corn does in August. Growing "out of season" (October/November) makes turnip a valuable crop for late fall grazing.

The proportions of tops and roots varies markedly depending on variety, crop age, and planting date. Research by the USDA Pasture Laboratory showed that turnip crops can vary from 90 percent tops/10 percent roots to 15 percent tops/85 percent roots. Some hybrids have fibrous roots which will not be readily grazed by livestock. All varieties produce primarily tops during the first 45 days of growth. Sixty to 90 days after seeding, turnip varieties such as Savannah and All Top continue to produce a high proportion of tops. During the same period, other turnip varieties have nearly equal top and root production and Purple Top has a greater root than top production. The significance in the proportion of tops and roots is that the crude protein concentration (8 to 10%) of roots is approximately one-half of that in turnip tops. Therefore, greater root production tends to reduce the crude protein yield of the total crop. On the other hand, stockpiled tops appear to be more vulnerable to weather and pest damage than roots. Varieties differ in resistance to diseases, but this often is not evident until the crop is

more than 80 days of age and the plants are reaching full production.

Other Forage Brassicas

Several hybrids of brassica species are also used as forage crops, however, there is limited research information on the production and management of these hybrids. The more common hybrids include a cross between Chinese cabbage (Brassica campesteris sensulato L.) and rape (Perko), turnip (Tyfon, Buko), and swede (Wairangi).

Brassica Crop Establishment

All brassica crops require good soil drainage and a soil pH between 5.3 and 6.8 for optimum production. Good stands can be established by planting 3.5 to 4 pounds per acre of kale or rape, or 1.5 to 2 pounds per acre of swede or turnip. The higher seeding rates are recommended for spring plantings. The seeds should be planted in rows 6 to 8 inches apart and not more than one-half inch deep. However, brassica seed can also be broadcast and incorporated into tilled seedbeds by cultipacking. When preparing a tilled seedbed for brassica planting, plow the ground several weeks before planting to allow weed seeds to germinate before secondary tillage is completed to form a firm and fine seedbed that is free of weeds. In addition, the preplant incorporated herbicide, Treflan (Trifluralin), is labeled at 0.5 to 1.0 pint active ingredient per acre for control of annual grass and small seeded broadleaf weeds in brassicas.

Brassica stands can also be established by no-till planting in grass sod that is suppressed with paraquat or glyphosate herbicides. Read pesticide labels and precautions before using either of these herbicides. Ideally, the grass sod should be grazed through June with the grazing prior to brassica seeding being very close. Approximately two weeks before planting the herbicide should be applied to the grass sod. Another option for no-till establishment would be to apply a manure slurry to the sod, which will burn the sod back, and then no-till seed the brassicas seeds through the slurry. In addition to reduced erosion concerns with no-till planting, there are generally fewer insect problems than with conventionally seeded brassicas. The following recommendations will improve the chances of successful brassica establishment.

1. Attempt establishment only on well drained soils.
2. Do not seed deeper than one-half inch.
3. When seeding into a sod, suppress the sod long enough (2 to 3 weeks) to allow the brassicas to establish.
4. Apply 75 pounds of nitrogen at seeding to stimulate establishment and growth.

As previously mentioned, forage brassicas can be grown to supplement

perennial cool-season pastures in August and September or to extend the grazing season in November and December. In the first instance, brassicas would be planted in May or early June when spring rains will help assure production for August and September grazing. Turnip, rape, or stemless kale could be used for this purpose. In the second instance, swede or kale would be planted in spring, or rape, turnip and turnip hybrids would be planted in late July or early August, and growth allowed to accumulate until November or December.

Brassica Harvest Management

Brassicas can be harvested for greenchop or silage but are most frequently grazed. Grazing management is important to optimize the true potential of these crops. Strip grazing small areas of brassica at a time provides the most efficient utilization. Grazing large areas increases trampling and waste of the available forage. Rape is more easily managed for multiple grazings than are the other brassica species. Approximately 6 to 10 inches of stubble should remain after grazing rape to promote rapid regrowth. Regrowth may be grazed in as few as 4 weeks after the first grazing. Graze rape close to ground level during the final grazing.

When turnips are grazed twice, only the tops should be grazed during the first grazing. Turnip regrowth is initiated at the top of the root, so this part of the plant should not be removed until the second and final grazing when the whole plant can be consumed. Like rape, regrowth of turnips can be sufficient to graze within 4 weeks of the first grazing.

Yield and Nutritional Value

Brassica dry matter yield will depend on the production potential of the soil and environment, and the brassica species. Average yields in Pennsylvania have been 3.1 tons of dry matter per acre at 90 days after planting. Slower maturing kale and swede average over 4 tons per acre at 120 days after planting. For a grazing situation, an average carrying capacity of a good brassica stand would be approximately 1550 ewe- or 160 cow-grazing days per acre.

Dry matter digestibility generally exceeds 90 percent for all plant parts except kale stems at maturity. By comparision, dairy quality alfalfa hay is approximately 70 percent digestible. With adequate fertility, brassicas can produce equivalent amounts of digestible energy per acre as corn yielding 115 bushel per acre. Unlike perennial forage crops, the dry matter digestibility of brassicas does not decrease markedly with increasing plant maturity. This characteristic makes them ideal for stockpiling. Ruminant diets should not contain more than 75 percent brassica forage because the fiber content of brassica crops is too low for

maintenance of proper rumen activity. With their high digestibility and low fiber content, brassicas should actually be considered as "concentrates" rather than "forage" in nutritional planning for livestock. Crude protein concentration of brassicas range from 8 to 10 percent in turnip roots to 30 percent in rape leaves.

Feeding Concerns

Brassica crops can cause health disorders in grazing animals if not managed properly. The main disorders are bloat, atypical pneumonia, nitrate poisoning, hemolytic anemia (mainly with kale), hypothyroidism, and polioencephalomalacia. Researchers have discovered that these disorders can be avoided by adhering to a couple management rules:

1. Introduce grazing animals to brassica pastures slowly. Avoid abrupt changes from dried-up summer pastures to lush brassica pastures. Don't turn hungry animals that are not adapted to brassicas into a brassica pasture.
2. Brassicas should not constitute more than 75 percent of the animal's diet. Supplement with dry hay if continually grazing brassicas or allow grazing animals access to grass pastures while grazing brassicas. No-till establishment into existing sod will reduce the risk of these disorders because of grass in the brassica pasture.

Brassica Fertilization

Phosphorus and potassium soil test levels should be in the optimum range prior to planting. If the phosphorus level is below 55 pounds per acre, the application of phosphorus during brassica development may be warranted. Application under this condition tends to increase yield if nitrogen is not limiting growth. However, phosphorus applications decrease crude protein concentration of the brassica forage.

In addition to the nitrogen applied at planting, when multiple grazings are planned an additional 70 pounds should be applied between 60 and 80 days after seeding to increase yield and crude protein level of the brassica tops. Unfortunately, the nitrogen induced yield increase in turnip and swede tops causes a reduction in root yield. When seeding into a suppressed grass sward, nitrogen application tends to increase the efficacy of the suppressing herbicide and reduces the proportion of grass in the brassica-grass sward.

Brassica Pests

Once established, brassicas are very competitive with weeds. However,

precautions should be made prior to planting to reduce weed competition during brassica establishment.

Insects, such as aphids, flea beetles, and imported cabbage worms, that feed on brassicas are not consistently a problem in Pennsylvania. However, appropriate use of insecticides may be warranted if insect populations become severe.

Diseases such as bacterial soft rot of brassica roots and leaf spot are generally not a problem until the plants near maturity. Stockpiling (delaying grazing until a later date than maturity) should not be attempted in fields were brassicas have high levels of foliar disease at maturity. Research has shown yield reductions of 40 percent when disease infected brassica crops were stockpiled for 45 days. Generally, Forage Star turnip and Rangi rape are better suited for stockpiling than other varieties because of lower disease infestation. To reduce disease occurrence, brassicas should not be grown on the same field for more than two consecutive years.

Brassica Crop Summary

Brassica crops can produce high yields of highly digestible forage during periods when perennial forages have limited production. In addition, the digestibility of the forage remains high over a relatively longer period than perennial crops. Few crops offer as much potential as do brassicas to improve livestock carrying capacity from August through December. Spring-seeded brassicas can be used to supplement low producing cool-season pastures or as insurance against summer drought. Summer-seeded brassicas can extend the potential grazing season by providing forage for fall and winter grazing. These characteristics make the use of brassica crops in grazing situations very flexible and appealing to producers utilizing pastures in their livestock operation.

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Electronic mailing lists:

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Suggested references:

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Frequently Asked Questions:

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Characteristics of Brassica Crops

Cool-season perennial grass and grass-legume pastures typically become less productive as the grazing season advances from June to November. Forage brassica crops such as turnip, swede, rape, and kale can be spring-seeded to supplement the perennial cool-season pastures in August and September or summer-seeded to extend the grazing season in November and December. Brassicas are annual crops which are highly productive and digestible and can be grazed 80 to 150 days after seeding, depending on the species. In addition, crude protein levels are high, varying from 15 to 25 percent in the herbage and 8 to 15 percent in the roots depending on the level of nitrogen fertilization and weather conditions.

Adapted Brassica Species & Varieties

Kale (Brassica oleracea L.)

Varieties of kale differ markedly in rate of establishment, stem development, time required to reach maturity, and in winterhardiness. The stemless type kale (e.g. Premier) has a faster rate of establishment than varieties which produce stems. Crop height of the stemless type is approximately 25 inches, whereas that of marrow stem kale is 60 inches with primary stems often 2 inches in diameter. Stemless kale attains maturity in approximately 90 days, allowing two crops/year, whereas varieties that develop stems require 150 to 180 days to attain maximum production. Premier has consistently survived winters in central Pennsylvania, whereas other varieties of kale usually are winter-killed in December.

Rape (Brassica napus L.)

Mature forage rape is one of the best crops available for fattening lambs and flushing ewes. Rape is a multistemmed crop with fibrous roots. The stems vary in length, diameter, and in palatability to livestock. Forage yields of spring- planted rape increase until plants become physiologically mature. Growth slows or ceases at maturity and yields plateau until leaves senesce and die. Varieties differ in when this occurs, however, Rangi rape retains its leaves longer than most varieties. Generally, yields of rape varieties in Pennsylvania are maximized with two , 90-day growth periods. However, performance of Emerald and Winfred rape varieties, is best with one 180-day growth period, and yields of rape hybrids were greatest with 60 days of growth before the first harvest and a 30-day growth period before the second harvest.

Swede (Brassica napus L.)

Like turnip, swedes produce a large edible root. Yields are higher than those of turnip, but they grow slower and require 150 to 180 days to reach maximum production. Swedes usually produce a

short stem (neck), but can have stems 2 1/2 feet long when grown with tall crops which shade the swede. Unfortunately, stem elongation is at the expense of root development. The variety Calder was found to be cold hardy in central Pennsylvania and thus ideal for stockpiling and late fall or early winter grazing. In general, all swede varieties are recommended for late fall grazing.

Turnip (Brassica rapa L.) or **Turnip Hybrids**

These crops grow very fast, reaching near maximum production levels in 80 to 90 days. Studies in southwestern Pennsylvania showed that turnip can accumulate dry matter in October as fast as field corn does in August. Growing "out of season" (October/November) makes turnip a valuable crop for late fall grazing.

The proportions of tops and roots varies markedly depending on variety, crop age, and planting date. Research by the USDA Pasture Laboratory showed that turnip crops can vary from 90 percent tops/10 percent roots to 15 percent tops/85 percent roots. Some hybrids have fibrous roots which will not be readily grazed by livestock. All varieties produce primarily tops during the first 45 days of growth. Sixty to 90 days after seeding, turnip varieties such as Savannah and All Top continue to produce a high proportion of tops. During the same period, other turnip varieties have nearly equal top and root production and Purple Top has a greater root than top production. The significance in the proportion of tops and roots is that the crude protein concentration (8 to 10%) of roots is approximately one-half of that in turnip tops. Therefore, greater root production tends to reduce the crude protein yield of the total crop. On the other hand, stockpiled tops appear to be more vulnerable to weather and pest damage than roots. Varieties differ in resistance to diseases, but this often is not evident until the crop is more than 80 days of age and the plants are reaching full production.

Other Forage Brassicas

Several hybrids of brassica species are also used as forage crops, however, there is limited research information on the production and management of these hybrids. The more common hybrids include a cross between Chinese cabbage (Brassica campesteris sensulato L.) and rape (Perko), turnip (Tyfon, Buko), and swede (Wairangi).

Brassica Crop Establishment

All brassica crops require good soil drainage and a soil pH between 5.3 and 6.8 for optimum production. Good stands can be established by planting 3.5 to 4 pounds per acre of kale or rape, or 1.5 to 2 pounds per acre of swede or turnip. The higher seeding rates are recommended for spring plantings. The seeds should be planted in rows 6 to 8 inches apart and not more than one-half inch deep. However, brassica seed can also be broadcast and incorporated into tilled seedbeds by cultipacking. When preparing a tilled seedbed for brassica planting, plow the ground several weeks before planting to allow weed seeds to germinate before secondary tillage is completed to form a firm and fine seedbed that is free of weeds. In addition, the preplant incorporated herbicide, Treflan (Trifluralin), is labeled at 0.5 to 1.0 pint active ingredient per acre for control of annual grass and small seeded broadleaf weeds in brassicas.

Brassica stands can also be established by no-till planting in grass sod that is suppressed with

paraquat or glyphosate herbicides. Read pesticide labels and precautions before using either of these herbicides. Ideally, the grass sod should be grazed through June with the grazing prior to brassica seeding being very close. Approximately two weeks before planting the herbicide should be applied to the grass sod. Another option for no-till establishment would be to apply a manure slurry to the sod, which will burn the sod back, and then no-till seed the brassicas seeds through the slurry. In addition to reduced erosion concerns with no-till planting, there are generally fewer insect problems than with conventionally seeded brassicas. The following recommendations will improve the chances of successful brassica establishment.

1. Attempt establishment only on well drained soils.
2. Do not seed deeper than one-half inch.
3. When seeding into a sod, suppress the sod long enough (2 to 3 weeks) to allow the brassicas to establish.
4. Apply 75 pounds of nitrogen at seeding to stimulate establishment and growth.

As previously mentioned, forage brassicas can be grown to supplement perennial cool-season pastures in August and September or to extend the grazing season in November and December. In the first instance, brassicas would be planted in May or early June when spring rains will help assure production for August and September grazing. Turnip, rape, or stemless kale could be used for this purpose. In the second instance, swede or kale would be planted in spring, or rape, turnip and turnip hybrids would be planted in late July or early August, and growth allowed to accumulate until November or December.

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Brassicas can be harvested for greenchop or silage but are most frequently grazed. Grazing management is important to optimize the true potential of these crops. Strip grazing small areas of brassica at a time provides the most efficient utilization. Grazing large areas increases trampling and waste of the available forage. Rape is more easily managed for multiple grazings than are the other brassica species. Approximately 6 to 10 inches of stubble should remain after grazing rape to promote rapid regrowth. Regrowth may be grazed in as few as 4 weeks after the first grazing. Graze rape close to ground level during the final grazing.

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Growing Chicory

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Characteristics of Forage Chicory

Forage chicory (Cichorium intybus L) is a perennial plant that is suited to well or moderately drained soils with medium to high fertility levels and a pH of 5.5 or greater. Chicory produces leafy growth which is higher in nutritive and mineral content (if managed properly) than alfalfa or cool- season grasses. It has a relatively deep taproot which provides tolerance to drought conditions. Chicory provides both spring and summer forage with average growth rates from April through October of 50 lb per acre per day. During peak growth periods chicory produced 73 lb per acre per day. While chicory is a relatively new forage crop in the United States it has been used in other countries for over 300 years. Although it originated in Central Europe, much of the breeding for improved forage characteristics has been completed in New Zealand.

Forage chicory is a low growing rosette plant with broad leaves in the winter, very much like dandelion. With warm temperatures in the spring, it rapidly produces large numbers of leaves from the crown. In late spring, after the establishment year, a few flower stems begin to develop from the crown and will reach heights of 6 ft if ungrazed. The thick tap root of chicory can be exposed and damaged by overgrazing, excessive hoof traffic, and frost heaving.

Adapted Chicory Varieties

'Puna' is the only variety of chicory that is currently sold in the U.S. This variety was developed in New Zealand under grazing conditions and has been very productive in Pennsylvania. Other chicory varieties are being developed and evaluated in New Zealand but are not yet available in this country.

Chicory Establishment

Seeding into a Tilled Seedbed - A moist, firm seedbed is required for forage chicory, chicory-grass, or chicory-legume mixtures. Spring seedings (April 15 through June 1) of chicory have been successful in Pennsylvania. Summer seedings have been successful in New Zealand but have not been tested in Pennsylvania. If chicory is seeded in the summer, seeding should be completed by early August. Cool temperatures and shortening day lengths in the fall impede chicory stand development. Therefore, summer seedings later than recommended may not establish adequately to survive Pennsylvania winters.

Seed may be either drilled or broadcast. Drilling is preferred because it provides a more uniform depth of planting. Plant chicory seeds .25 to .5 inch deep. If chicory is to be broadcast seeded, cultipack the seedbed before and after seeding. This will ensure that the seeds are not planted too deep and that there is good seed-to- soil contact.

Seeding into an Existing Pasture - Broadcasting or no-till drilling the seed are two methods that can be used to seed chicory into existing pastures. Broadcast chicory seed onto existing pastures during the late winter or early spring when the soil freezes at night but thaws during the day. The freezing creates ice crystals which melt during the day leaving small holes in which the seeds can fall. To improve the success of this method, also called frost seeding, be certain to broadcast the seed early in the day before the soil thaws and becomes "greasy".

No-till seeding of chicory into existing pastures has been successful in Pennsylvania. However, proper management is necessary to improve potential establishment with this method. Suppression of the existing sod to reduce competition is the first step in no-till seeding of chicory. Seeding early in the spring or using a molluscide bait will reduce the potential damage associated with slug feeding on chicory seedlings. Generally, slugs hatch around May 15 (in central Pennsylvania) and seeding prior to slug hatching reduces the slug problem.

Seeding rates in mixtures- Chicory seeding rate varies with seedbed condition, method of seeding, and quality of seed. Generally, when seeding chicory alone, rates of 3 to 4 lb per acre are sufficient. When seeding in mixtures, it is advantageous to include a legume because of its nitrogen fixing capability. Germination of stored seed can decline rapidly, therefore seed should be used promptly and not stored from year to year.

No herbicides are currently registered for use with chicory either during or after establishment. Therefore it is important to select fields with little weed pressure for chicory seeding. If weeds do become a problem

during establishment, mowing can help suppress the weeds. Chicory regrows rapidly after mowing and can out-grow most weeds.

Chicory Harvest Management

Correct grazing management is essential to maximize the life (5-7 years) of the chicory stand and maintain forage quality. Spring seeded chicory can be grazed after 80 to 100 days depending on climatic conditions. Research at the USDA Pasture Laboratory found that Puna chicory can yield over 3 tons per acre during the seeding year. Chicory production is optimized under rotational grazing management. Depending on time of year, a rest period of 25 to 30 days between grazings is best for chicory persistence and performance. A stubble height of 1.5 to 2 inches should remain after grazing.

After the seeding year, chicory will grow vigorously and attempt to produce stems in the late spring and early summer. Stubble heights greater than 1.5 inches or rest period longer than 25 days can allow stems to bolt (period of rapid stem growth). Once chicory stems have bolted, the production potential of chicory will be reduced for the remainder of the grazing season or until the stems are mowed. Grazing practices which do not allow the chicory flower stems to exceed a six inch height in late May, before they are grazed, and grazing to a 1.5 inch stubble height will reduce the amount of stem bolting.

Keep stems from growing!

When strip grazing chicory, a back fence should be used so that regrowth will not be grazed and weaken the stand.

Established forage chicory stands have yield and quality potentials comparable to many other Pennsylvania forage crops. Yields of 6 ton/acre have been obtained from pure chicory stands in Pennsylvania trials. The digestibility and the mineral content of chicory leaves are greater than alfalfa. The digestibility of chicory leaves is generally between 90 and 95%. Chicory flower stems are less digestible than leaves. This is an additional reason to manage chicory pastures so that stems do not fully develop. Protein levels in chicory range from 10 to 32% depending on plant maturity.

Animal performance on forage chicory has been exceptional. In West Virginia trials, forage chicory pastures produced lamb gains of 820 lb per acre. Studies in New Zealand have reported animal gains of 0.6 lb per day for lambs and 2 lb per day for friesian bulls grazing chicory. Chicory contains relatively high levels of minerals (potassium, calcium, magnesium, sulfur, zinc, and sodium) which are essential for proper animal nutrition.

Forage Chicory Fertility

Fertility needs at seeding should be determined by soil test. Chicory will remain productive at soil pH levels of 4.5, however, it is recommended that soil pH be above 5.5 at seeding to optimize plant establishment. Phosphorus and potassium levels should be in the moderate to optimum range at seeding. Apply nitrogen fertilizer at 35 lb per acre at seeding to stimulate chicory establishment. In the absence of a soil test, assuming a medium-fertility soil, plow down 0-45- 135 lb. per acre and apply 50-20-20 lb. per acre at seeding. If chicory is seeded with a legume, reduce the nitrogen application at seeding.

Chicory requires a high level of fertility for maximum production. It is also very responsive to N fertilization. If chicory is grown without a legume, apply 100 to 150 lb N per acre in split applications of 50 lb per acre in early spring when the chicory becomes green and 50 lb per acre in early summer and in early fall. Yield responses to N fertilizer have been reported up to 200 lb N per acre. However, as N rate increases so does stem growth. Therefore, the yield increase from N fertilization must be weighed against the ability to keep chicory grazed so that stems do not bolt. If chicory is planted with alfalfa or another legume, restrict annual N applications to limit the effect N has on reducing nitrogen fixation of the legume.

Forage Chicory Summary

Forage chicory is a deep-rooted plant which grows best on fertile, well-drained soils. It will provide spring and summer growth which can supplement the grazing season during the traditional "summer slump" of the cool-season forage species. Puna, the only variety of forage chicory currently sold in Pennsylvania, has performed well under Pennsylvania conditions. However, proper management is essential to obtain adequate yield, quality, and persistence.

Related web pages:

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Electronic mailing lists:

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Growing Field Corn

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Does planting narrow rows increase production or cut down on weeds?

- **Suggestion A:** We had a small plot this year that was encouraging.
- **Suggestion B:** We did plant 20" rows for several years, but had problems with trying to stay between the rows when spraying. (We have quite a few hillsides.) Since we are totally no-till the thought of using narrower tires gave us bad dreams about compaction. We currently are using 30" rows and are satisfied with the results. As far as weed competition, yes the narrow rows did seem to help, But not enough to eliminate the late germinating weeds.
- **Suggestion C:** We are thinking of going to a population of 32,000- we hope to get enough yield increase to pay for the extra seed (currently we are at 22,000). Our rationale is that the combination of high population and narrow row spacing should help with competition for late germinating weeds. The sprayer could be a problem, but we're more worried about harvest.
- **Suggestion D:** There is some interesting research going on around here on narrow rows, and higher population, but I haven't heard of any earth shattering results. One thing I heard recently was of some research on hybrids that are made to put out 2 ears per stalk - one half the field was planted at 26000 seeds per acre, the other half at 21000 (30" rows, min till) the 21000 came up about 3 to 4 bu/acre better (around 160 bu/acre to 164 bu/acre) with the price of the new BT corn seed, this may be something to think about.

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Periodicals:

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Frequently Asked Questions:

- Does planting narrow rows increase production or cut down on weeds?

Other Information Sources:

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- Commercial suppliers
- Electronic mailing lists
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Does planting narrow rows increase production or cut down on weeds?

- **Suggestion A:** We had a small plot this year that was encouraging.
- **Suggestion B:** We did plant 20" rows for several years, but had problems with trying to stay between the rows when spraying. (We have quite a few hillsides.) Since we are totally no-till the thought of using narrower tires gave us bad dreams about compaction. We currently are using 30" rows and are satisfied with the results. As far as weed competition, yes the narrow rows did seem to help, But not enough to eliminate the late germinating weeds.
- **Suggestion C:** We are thinking of going to a population of 32,000- we hope to get enough yield increase to pay for the extra seed (currently we are at 22,000). Our rationale is that the combination of high population and narrow row spacing should help with competition for late germinating weeds. The sprayer could be a problem, but we're more worried about harvest.
- **Suggestion D:** There is some interesting research going on around here on narrow rows, and higher population, but I haven't heard of any earth shattering results. One thing I heard recently was of some research on hybrids that are made to put out 2 ears per stalk - one half the field was planted at 26000 seeds per acre, the other half at 21000 (30" rows, min till) the 21000 came up about 3 to 4 bu/acre better (around 160 bu/acre to 164 bu/acre) with the price of the new BT corn seed, this may be something to think about.

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Growing Hay

Frequently Asked Questions Other Information Sources Return to Forage Crops

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- How can you tell how much fertilizer your hayfield needs?

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Raising Horses

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Basics of Horse Nutrition

Several breeds and types of horses are used in a wide variety of activities throughout Pennsylvania and surrounding states. The majority of these horses are owned and managed for recreation or sport and not for profit by the owners. One of the greatest expenses in owning horses is feed. Feed costs can be minimized by keeping the horse healthy and by feeding a balanced ration that meets the horses nutritional needs.

More myths are associated with feeding horses than with feeding most other animals. This is in part due to the lack of current nutritional research information as well as an increasing number of horse owners who are unfamiliar with the basics of horse nutrition. Nutritional needs will vary considerably among horses depending on individual age, weight, and level of activity. There are no magic supplements, high performance feed "secrets", or short cuts that will transform any horse into a champion.

Horses naturally use forages as a primary component of their diets. Adequate forages are a basic necessity for normal functioning of the horses digestive system. This requirement for forages is most easily supplied by pasture and hay.

Mature horses will generally consume 2 to 2.5 percent of their body weight in feed each day. For example, a 1,000 pound horse should consume approximately 20 to 25 pounds (90 percent dry matter) of feed per day. The anatomy of the horse's digestive tract restricts effective digestion and utilization of low quality forages that are high in fiber. The poor digestion of low-quality forages can restrict the amount of dry matter that a horse can eat to a level below what is necessary to meet the horses nutrient needs. Therefore a premium should be placed on using high-quality forages in the horse's diet.

Ideally, horses should consume a minimum of 1 percent of their body weight in hay or pastures each day. Mature horses performing minimal or no work can be maintained on high quality forages without supplementing their diet with grain. However, growing, breeding, or working horses require supplementing the forage with a grain or concentrate to meet their additional nutrient requirements. As a general rule, forages should supply one half or more of the total weight of the feed consumed daily for optimum horse growth and development.

Forages can provide varying amounts of the nutrient requirements depending on the forage quality and amount consumed. The nutrient content of the forage and concentrate in the horse's diet must be known to properly balance the diet. Once the quality of the feeds are known, then proper amounts of each can be calculated to meet the nutrient requirements.

Pasture for Horses

High-quality, properly-fenced pasture represents one of the best and least expensive sources of summer feed for a horse. In addition, a well kept pasture can provide the most natural and healthy environment for exercise and rest.

Productive, well-managed pastures can provide most of the feed requirements of horses at the lowest cost. In fact, good pasture alone is sufficient to meet all of the nutritional requirements for many classes of horses. Yet, poorly-managed pastures supply little or no feed, and are frequently the source of many internal parasites.

General guidelines for the pasture needs (if the pasture is to serve as a feed source) for horses which have a mature weight of 1000 to 1200 lbs. are:

- Mare and foal: 1.75 to 2 acres
- Yearlings: 1.5 to 2 acres
- Weanlings: 0.5 to 1 acre

When acreage is very limited (less than one acre per horse), exercise may be the main use of the pasture. Pasture for this purpose will not supply more than a minimum amount of feed. However, with limited pasture pasture acreage, rotational grazing systems are the most effective method to maximize forage production and consumption. In this system, a group of compatible horses can graze a paddock (area of divided pasture) for approximately 3 to 6 days and then be moved (rotated) to a fresh paddock. Well limed and fertilized Kentucky bluegrass should be the main grass for this type of area. Kentucky bluegrass withstands close and continuous grazing better than most other grasses and when well established and properly fertilized, it

produces a reasonably dense and attractive sod.

Pasture Improvement

If you already have good stands of desirable grass and legume species, proper soil fertility combined with good management will be sufficient to assure good horse pasture. Most permanent bluegrass pastures produce less than 2000 pounds of dry matter per acre per year which is far below their potential. Yields on many pastures can be doubled simply by applying lime and fertilizer. Liming and topdressing Kentucky bluegrass pastures with phosphate, potash and nitrogen costs much less and is less work than complete pasture renovation. Furthermore, it is often possible to have these materials custom applied at a relatively low cost.

Apply lime and fertilizer according to soil test results and recommendations. A soil test will determine the pH (acidity) and nutrient level of your soil. Soil testing kits and information on how to take samples are available through your local extension agricultural agent. The response is often slow when you apply lime and fertilizer on the surface of established pastures. It may take 1 to 3 years, depending largely on the lime needs and species present in the pasture, before your pasture sod is thick and productive again.

If you don't have a good stand of desirable species, you may want to renovate the pasture by destroying the existing plants and planting productive mixtures. This procedure usually results in the highest yield increase per acre, but will also be relatively expensive to complete. If you plan to renovate an old pasture you should consider the following points:

1. Soil test for lime and fertilizer requirements. This is the only sure way of knowing how much lime and fertilizer are needed.
2. Apply required lime several months before the actual seeding. Disking or plowing will help to mix the lime evenly throughout the soil.
3. Select a seed mixture that complements the pasture drainage characteristics.
4. Destroy or suppress the old pasture by plowing or use of herbicides.
5. Use the appropriate method of seeding based on extent of tillage.
6. Protect the seeded area until the new plants are well established. Where recommended mixtures are seeded without a companion crop and weeds are controlled, new seedings can become established in a single year.

In heavy traffic areas, along fences and around gates and water troughs,

tall fescue may be used. While it is generally considered less palatable than bluegrass, tall fescue produces one of the toughest and heavy traffic sods of any adapted grass. Older stands of fescue often are infested with an endophyte (within the plant) fungus. Toxins associated with this fungus can cause lowered reproductive rates, abortion, agalactia (lack of milk) and prolonged gestation with mares. Use endophyte-free tall fescue seed whenever establishing new fescue stands for horses. Brood mares should be removed from pastures containing endophyte infested tall fescue at least 90 days prior to foaling.

Pasture Management

Whether you improve your pastures by the use of lime and fertilizer or by reseeding, sound management is essential to keep the desired species persistent and productive.

Avoid over or under grazing. Horses are notorious spot grazers. They will seriously damage desired species in some areas unless they are moved into new pastures frequently. Therefore, some form of rotational grazing is desirable. The correct acreage per horse changes with the season as well as with other factors. However, a good rule is to provide at least one acre of good quality pasture per horse. Then set up 5 or 6 paddocks, letting the horses graze first in one area for about one week and then change to another. This system helps to keep the legumes and grasses growing better and increases the feed available per acre. In addition, by rotating the horses from pasture to pasture you can break the life cycle of some parasites.

Clip pastures regularly during the growing season. Clipping at a height of 2 to 3 inches after horses are moved to a new paddock helps to control weeds, prevent grasses from heading and in general keeps the pasture in a more desirable condition.

Drag pastures with a chain link harrow at least once per year. Dragging helps to spread manure droppings which reduces the parasite populations by exposing them to air and sunlight. Dragging also helps to smooth over areas dug up by horses' hoofs on wet soil.

Apply fertilizer as needed. Improved horse pastures must be fertilized annually if legumes and grasses are to persist and remain productive. The fertilizer to use depends on the pasture species present. A complete soil test every 2 or 3 years is your best guide.

Hay for Horses

High quality hay can provide most of the nutrients needed for a mature

horse. High quality hay is cut early and is leafy, green in color, and is free of must, mold, dust, and foreign material such as weeds and stubble. This type of hay is usually rich in energy, protein, minerals and vitamins, and is readily consumed by horses.

In the past, there has been a belief that horses should not be fed a legume hay because it would cause digestive disorders. Grass hay, especially timothy has been the preferred hay. However, research has dispelled the notion that legumes do not make good hay for horses.

Straight legume hay or legume-grass mixed hay are highly acceptable when they are cut early, leafy and free of molds or other dusts. Respiratory or digestive disturbances frequently associated with feeding hay are more related to dust and mold than to mixtures. In general, well managed legume-grass hays are higher in protein and minerals than straight grasses under similar management. However, protein and mineral levels are readily changed by time of cutting and other hay-making practices. With good management most hay species or mixtures can be satisfactory for horses. Alfalfa hay, while normally high in protein, may contain an excessive amount of calcium in relationship to phosphorus (wide Ca:P ratio) when fed as the sole source of forage to young, growing horses.

To be sure of the nutritive quality of the hay which is being fed, have it analyzed. For more information on testing the quality of forages check with your local county agricultural extension agent.

Hay Production Tips

If you plan to buy hay for your horse, then consider the factors discussed above. However, if you plan to grow and harvest your own hay, follow the steps listed below. They will help you to consistently produce high yields of high quality hay.

1. Choose adapted species, varieties and mixtures. In general, simple mixtures consisting of a single legume such as alfalfa and a single grass such as timothy are preferred over straight legume or straight grass seedings. The Penn State Agronomy Guide is an excellent source of information on species and mixture selection. It is available through your county extension office.
2. Fertilize annually. A complete soil test provides the best guide for proper fertilization. Where soil test information is not available, topdress legume-grass stands annually with a minimum of 50 pounds of phosphate and 150 lbs. of potash (example 500 pounds of 0-10-30 or equivalent) per acre. If your hay field contains less than a 30% stand of legumes you can increase yield by applying 60 pounds of nitrogen per acre in late winter or early spring.

3. Harvest on time. To assure high quality feed, and at the same time keep stands productive and persistent, harvest hay crops at the proper maturity stages.
4. Plan hay making operations to save leaves. The plant leaves are higher in digestibility and feed value, including protein and minerals than any other plant parts. Hay that has been cut early and conditioned will normally contain more leaves and dry much faster than non- conditioned hay. It also tends to be softer and more readily accepted by animals. Other field operations such as raking should be carried out at high enough moisture levels to minimize leaf loss.
5. Dry and store to prevent dusts and molds. As indicated previously, dusty and moldy hay is unacceptable for horses. Conventional field dried hay must be 20 percent moisture or less for safe storage. Of all perennial species grown for hay in Pennsylvania, red clover is one of the most difficult to field cure.

Today a number of chemical preservatives are being marketed which if properly applied at the time of baling make it possible to bale and store hay safely at moistures up to 25 percent. Research indicates that hay treated with most chemical preservatives is safe to feed to horses as long as no dust or mold is present.

Health Concerns when Feeding Forages to Horses

Horses are extremely susceptible to molds, fungi, and other sources of toxic substances in forage. Mold problems generally occur in hay that has been baled at too high a moisture level (20% or more) without the use of a preservative. This is especially a problem with first cutting hay because it is harvested during a period of time when it rains frequently and the weather conditions are less than ideal for hay drying.

Always use clean, unmoldy forages when feeding horses. In addition to molds and fungi, some forage species contain chemical compounds that can have negative health effects on horses.

- **Sudangrass and sorghum-sudangrass hybrids contain compounds which can cause muscle weakness, urinary problems and death in severe cases. Do not feed these grasses to horses!**
- **Older varieties of tall fescue contained an endophyte fungus that could cause severe health problems if horses have only tall fescue to eat during the summer months**. Mares are especially sensitive to the health problems associated with tall fescue. On pastures that contain endophyte infected tall fescue, remove mares from the pastures during the last three months of gestation. Newer tall fescue varieties that are free of the

endophyte fungus are now available.

Another health problem could occur when horses are fed hay that contains **blister beetles**. When consumed, the beetle causes irritation to the lining of the digestive tract which usually results in death. Alfalfa hay that has been produced in southern areas of the U.S. is most generally associated with the potential to contain blister beetles. **Do not feed any hay containing blister beetles to horses**! Poisonous plants in pastures or hay can be fatal to horses. **Ornamental shrubs and nightshade** are the most common poisonous plants in Pennsylvania. However, any plant that is known to be poisonous to other animals is probably poisonous to horses. Some poisonous plants are highly palatable and should be identified and removed from pastures. However, many poisonous plants are not palatable and horses will not eat them unless there is inadequate forage available to meet their needs.

Black Walnut Toxicity

Horses may be affected by black walnut chips or sawdust when they are used for bedding material. Close association with walnut trees while pollen is being shed (typically in May) also produce allergic symptoms in both horses and humans. The juglone toxin occurs in the leaves, bark and wood of walnut, but these contain lower concentrations than in the roots. Juglone is poorly soluble in water and does not move very far in the soil.

Related web pages:

- The American Shire Horse Association can be visited at www.ultranet.com/~asha/

Commercial suppliers:

- None identified.

Electronic mailing lists:

- **EQUINE-L**

  Subscription address: listserv@psuvm.psu.edu (two-part subscription, requires confirmation)

  Topics: Discussion forum for horse fanciers; all phases of horse ownership, management, use and related concerns

for all horse breeds, both hot and cold blood. NOTE: This list generates heavy traffic.

Subscribe to EQUINE-L. Type "subscribe EQUINE-L Your Name" in the message body. (Not supported by all browsers.)

- **EQREPRO-L: Equine Reproduction Mailing List**

  Subscription address: listproc@cornell.edu

  Topics: For scientists, practicing veterinarians and animal technicians with a special interest in equine reproduction. Topics include but are not limited to clinical equine reproduction, endocrinology, semen preservation, embryo transfer, mare and stallion infertility, gamete research, neonatology, meetings, continuing education seminars as they relate to the horse, donkey or other equids.

  Number of subscribers: 189

  Number of countries: 17

  Subscribe to EQREPRO-L. Type "subscribe EQREPRO-L Your Name" in the message body. (Not supported by all browsers.)

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- A First Guide to Horse and Pony Care - by Jane Kidd (Editor) - List $29.95 - Publication Date: October 1, 1991
  Card catalog description:
  Discusses the anatomy, life cycle, care, and grooming of horses and ponies.
  The publisher, Howell:
  Written especially for children ages 8 to 12, here is pertinent information on the basic anatomy and biology of the horse; tack, feeds, and supplements; caring for the horse; grooming; and troubleshooting problems.
- Andalusian Horses (Magnificent Horses of the World) - by Hans-Jorg Schrenk, Tomas Micek (Photographer) - List: $23.75 - Publication Date: July 1, 1995
  Card catalog description:

Text and photographs depict the characteristics and behavior of this purebred Spanish horse.

- Appaloosa Horses - by Dorothy Hinshaw Patent - List: $16.95 - Publication Date: October 1, 1988
  Card catalog description:
  Examines the origins, traits, and activities of this spotted breed and discusses racing and breeding.
- Arabian Horses - by Janet L. Gammie - List: $19.97 - Publication Date: 1996
- Arabian Horses (Magnificent Horses of the World) - by Hans-Jorg Schrenk, Tomas Micek (Photographer) - List: $21.27 - Publication Date: July 1995
  Card catalog description:
  Text and photographs depict the characteristics and behavior of the oldest purebred horse in the world.
- A-Z of Horse Diseases and Health Problems : Signs, Diagnoses, Causes, Treatment - by Tim Hawcroft - List: $24.95 - Publication Date: March 1, 1990
  The publisher, Howell:
  Descriptive color photographs of disorders and a detailed index provide instant access to disease symptoms and signs, diagnoses, causes, and treatments, as well as basic first aid, the skeletal system, points of a horse, and a great deal more.
  Book News, Inc., 02/01/91:
  This book is organized to enable the reader to spot disease symptoms in their early stages and to respond with the most appropriate treatment. Based on the signs observed, the reader is guided to additional signs and possible diagnoses, background causes, and treatments. Each disorder is accompanied by a descriptive color photograph. The detailed index gives quick access, and the handy trim size makes the book a practical diagnostic reference in the stable, on the trail, or in competition. Annotation copyright Book News, Inc. Portland, Or.
- Basic Horse Care (Doubleday Equestrian Library) - by Eleanor F. Prince, Gaydell M. Collier - List: $15.95 - Publication Date: June 1, 1989
  Synopsis:
  This authoritative book gives the horse owner and potential owner practical advice on all aspects of horse care, including how to bathe and groom horses, how to breed and raise horses, how to choose a qualified veterinarian, and much more. Illustrated.
  The publisher, Bantam Doubleday Dell Publishing Group, Inc.: "By the authors of the best-selling Basic Horsemanship, this indispensable companion volume covers the essentials of horse

care -- a must for anyone who owns a horse or is thinking of buying one

- First Pony (The Usborne Riding School) - by Kate Needham, Mikki Rain (Illustrator), Kit Houghton (Photographer) - List: $5.95 - Publication Date: September 1, 1996
- Roofs and Rails : How to Plan and Build Your Ideal Horse Facility/a Western Horseman Book - by Gavin Ehringer, Gary Vorhes - List: $14.95 - Publication Date: May 1, 1995
- Simon and Schuster's Guide to Horses and Ponies of the World - by Maurizio Bongianni - List: $14.00 - Publication Date: May 1, 1988
  Synopsis:
  A compact, comprehensive, and authoritative source for horse-lovers and professionals alike, this guide begins with general information on the origin and evolution of each species, followed by practical facts on everything from breaking and rearing to equestrian psychology. 230 full-color photos.
- The Affordable Horse : A Guide to Low-Cost Ownership - by Sharon B. Smith - List: $17.00 - Publication Date: June 1, 1994
  The publisher, Howell:
  How people with ordinary incomes can reduce the costs of each aspect of ownership--even the costs of shoeing, veterinary care, and insurance can be diminished without compromising quality or safety.
- The American Paint Horse - by Glynn W. Haynes - List: $19.95 - Publication Date: August 1988
- The American Saddlebred Horse (Learning About Horses) - by Charlotte Wilcox - Publication Date: January 1996 - List: $19.00
  Card catalog description :
  Discusses the lineage, physical characteristics, life span, breeding, and uses of the American saddlebred, considered to be one of the most beautiful horses in the world.
- The Anatomy of the Horse - by George Stubbs - Publication Date: February 1977 - List: $14.95
  Synopsis:
  A facsimile edition of the classic equine anatomy text, first published in 1777, includes precise, richly detailed anatomical descriptions and drawings, designed to assist artists and designers in their work. --This text refers to an out of print or unavailable edition of this title.
- The Arabian Horse (Learning About Horses) - by Gail Stewart - Publication Date: January 1995 - List: $19.00
- The Athletic Development of the Dressage Horse : Manege

Patterns - by Charles De Kunffy - Publication Date: August 1992 - List: $28.00
The publisher, Howell :
A program of manege exercises that promote better suspension, collection, changes of tempo and gaits and will enable the horse to perform as a sound, relaxed, and superbly conditioned athlete.
Booknews, Inc. , 10/01/92:
Focuses on the meaning and usefulness of patterns in riding in the respected dressage tradition. First book devoted entirely to classical manege exercises which are ridden to supple, strengthen and, when necessary, correct. Illustrated with 35 photos and 38 diagrams. Annotation copyright Book News, Inc. Portland, Or.

- The International Encyclopedia of Horses and Ponies (The Howell Equestrian Library) - by Jane Kidd (Editor) - Publication Date: July 1, 1995 - List: $29.95
  Synopsis:
  Perfect for horse lovers of all ages, this lavishly illustrated reference takes readers on a magical tour of the equine world, showcasing more than 100 breeds. The book explores the evolution of this magnificent animal, and addresses behavior, providing an understanding of why horses and ponies act the way they do. 450 color photos. The publisher, Howell :
  This remarkable volume first explains how the horse came to evolve over the course of millions of years from a creature not much bigger than a fox into the magnificent animal we know today.
- The Man Who Listens to Horses - by Monty Roberts, Lawrence Scanlan (Introduction) - Publication Date: August 1, 1997 - List: $23.00
  The New York Times Book Review, Maxine Kumin :
  The Man Who Listens to Horses is a riveting and inspirational story, easy to read and hard to put down.... Monty Roberts will soften you up, get you chewing and listening to his insights into equine behavior and make you marvel at the success of his spiritual quest.
- The New Guide to Horse Breeds : The Complete Reference to Horse and Pony Breeds of the World - by Judith Draper, Kit Houghton (Photographer) - Publication Date: March 1, 1997 - List: $15.98
  Synopsis:
  A compendium of the world's most important breeds of horses and their varieties of shapes, sizes, and qualities provides a complete visual and textual reference on the history of horses throughout the world.

- The Pony Breeder's Companion : A Guide for Owners and Breeders (Howell Equestrian Library) - by Caroline Nesbitt - Publication Date: November 1, 1995 - List: $29.95
  The publisher, Howell :
  Perfect for both the professional and hobby breeder, this down-to-earth guide addresses what all breeders need to know, from deciding on a breed to targeting a market and producing salable youngstock.
- The Shetland Pony (Learning About Horses) - by William Munoz (Photographer), Gail B. Stewart - Publication Date: January 1996 - List: $19.00
  Card catalog description :
  A brief history and description of the Shetland pony, including its origins in Great Britain and its appeal to children.
- The United States Pony Club Manual of Horsemanship : Intermediate Horsemanship/C Level - by Susan E. Harris, Ruth Ring Harvie - Publication Date: June 1, 1995 - List: $17.95
  The publisher, Howell :
  Required reading by the 14,000 members of the USPC, this C Level manual is written for children ages ten to fourteen, whether they are Pony Clubbers who have passed the D tests or simply riders who have mastered the same basics. It teaches the skills needed to ride--with good position--on the flat, over fences and in the open.
- Young Rider's Guide to Buying a Horse or Pony - by Lesley Ward - Publication Date: September 1, 1996 - List: $14.95
  Card catalog description :
  Covers everything a rider and her parents need to consider before buying a horse or a pony.
- Young Rider's Guide to Caring for a Horse or Pony (Young Rider's Guides) - by Lesley Ward - Publication Date: September 1, 1996 - List: $14.95
  Card catalog description :
  Discusses various aspects of caring for a horse or pony, including feeding, grooming, tacking up, and traveling.
- Young Rider's Guide to Riding a Horse or Pony (Young Rider's Guides) - by Lesley Ward - Publication Date: September 1, 1996 - List: $14.95
  Card catalog description :
  Discusses various aspects of riding a horse or pony, including getting started, sitting in the saddle, walking, trotting, galloping, and jumping.
- Your Pony, Your Horse : A Kid's Guide to Care and Enjoyment - by Cherry Hill - Publication Date: December 1995 - List: $12.95

Card catalog description :
Introduces routines for handling and caring for a pony or horse, providing step-by-step instructions and discussing safety, responsibility, horse clubs, and other community activities.

- Complete Plans for Building Horse Barns Big and Small - by Nancy W. Ambrosiano, Mary F. Harcourt - Publication Date: December 1, 1989
  The author, Nancy W. Ambrosiano , 01/18/97:
  "Barns" is designed to help horsemen solve housing problems. We have worked with horsemen from around the country, from back yard innovators to Olympic Team members, to find good solutions to common and uncommon horsekeeping challenges. From clever watering systems to low-cost horse housing, we've found people with good ideas they are willing to share. And with our backgrounds as equestrian management professionals, we've been able to review each idea with an eye to safety, economy and the reality of the average horse owner.
- Horsekeeping on a Small Acreage : Facilities Design and Management - by Cherry Hill, Richard Klimesh (Illustrator) - Publication Date: October 1991 - List: $16.95
  The author, Cherry Hill (KLIMTEAM@aol.com or http://www.intertex.net/users/rzu2u/chbooks.htm) , 08/05/97:
  Learn How to Design and Maintain Your Dream Acreage
  Whether you have one acre or one hundred, this book will help you design, remodel, and manage your horse facilities with safety, comfort, and convenience in mind. Since land is becoming more scarce with each moment, we need to learn how to protect this valuable resource and still enjoy our horses. I cover designing the layout, barn planning, fencing, training facilities, pasture management, tractor and implement selection, water, sanitation, routines and records and more. The 179 pages contain over 120 photos and illustrations.
- Riding for the Rest of Us : A Practical Guide for Adult Riders - by Jessica Jahiel - Publication Date: April 1, 1996 - List: $27.95
  The publisher, Howell :
  This title addresses everything the adult rider needs to know to perform to the best of his or her ability and resources. The focus is on setting and achieving realistic goals in terms of both fitness and finance. This book makes the world of riding available for everyone to experience and enjoy.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Basics of Horse Nutrition

Several breeds and types of horses are used in a wide variety of activities throughout Pennsylvania and surrounding states. The majority of these horses are owned and managed for recreation or sport and not for profit by the owners. One of the greatest expenses in owning horses is feed. Feed costs can be minimized by keeping the horse healthy and by feeding a balanced ration that meets the horses nutritional needs.

More myths are associated with feeding horses than with feeding most other animals. This is in part due to the lack of current nutritional research information as well as an increasing number of horse owners who are unfamiliar with the basics of horse nutrition. Nutritional needs will vary considerably among horses depending on individual age, weight, and level of activity. There are no magic supplements, high performance feed "secrets", or short cuts that will transform any horse into a champion.

Horses naturally use forages as a primary component of their diets. Adequate forages are a basic necessity for normal functioning of the horses digestive system. This requirement for forages is most easily supplied by pasture and hay.

Mature horses will generally consume 2 to 2.5 percent of their body weight in feed each day. For example, a 1,000 pound horse should consume approximately 20 to 25 pounds (90 percent dry matter) of feed per day. The anatomy of the horse's digestive tract restricts effective digestion and utilization of low quality forages that are high in fiber. The poor digestion of low-quality forages can restrict the amount of dry matter that a horse can eat to a level below what is necessary to meet the horses nutrient needs. Therefore a premium should be placed on using high-quality forages in the horse's diet.

Ideally, horses should consume a minimum of 1 percent of their body weight in hay or pastures each day. Mature horses performing minimal or no work can be maintained on high quality forages without supplementing their diet with grain. However, growing, breeding, or working horses require supplementing the forage with a grain or concentrate to meet their additional nutrient requirements. As a general rule, forages should supply one half or more of the total weight of the feed consumed daily for optimum horse growth and development.

Forages can provide varying amounts of the nutrient requirements depending on the forage quality and amount consumed. The nutrient content of the forage and concentrate in the horse's diet must be known to properly balance the diet. Once the quality of the feeds are known, then proper amounts of each can be calculated to meet the nutrient requirements.

Pasture for Horses

High-quality, properly-fenced pasture represents one of the best and least expensive sources of summer feed for a horse. In addition, a well kept pasture can provide the most natural and healthy environment for exercise and rest.

Productive, well-managed pastures can provide most of the feed requirements of horses at the lowest cost. In fact, good pasture alone is sufficient to meet all of the nutritional requirements for many classes of horses. Yet, poorly-managed pastures supply little or no feed, and are frequently the source of many internal parasites.

General guidelines for the pasture needs (if the pasture is to serve as a feed source) for horses which have a mature weight of 1000 to 1200 lbs. are:

- Mare and foal: 1.75 to 2 acres
- Yearlings: 1.5 to 2 acres
- Weanlings: 0.5 to 1 acre

When acreage is very limited (less than one acre per horse), exercise may be the main use of the pasture. Pasture for this purpose will not supply more than a minimum amount of feed. However, with limited pasture pasture acreage, rotational grazing systems are the most effective method to maximize forage production and consumption. In this system, a group of compatible horses can graze a paddock (area of divided pasture) for approximately 3 to 6 days and then be moved (rotated) to a fresh paddock. Well limed and fertilized Kentucky bluegrass should be the main grass for this type of area. Kentucky bluegrass withstands close and continuous grazing better than most other grasses and when well established and properly fertilized, it produces a reasonably dense and attractive sod.

Pasture Improvement

If you already have good stands of desirable grass and legume species, proper soil fertility combined with good management will be sufficient to assure good horse pasture. Most permanent bluegrass pastures produce less than 2000 pounds of dry matter per acre per year which is far below their potential. Yields on many pastures can be doubled simply by applying lime and fertilizer. Liming and topdressing Kentucky bluegrass pastures with phosphate, potash and nitrogen costs much less and is less work than complete pasture renovation. Furthermore, it is often possible to have these materials custom applied at a relatively low cost.

Apply lime and fertilizer according to soil test results and recommendations. A soil test will determine the pH (acidity) and nutrient level of your soil. Soil testing kits and information on how to take samples are available through your local extension agricultural agent. The response is often slow when you apply lime and fertilizer on the surface of established pastures. It may take 1 to 3 years, depending largely on the lime needs and species present in the pasture, before your pasture sod is thick and productive again.

If you don't have a good stand of desirable species, you may want to renovate the pasture by destroying the existing plants and planting productive mixtures. This procedure usually results in

the highest yield increase per acre, but will also be relatively expensive to complete. If you plan to renovate an old pasture you should consider the following points:

1. Soil test for lime and fertilizer requirements. This is the only sure way of knowing how much lime and fertilizer are needed.
2. Apply required lime several months before the actual seeding. Disking or plowing will help to mix the lime evenly throughout the soil.
3. Select a seed mixture that complements the pasture drainage characteristics.
4. Destroy or suppress the old pasture by plowing or use of herbicides.
5. Use the appropriate method of seeding based on extent of tillage.
6. Protect the seeded area until the new plants are well established. Where recommended mixtures are seeded without a companion crop and weeds are controlled, new seedings can become established in a single year.

In heavy traffic areas, along fences and around gates and water troughs, tall fescue may be used. While it is generally considered less palatable than bluegrass, tall fescue produces one of the toughest and heavy traffic sods of any adapted grass. Older stands of fescue often are infested with an endophyte (within the plant) fungus. Toxins associated with this fungus can cause lowered reproductive rates, abortion, agalactia (lack of milk) and prolonged gestation with mares. Use endophyte-free tall fescue seed whenever establishing new fescue stands for horses. Brood mares should be removed from pastures containing endophyte infested tall fescue at least 90 days prior to foaling.

Pasture Management

Whether you improve your pastures by the use of lime and fertilizer or by reseeding, sound management is essential to keep the desired species persistent and productive.

Avoid over or under grazing. Horses are notorious spot grazers. They will seriously damage desired species in some areas unless they are moved into new pastures frequently. Therefore, some form of rotational grazing is desirable. The correct acreage per horse changes with the season as well as with other factors. However, a good rule is to provide at least one acre of good quality pasture per horse. Then set up 5 or 6 paddocks, letting the horses graze first in one area for about one week and then change to another. This system helps to keep the legumes and grasses growing better and increases the feed available per acre. In addition, by rotating the horses from pasture to pasture you can break the life cycle of some parasites.

Clip pastures regularly during the growing season. Clipping at a height of 2 to 3 inches after horses are moved to a new paddock helps to control weeds, prevent grasses from heading and in general keeps the pasture in a more desirable condition.

Drag pastures with a chain link harrow at least once per year. Dragging helps to spread manure droppings which reduces the parasite populations by exposing them to air and sunlight. Dragging also helps to smooth over areas dug up by horses' hoofs on wet soil.

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4. Plan hay making operations to save leaves. The plant leaves are higher in digestibility and feed value, including protein and minerals than any other plant parts. Hay that has been cut early and conditioned will normally contain more leaves and dry much faster than non-conditioned hay. It also tends to be softer and more readily accepted by animals. Other field operations such as raking should be carried out at high enough moisture levels to minimize leaf loss.
5. Dry and store to prevent dusts and molds. As indicated previously, dusty and moldy hay is unacceptable for horses. Conventional field dried hay must be 20 percent moisture or less for safe storage. Of all perennial species grown for hay in Pennsylvania, red clover is one of the most difficult to field cure.

Today a number of chemical preservatives are being marketed which if properly applied at the time of baling make it possible to bale and store hay safely at moistures up to 25 percent. Research indicates that hay treated with most chemical preservatives is safe to feed to horses as long as no dust or mold is present.

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Horses are extremely susceptible to molds, fungi, and other sources of toxic substances in forage. Mold problems generally occur in hay that has been baled at too high a moisture level (20% or more) without the use of a preservative. This is especially a problem with first cutting hay because it is harvested during a period of time when it rains frequently and the weather conditions are less than ideal for hay drying.

Always use clean, unmoldy forages when feeding horses. In addition to molds and fungi, some forage species contain chemical compounds that can have negative health effects on horses.

- **Sudangrass and sorghum-sudangrass hybrids contain compounds which can cause muscle weakness, urinary problems and death in severe cases. Do not feed these grasses to horses!**
- **Older varieties of tall fescue contained an endophyte fungus that could cause severe health problems if horses have only tall fescue to eat during the summer months**. Mares are especially sensitive to the health problems associated with tall fescue. On pastures that contain endophyte infected tall fescue, remove mares from the pastures during the last three months of gestation. Newer tall fescue varieties that are free of the endophyte fungus are now available.

Another health problem could occur when horses are fed hay that contains **blister beetles**. When consumed, the beetle causes irritation to the lining of the digestive tract which usually results in death. Alfalfa hay that has been produced in southern areas of the U.S. is most generally associated with the potential to contain blister beetles. **Do not feed any hay containing blister beetles to horses**! Poisonous plants in pastures or hay can be fatal to horses. **Ornamental shrubs and nightshade** are the most common poisonous plants in Pennsylvania. However, any plant that is known to be poisonous to other animals is probably poisonous to horses. Some poisonous plants are highly palatable and should be identified and removed from pastures. However, many

poisonous plants are not palatable and horses will not eat them unless there is inadequate forage available to meet their needs.

Black Walnut Toxicity

Horses may be affected by black walnut chips or sawdust when they are used for bedding material. Close association with walnut trees while pollen is being shed (typically in May) also produce allergic symptoms in both horses and humans. The juglone toxin occurs in the leaves, bark and wood of walnut, but these contain lower concentrations than in the roots. Juglone is poorly soluble in water and does not move very far in the soil.

Related web pages:

- The American Shire Horse Association can be visited at www.ultranet.com/~asha/

Commercial suppliers:

- None identified.

Electronic mailing lists:

- **EQUINE-L**

  Subscription address: listserv@psuvm.psu.edu (two-part subscription, requires confirmation)

  Topics: Discussion forum for horse fanciers; all phases of horse ownership, management, use and related concerns for all horse breeds, both hot and cold blood. NOTE: This list generates heavy traffic.

  Subscribe to EQUINE-L. Type "subscribe EQUINE-L Your Name" in the message body. (Not supported by all browsers.)

- **EQREPRO-L: Equine Reproduction Mailing List**

  Subscription address: listproc@cornell.edu

  Topics: For scientists, practicing veterinarians and animal technicians with a special interest in equine reproduction. Topics include but are not limited to clinical equine reproduction, endocrinology, semen preservation, embryo transfer, mare and stallion infertility, gamete research, neonatology, meetings, continuing education seminars as they relate to the horse, donkey or other equids.

  Number of subscribers: 189

Number of countries: 17

Subscribe to EQREPRO-L. Type "subscribe EQREPRO-L Your Name" in the message body. (Not supported by all browsers.)

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- A First Guide to Horse and Pony Care - by Jane Kidd (Editor) - List $29.95 - Publication Date: October 1, 1991
  Card catalog description:
  Discusses the anatomy, life cycle, care, and grooming of horses and ponies.
  The publisher, Howell:
  Written especially for children ages 8 to 12, here is pertinent information on the basic anatomy and biology of the horse; tack, feeds, and supplements; caring for the horse; grooming; and troubleshooting problems.
- Andalusian Horses (Magnificent Horses of the World) - by Hans-Jorg Schrenk, Tomas Micek (Photographer) - List: $23.75 - Publication Date: July 1, 1995
  Card catalog description:
  Text and photographs depict the characteristics and behavior of this purebred Spanish horse.
- Appaloosa Horses - by Dorothy Hinshaw Patent - List: $16.95 - Publication Date: October 1, 1988
  Card catalog description:
  Examines the origins, traits, and activities of this spotted breed and discusses racing and breeding.
- Arabian Horses - by Janet L. Gammie - List: $19.97 - Publication Date: 1996
- Arabian Horses (Magnificent Horses of the World) - by Hans-Jorg Schrenk, Tomas Micek (Photographer) - List: $21.27 - Publication Date: July 1995
  Card catalog description:
  Text and photographs depict the characteristics and behavior of the oldest purebred horse in the world.
- A-Z of Horse Diseases and Health Problems : Signs, Diagnoses, Causes, Treatment - by Tim Hawcroft - List: $24.95 - Publication Date: March 1, 1990
  The publisher, Howell:
  Descriptive color photographs of disorders and a detailed index provide instant access to disease symptoms and signs, diagnoses, causes, and treatments, as well as basic first aid, the skeletal system, points of a horse, and a great deal more.
  Book News, Inc., 02/01/91:

This book is organized to enable the reader to spot disease symptoms in their early stages and to respond with the most appropriate treatment. Based on the signs observed, the reader is guided to additional signs and possible diagnoses, background causes, and treatments. Each disorder is accompanied by a descriptive color photograph. The detailed index gives quick access, and the handy trim size makes the book a practical diagnostic reference in the stable, on the trail, or in competition. Annotation copyright Book News, Inc. Portland, Or.

- Basic Horse Care (Doubleday Equestrian Library) - by Eleanor F. Prince, Gaydell M. Collier - List: $15.95 - Publication Date: June 1, 1989
  Synopsis:
  This authoritative book gives the horse owner and potential owner practical advice on all aspects of horse care, including how to bathe and groom horses, how to breed and raise horses, how to choose a qualified veterinarian, and much more. Illustrated.
  The publisher, Bantam Doubleday Dell Publishing Group, Inc.:
  "By the authors of the best-selling Basic Horsemanship, this indispensable companion volume covers the essentials of horse care -- a must for anyone who owns a horse or is thinking of buying one
- First Pony (The Usborne Riding School) - by Kate Needham, Mikki Rain (Illustrator), Kit Houghton (Photographer) - List: $5.95 - Publication Date: September 1, 1996
- Roofs and Rails : How to Plan and Build Your Ideal Horse Facility/a Western Horseman Book - by Gavin Ehringer, Gary Vorhes - List: $14.95 - Publication Date: May 1, 1995
- Simon and Schuster's Guide to Horses and Ponies of the World - by Maurizio Bongianni - List: $14.00 - Publication Date: May 1, 1988
  Synopsis:
  A compact, comprehensive, and authoritative source for horse-lovers and professionals alike, this guide begins with general information on the origin and evolution of each species, followed by practical facts on everything from breaking and rearing to equestrian psychology. 230 full-color photos.
- The Affordable Horse : A Guide to Low-Cost Ownership - by Sharon B. Smith - List: $17.00 - Publication Date: June 1, 1994
  The publisher, Howell:
  How people with ordinary incomes can reduce the costs of each aspect of ownership--even the costs of shoeing, veterinary care, and insurance can be diminished without compromising quality or safety.
- The American Paint Horse - by Glynn W. Haynes - List: $19.95 - Publication Date: August 1988
- The American Saddlebred Horse (Learning About Horses) - by Charlotte Wilcox - Publication Date: January 1996 - List: $19.00
  Card catalog description :
  Discusses the lineage, physical characteristics, life span, breeding, and uses of the American saddlebred, considered to be one of the most beautiful horses in the world.
- The Anatomy of the Horse - by George Stubbs - Publication Date: February 1977 - List: $14.95

Synopsis:
A facsimile edition of the classic equine anatomy text, first published in 1777, includes precise, richly detailed anatomical descriptions and drawings, designed to assist artists and designers in their work. --This text refers to an out of print or unavailable edition of this title.

- The Arabian Horse (Learning About Horses) - by Gail Stewart - Publication Date: January 1995 - List: $19.00
- The Athletic Development of the Dressage Horse : Manege Patterns - by Charles De Kunffy - Publication Date: August 1992 - List: $28.00
  The publisher, Howell :
  A program of manege exercises that promote better suspension, collection, changes of tempo and gaits and will enable the horse to perform as a sound, relaxed, and superbly conditioned athlete.
  Booknews, Inc. , 10/01/92:
  Focuses on the meaning and usefulness of patterns in riding in the respected dressage tradition. First book devoted entirely to classical manege exercises which are ridden to supple, strengthen and, when necessary, correct. Illustrated with 35 photos and 38 diagrams. Annotation copyright Book News, Inc. Portland, Or.
- The International Encyclopedia of Horses and Ponies (The Howell Equestrian Library) - by Jane Kidd (Editor) - Publication Date: July 1, 1995 - List: $29.95
  Synopsis:
  Perfect for horse lovers of all ages, this lavishly illustrated reference takes readers on a magical tour of the equine world, showcasing more than 100 breeds. The book explores the evolution of this magnificent animal, and addresses behavior, providing an understanding of why horses and ponies act the way they do. 450 color photos. The publisher, Howell :
  This remarkable volume first explains how the horse came to evolve over the course of millions of years from a creature not much bigger than a fox into the magnificent animal we know today.
- The Man Who Listens to Horses - by Monty Roberts, Lawrence Scanlan (Introduction) - Publication Date: August 1, 1997 - List: $23.00
  The New York Times Book Review, Maxine Kumin :
  The Man Who Listens to Horses is a riveting and inspirational story, easy to read and hard to put down.... Monty Roberts will soften you up, get you chewing and listening to his insights into equine behavior and make you marvel at the success of his spiritual quest.
- The New Guide to Horse Breeds : The Complete Reference to Horse and Pony Breeds of the World - by Judith Draper, Kit Houghton (Photographer) - Publication Date: March 1, 1997 - List: $15.98
  Synopsis:
  A compendium of the world's most important breeds of horses and their varieties of shapes, sizes, and qualities provides a complete visual and textual reference on the history of horses throughout the world.
- The Pony Breeder's Companion : A Guide for Owners and Breeders (Howell Equestrian Library) - by Caroline Nesbitt - Publication Date: November 1, 1995 - List: $29.95

The publisher, Howell :
Perfect for both the professional and hobby breeder, this down-to-earth guide addresses what all breeders need to know, from deciding on a breed to targeting a market and producing salable youngstock.

- The Shetland Pony (Learning About Horses) - by William Munoz (Photographer), Gail B. Stewart - Publication Date: January 1996 - List: $19.00
  Card catalog description :
  A brief history and description of the Shetland pony, including its origins in Great Britain and its appeal to children.
- The United States Pony Club Manual of Horsemanship : Intermediate Horsemanship/C Level - by Susan E. Harris, Ruth Ring Harvie - Publication Date: June 1, 1995 - List: $17.95
  The publisher, Howell :
  Required reading by the 14,000 members of the USPC, this C Level manual is written for children ages ten to fourteen, whether they are Pony Clubbers who have passed the D tests or simply riders who have mastered the same basics. It teaches the skills needed to ride--with good position--on the flat, over fences and in the open.
- Young Rider's Guide to Buying a Horse or Pony - by Lesley Ward - Publication Date: September 1, 1996 - List: $14.95
  Card catalog description :
  Covers everything a rider and her parents need to consider before buying a horse or a pony.
- Young Rider's Guide to Caring for a Horse or Pony (Young Rider's Guides) - by Lesley Ward - Publication Date: September 1, 1996 - List: $14.95
  Card catalog description :
  Discusses various aspects of caring for a horse or pony, including feeding, grooming, tacking up, and traveling.
- Young Rider's Guide to Riding a Horse or Pony (Young Rider's Guides) - by Lesley Ward - Publication Date: September 1, 1996 - List: $14.95
  Card catalog description :
  Discusses various aspects of riding a horse or pony, including getting started, sitting in the saddle, walking, trotting, galloping, and jumping.
- Your Pony, Your Horse : A Kid's Guide to Care and Enjoyment - by Cherry Hill - Publication Date: December 1995 - List: $12.95
  Card catalog description :
  Introduces routines for handling and caring for a pony or horse, providing step-by-step instructions and discussing safety, responsibility, horse clubs, and other community activities.
- Complete Plans for Building Horse Barns Big and Small - by Nancy W. Ambrosiano, Mary F. Harcourt - Publication Date: December 1, 1989
  The author, Nancy W. Ambrosiano , 01/18/97:
  "Barns" is designed to help horsemen solve housing problems. We have worked with horsemen from around the country, from back yard innovators to Olympic Team members, to find good solutions to common and uncommon horsekeeping challenges. From clever watering systems to low-cost horse housing, we've found people with good ideas they are

willing to share. And with our backgrounds as equestrian management professionals, we've been able to review each idea with an eye to safety, economy and the reality of the average horse owner.

- Horsekeeping on a Small Acreage : Facilities Design and Management - by Cherry Hill, Richard Klimesh (Illustrator) - Publication Date: October 1991 - List: $16.95
  The author, Cherry Hill (KLIMTEAM@aol.com or http://www.intertex.net/users/rzu2u/chbooks.htm) , 08/05/97:
  Learn How to Design and Maintain Your Dream Acreage
  Whether you have one acre or one hundred, this book will help you design, remodel, and manage your horse facilities with safety, comfort, and convenience in mind. Since land is becoming more scarce with each moment, we need to learn how to protect this valuable resource and still enjoy our horses. I cover designing the layout, barn planning, fencing, training facilities, pasture management, tractor and implement selection, water, sanitation, routines and records and more. The 179 pages contain over 120 photos and illustrations.
- Riding for the Rest of Us : A Practical Guide for Adult Riders - by Jessica Jahiel - Publication Date: April 1, 1996 - List: $27.95
  The publisher, Howell :
  This title addresses everything the adult rider needs to know to perform to the best of his or her ability and resources. The focus is on setting and achieving realistic goals in terms of both fitness and finance. This book makes the world of riding available for everyone to experience and enjoy.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Livestock Contents

Return to the Small Farm Resource

If you have a question, we will post the question in the appropriate contents page to get suggestions from our site visitors.

Questions and suggestions can be sent to us via our Feedback form.

Visitor Questions:

Go to Exotic Livestock Page

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Beef Cattle Index

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If you have a question, we will post the question in the appropriate contents page to get suggestions from our site visitors.

Questions and suggestions can be sent to us via our Feedback form.

Visitor Questions:

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Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Is there software specifically written for raising beef cattle?

- **Suggestion:** Get a good spread sheet and relational data base and learn to use them. All record keeping will fit in to these two categories pretty well and you will understand what is going on because you did it. There are some good programs out there and they are a lot less expensive than the many hours you will spend doing it your self. But the experience you gain implementing them your self will reap a lot of benefits in understanding your operation and produce a flexible system that you can make fit the future changes in your operation. But it will take a lot of your time.

What about these ID radios for cattle?

- Radio transponders have a variety of uses, including pet and livestock identification, tracking salmon through dams, penguins in Antarctica, chimpanzees (buried antennas in their habitat), autos at toll booths (transponder on your dashboard), and ski lift ticket validation. Transponder sizes range from rice grain to credit-card. Larger transponders can be read from a greater distance. Each transponder has its own unique 13-digit (or so) code. Transponders are passive devices...no batteries. Transponder prices for large quantities range down to $2-something each. Readers (receivers) can be hand-held units, and frequently have computer data outputs for logging who passed by or through the antenna. Antennas range from pen-shaped objects to 15-inch (40-cm) diameter circles, or larger.

What is the Highland Breed?

The Highland breed has lived for centuries in the rugged remote Scottish Highlands. The extremely harsh conditions created a process of natural selection, where only the fittest and most adaptable animals survived to carry on the breed. Originally there were two distinct classes: the slightly smaller and usually black Kyloe, whose primary domain was the islands off the west coast of northern Scotland; the other, a larger animal generally reddish in color, whose territory was the remote Highlands of Scotland. Today both of these strains are regarded as one breed - the Highland. In addition to the original strains, yellow, dun, white, brindle and silver are also considered traditional colors.

Highlands require little in the way of shelter, feed supplements or expensive grains to achieve and maintain good condition. In fact, cold weather and snow have little effect on them. They have been raised as far north as Alaska and the Scandinavian countries. They also adapt well to the more southerly climates with successful herds as far south as Texas and Georgia. Less than ideal pasture or range land is another reason to consider the Highland breed. These cattle are excellent browsers, able to clear a brush lot with speed and efficiency.

What are beefalo?

- They are a fertile hybrid of BEEF cattle and the American Bison, which is more commonly known as buffalo. In a full-blood beefalo the bison is 3/8 of the ancestry. The meat is delicious and tender (Do not over-cook. Beefalo takes about 1/3 less time in dry cooking methods.). The meat is also ultra lean and very low in cholesterol. According to lab tests, it is not only lower in cholesterol than regular beef, it is lower than chicken broiled without skin. Beefalo can be handled by the same methods as ordinary beef. They have good dispositions. Beefalo have excellent maternal qualities. They calve unassisted and during daylight hours. Calves are small and lively. Average calf weight is about 65 lb., except for first calf heifers, which are more around 50 lb. Beefalo have a dense hair coat which seems to give them better tolerance for extreme weather. It is easy to keep flesh on our beefalo in the winter with just hay. In the 70's Bud Bassolo promoted beefalo. He coined the name.

What are Miniature Herefords?

Miniature Herefords are purebred strains of Hereford cattle with pedigrees going back up to one hundred years. They look like other pure Hereford cattle but are smaller, always being under 48" tall with some strains being under 36" tall at the shoulder. At the beginning of 1995 there were fewer than 250 Miniature Herefords in the world.

Miniature Herefords:

- are under 36', 38", 40", 42", 44", 46" or 48" tall
- are more efficient feed converters
- are more efficient beef producers
- have a lovely docile nature
- have a larger ribeye in proportion to body weight
- produce prime tender beef cuts for an exclusive market
- require only one third the nutrition of an average bovine
- produce up to 67% carcass weight
- will grade prime at less than 14 months of age
- have very high genetic heritability traits
- suit small farms as well as large
- are easily handled without heavy pens and equipment
- will breed to calve at 2 years of age or younger
- weigh 70% of their mother's weight at 7 months
- are lovely pets
- are in very high demand overseas
- are extremely rare and valuable
- provide the genetic tool for herd improvement

The Miniature Hereford is an unique breed of cattle. Although rare, they exhibit all of the well-known traits of the classic Hereford breeds. They are hardy and docile and very reliable breeders. This breed has been developed over many decades by devoted stud cattle breeders who correctly anticipated a growing world trend back to more moderate-sized animals with all of the attendant benefits.

Released on the market only recently, Miniature Hereford Cattle have the ability to reduce herd animal size, improve feed conversion and carcass ratio all in the same generation. The smaller size of these animals makes them extremely practical as you can run twice as many animals on a given acreage. Also the cow/calf weaning ratio is very high at around 65%. Comparison studies have shown just how efficient these animals are compared with their larger counterparts.

Feeding requirements during drought

Supplementing pasture with alternate grazing

The first problem you usually face in a dry year is lack of pasture. If there is some grass, you can stretch it by feeding grain and hay or straw in the pasture. Barley chop at 5 pounds per cow daily is like 20 percent

more pasture.

The most important consideration is getting the cows bred so there will be a calf crop next year. Energy is important. So is vitamin A and phosphorus. These are in short supply on dry pasture. An average milking cow needs about 75,000 IU of vitamin A daily either by injection every sixty days or in the grain. Intake of 1:1 calcium:phosphorus mineral should be about 4 ounces (100 grams) per cow daily. Mix with salt or feed with grain to make sure it is consumed.

If there is no grass you should consider sowing cereal crops for use as emergency pasture. Although feed can be purchased and transported to your farm, growing as much of your own as possible is usually the cheaper choice. Using cereal crops to extend fodder supplies is probably the most economical way of carrying your livestock through a period when pasture conditions are poor.

Oats can provide substantial emergency grazing if it is seeded on summerfallow or on low lying land where moisture is most plentiful. Barley, winter wheat and fall rye can yield as well as, or better than, oats and are also suitable to establish and produce high pasture yields in July but taper off rather quickly in August. The spring seeded winter cereals are a little slower to establish than spring cereals and produce high pasture yields in July and August. Their yield tapers off in September and October but they do continue to produce low yields during this period as well. Fall rye can be grazed for a period and still harvested for grain if there is sufficient moisture. Grazing in the spring reduced yield 10 per cent; fall grazing reduced yield 17 per cent and grazing in fall and spring reduced yield by 25 percent.

Cereals can be grazed approximately 4 to 6 weeks after seeding, and can be stocked heavily to use all available growth. It is advisable to seed a second field 3 weeks after you seed the first so that when the first one is grazed off, the second will be ready and so on. If drinking water supplies are adequately located this system can provide continuous pasture all summer. If it rains enough later in the summer, the fields your herds grazed early in the season may regrow and produce either additional pasture or hay in the fall. In times of drought, the previously mentioned cereals usually out yield other annual forages such as millet and sudangrass by substantial amount.

Other management considerations for coping with inadequate pastures are as follows:

- Confining cattle to a small part of the total pasture area for as long as possible in order to give the remainder of the pasture additional time to grow. The rotational grazing concept will increase forage production in dry years as well as in times of adequate moisture.

- Grazing grass hayland rather than legume forage stands if it becomes necessary to pasture hayland because legumes provide much better second-cut potential than grasses.
- Cutting greenfeed from a portion of cereal crops intended for harvest as grain. Weed field would be the most likely candidates.

Creep feeding and weaning early

Creep feeding takes the pressure off the cows, leaving them as much as 50 pounds heavier in the fall. That's important for winter maintenance. Calves gain efficiently, with feed conversions between 5:1 and 7:1. You will have heavier calves in the fall.

Calves like whole, coursely cracked or rolled grain. The creep ration should contain 70 per cent TDN (energy) and 12 percent or more crude protein. Good quality whole oats is favoured by many cattlemen. When pastures are dry, it pays to increase protein in the creep feed. Use a natural protein source (no urea); pelleted so it won't separate. An example creep feed might be 40 percent rolled barley, 50 per cent whole oats and 10 percent pelleted canola meal or commercial 32 (0) supplement.

The creep area doesn't have to be elaborate. Fence off an area close to water or salt, preferably with shade. An opening 16 to 18 inches wide and 3 to 3.5 feet high will let calves in and keep cows out. The creep feed can be fed in feed bunks, troughs or self feeders.

Start the calves on feed slowly, increase gradually. If too much feed is put out at first, some calves may overeat. Also the leftover feed will get stale and calves may back off. Once calves are used to the creep, don't let it run empty. Creep feeding works better on smaller pastures than open range with long distances between water holes or salt licks.

Wean the calves as early as possible. Feeding them directly is cheaper than feeding the cows to maintain production plus it allows the cows to pick up condition before winter. Calves can be weaned as young as 100 days, with no problems, provided they are fed a high quality feed. The feed should contain about 70 percent TDN, 14 percent crude protein (no urea), 0.6 percent calcium and 0.45 percent phosphorus. Talk to your livestock specialist or feed company. You may consider the ration more expensive per ton than cow feed. With calf intake about 8 pounds per day and gain about two pounds per day, it's low cost gain. Calves on creep feed for even two or three weeks before weaning, will wean and go on feed much easier. Follow recommended weaning practices to reduce stress on the calf. Where possible "process" the calf three weeks before weaning. Treat weaning as a single stress.

Calves can be weaned at 3 to 4 months if they are given a high quality

ration. It is cheaper to feed the calves directly than to feed the cows for milk production.

Winter Feed Supplies

Perennial forages require plentiful moisture by early May to yield well later in the year. You should avoid the temptation of being optimistic and waiting for the first hay growth to develop into a good crop after a dry spring because it won't. Perennial forages should be cut by the early blossom stages for legumes or early heading stages for grass, whether there is sufficient yield for hay or not. That way, if timely rains appear in late June or early July a good second cut can be obtained. If not cut, first growth will simply mature, with little second growth. Sloughs and roadsides can be cut for hay. Weedy crop areas such as wild oat patches are also good feed and reduce weed infestation next year. Oats planted after a late rain can still be cut for green feed. The same applies to cereals used for grazing and allowed to re-grow. Sometimes these fields can provide winter feed if there are later rains. Watch for nitrates if there's an early frost. Oats should be cut in the milk stage for best quality. Feed value drops off rapidly as it matures. Barley and wheat can be cut for green feed when slightly more mature. Livestock producers should also consider trying to save as much crop residue as needed during grain harvest to replace any hay production which may have been grazed as emergency pasture. Chaff can be collected as feed with the advantage of not removing all the plant material from an area, leaving the straw to help hold the soil from erosion. Chaff collection systems are becoming more effective and readily available. Chaff can make up a sizeable portion of the ration for wintering beef cattle or sheep. Chaff fits well into several self feeding systems such as electric wire. Yield of chaff is not consistent. Wheat crops have more chaff than barley or oats. Short crops and dry conditions produce more chaff as shorter material falls through the straw walkers. Type of combine and combine settings make a difference too. Chaff from some of the very rough awned bearded wheats such as Pitic-66 may cause palatability problems, especially with younger animals. Chaff from Wascana durum has been fed to young stock with no reported problems. The better condition cattle are in at the beginning of winter, the better they will tolerate the winter.

Winter Feeding Strategy

You may be faced with feeding less feed or feed of a poorer quality, yet your cattle still need adequate amounts of energy, protein, minerals, vitamins and roughage. Get a handle on available feed supplies for winter feeding-quality as well as quantity. If there isn't sufficient feed for the numbers of animals you usually overwinter, then you have to decide whether to buy feed or reduce the number of animals

overwintered.

Prioritize herd reduction. Top priority should be the pregnant brood cows. If you can get them through the winter with enough body condition after calving to rebreed on schedule, your breeding program won't suffer too badly. That will help you win the war even if you feel you are currently losing the battle.

Pregnancy check the herd in the fall. Cull the opens, cull the bad feet, udders, eyes and personalities. Cull the poor mothers. Here's where good records will help you. You can't always eyeball a loser or remember a problem from last spring. If there is extra feed after the main herd's needs are met, keep the best replacement heifers. Keep the bred heifers and if there's enough feed keep heifer calves from your best cows. Use your records.

How well cattle tolerate the winter depends on their condition at winter's onset. Thin cattle do not have fat reserves and need as much energy as during any normal winter. They are also more likely to have low vitamin and mineral reserves. Watch them closely for deficiencies, particularly vitamin A deficiency. Separate young and thin cows from the rest of the herd. Feed the young and thin cows extra forage or grain. Mature cows that finish the grazing season in better than average condition can withstand some feed cutbacks. You can reduce the roughage they receive from the 10 to 20 pounds you normally would feed daily to a minimum of four to five pounds daily, along with adequate grain. Greater reductions of forage would interfere with normal rumen function. During the winter feeding these cows can lose up to 120 pounds. After calving give them extra feed so they nurse properly and return to breeding condition. Larger weight losses may jeopardize their health or cause breeding problems.

If you have to buy feed, decide whether you need hay or can stretch existing roughage with grain or protein supplement. Poor quality roughages if properly supplemented to meet the animals' requirements can replace quality hay in maintaining the pregnant beef cow.

Thin cattle require more feed to keep warm. A thin cow can require 50 to 70 per cent more feed during a cold snap than a cow with some fat cover. That's why it pays to have cows come into winter in good condition - they need less feed.

Don't waste feed. Feeding on the ground can waste up to 50 percent of poor quality feed. Of all feeding gates tested, home-built "tombstone" type feeders wasted the least feed. If you are feeding with an electric wire keep it adjusted. Moving it a little twice daily is better than once daily and having the animals reach too much feed.

Retain the best quality feed for young stock and nursing cows after

calving, because both milk production and growth demand extra nutrients. Allow enough feed for nursing cows to provide twice their precalving energy and protein needs. Save your best roughage for replacement calves, bred heifers and cows after calving. Both milk production and growth demand extra nutrients.

Ammoniation of chaff and straw increases energy and crude protein content. If allowed free access to treated straw or chaff, cows will eat more than they would untreated. Intake increases from about 12 - 14 pounds of untreated to 18-22 pounds of treated. Grain required drops from 5-6 pounds per day to about 2 pounds. Conversely, if grain is fed at 5-6 pounds per head, intake of ammoniated material can be restricted and still maintain the animal in good condition.

Healthy cattle use feed more efficiently. Treat for warbles and lice in the fall. Re-treat for lice in mid winter. Make sure vitamins A, D, and E are adequate either through the feed or injections every 60 days. Balance rations with enough calcium, phosphorus and trace minerals, either mixed with the feed or fed free choice. Know your feed quality and your animal's requirements. Have your feeds analyzed. Discuss your situation with your Ag. Rep, Livestock Specialist or feed company nutritionist.

Feed all cattle extral in cold weather. Cattle need extra grain to help maintain body temperature.

Feed Alternatives

When choosing feed for livestock consider its nutritive value, bulkiness or lack of bulk, presence of other substances and health problems related to its use.

Hay

Dehydrated alfalfa pellets consist of finely ground artificially dried alfalfa forage in 1/4 inch diameter pellets. They can replace up to 14 pounds of forage in dairy rations. In beef cows rations of about 5 pounds daily can be used to supplement cereal straw. Alfalfa cubes can be used as the only forage for dairy cattle but fewer problems are encountered when at least 5 pounds of long hay are also fed. Dehydrated alfalfa pellets may also be used in sheep and swine rations. Dehydrated pellets can also be used as a protein supplement when fed with low quality roughage.

Slough hay can provide the forage requirements of beef cattle, sheep, and dairy replacement animals, if adequately supplemented. The feed value for slough hay is usually higher than cereal straw and can approach that of brome grass hay. Slough hay is more variable in quality than tame grasses. Generally, fine grasses are higher in value.

The coarse material is less digestible and will need supplementation with grain to meet the energy and protein requirements of wintering beef cows. Harvest should occur before killing frost as frozen slough hay will deteriorate quickly and is only about equivalent to cereal straw in value.

Cereal hay is suitable to provide the forage component of rations for all classes of beef cattle, sheep and dairy cattle and should be equal in value to good quality brome grass hay. Wheat, oats, barley, rye, rapeseed and mustard crops can be used for livestock feed. Harvesting should occur between heading and the soft dough stage and should be timed to retain as much leafy material as possible. Rye hay loses palatability and protein content rapidly after flowering. Good quality cereal hay or silage is about equivalent to brome grass hay in energy and protein content. Oat, mustard and rapeseed crops which have frozen or which have suffered from severe drought prior to harvest should be checked for nitrate content and the ration adjusted if significant amounts of nitrate are present.

Native grasses, referred to as "prairie wool", are suitable for use in most beef cattle and sheep rations, can be used for replacement dairy cattle and if necessary for milking dairy cattle. These grasses approach brome grass hay in protein and energy content. Stands which are more than one year old can be utilized if available. Care should be taken to avoid cutting while the spears are present on spear grass, generally during July and August.

Roadside hay primarily consists of grass hay, (bromes, crested wheat) and some clover or alfalfa. When harvesting and feeding it, avoid glass and other foreign material.

Russian thistle may be used for hay when other forages are not available. It can make up a significant portion of rations for beef cattle and sheep. Feed it in very limited amounts to dairy cattle. It is usually equal to a fair quality hay in protein content but is lower in TDN. It is a surprisingly palatable feed. Because of its high ash content, it may cause cattle to scour if fed at a high level.

False or wild barley (foxtail) has awns which, if fed in large quantities, can become impacted in the mouths of cattle. Use this forage cautiously. Grinding through a hammer mill may help to break up the awn.

Kochia weed is harvested before it matures is excellent cattle feed. It is as high or higher in energy and protein as good alfalfa hay. A high mineral content makes it extremely laxative. Kochia weed should not make up more than 25 per cent of the total diet.

Straw

Fresh cereal straw is a good alternative in wintering rations for cows and sheep if properly supplemented with an energy source like grain and with added minerals and vitamins. All cereal straws can be fed, with oat and barley straws being preferable because they are more palatable. Straw can be used in combination with other feeds as the sole roughage for beef cows, however, its use should be limited to 8 to 10 pounds to maintain milk production in dairy cows.

Straw one year old should also be considered a feed source. It usually is slightly more digestible and palatable than fresh straw.

Ammoniating straw and chaff will improve their feed value and increase consumption. Calculate the cost of ammoniation before treating straw. Ammoniation reduces but does not eliminate the need for grain.

Chaff can be used in a similar manner to straw in rations for beef cows and sheep. It contains some grain and weed seeds making it slightly better in feeding value than straw. It, however, still must be supplemented with minerals and vitamins and an energy source such as grain. Producers have successfully left chaff in fields as bunches to be grazed or fed in combination wintering rations. Feeding on the ground can waste up to 50 percent of poor quality feed. Using tombstone feeders or electric fences greatly reduces wastage. Using chaff as feed leaves the straw on the land to prevent erosion.

Flax straw is considered to be of lower feeding value than cereal straws. It is coarse and fibrous and as a result, cannot be processed but is readily eaten by cows. If frozen, it should be analysed for prussic acid, which can be poisonous to animals consuming it. Energy and protein must be adequate to guard against rumen impaction.

Protien Supplements

Liquid protein supplements can be used as part of balanced rations for ruminants. Most of the liquid protein supplements are mixtures based on molasses and contain urea and/or performed protein, supplemental minerals and vitamins. Read the label carefully to regulate the amounts animals receive or the amounts to be mixed in the grain rations. Most liquid protein supplements are low in calcium and require a calcium supplement to be fed. Do not feed with other feeds containing ureas or with ammoniated straw or chaff as toxicity may result. Do not feed straw and liquid protein supplement only. Some grain or quality hay is required to provide sufficient energy.

Canola meal, produced after oil is extracted from low erucic acid, low glucosinolates rapeseed contains about 37 per cent protein and same TDN as oat grain. It can be used as an alternative to soybean meal. If oil meals are used in place of commercial protein supplements, pay special

attention to minerals and vitamins in the rations. During a cold snap, cattle of low quality roughage need extra energy and protein to prevent rumen impaction.

Screenings

Western grain screenings (pelletized screenings) contain mixed grains, wild oats, weed seeds, chaff, hulls and some dust. The contents are finely ground and pelleted. They are similar to light oats in feeding characteristics (11-12 per cent protein and 60-68 per cent TDN). The amount fed to milking cows should not exceed 6-8 pounds per head daily. They can also be used to supplement roughage (replacing cereal grains) in feeding beef calves and cows and replacement dairy heifers. Because of their fine particle size and the characteristics of some of their ingredients, digestive upsets such as bloat, might occur if they are fed at a high level.

Pelleted flour mill by-products containing 15 percent protein, 3 to 6 per cent fat, 12.5 per cent fiber and 65 to 68 per cent TDN may be available in some areas. They consist of wheat bran, broken kernels and weed seeds, making them comparable in feeding value to oats. They, however, still must be supplemented with minerals and vitamins.

Rapeseed fine screenings are made up of pods, broken stems and dust particles along with some cereal grain and larger weed seeds. They have about the same feeding value as a medium quality hay.

Lentil screenings or lentils rejected because of ascochyta blight discoloration make a good protein source for cattle rations. Crude protein varies between 18 to 24 per cent. They can also be used as an energy source.

Grain

Barley is medium in energy (75 per cent TDN) and protein (10 - 12 per cent) among the cereals. It may be used successfully as the only grain rations for all animals. Its use is widespread in the grain portions of livestock rations, but it may also be used to replace part of the roughage and is a better choice than heavier grains (high energy) such as wheat and corn. A combination of barley with very poor roughage sources will give a feed mixture equivalent of high quality roughage (alfalfa hay, clover hay or brome hay)

Oats cereal is the lowest in energy (68 per cent TDN) and compares with barley grain in protein (10-12 per cent). Oats can be used as the only grain in beef cattle and sheep rations except when roughage quality is very low. Oats contain 10-12 per cent fibre and may be used to dilute heavy grains to avoid overfeeding of energy. Oats are the closest to roughages among cereals and make a good roughage

replacement. Barley, oats, wheat and rye are grains commonly used in rations

Wheat is a high energy (80 per cent TDN) high protein (13-15 per cent protein) cereal. It may not be used as the only grain because of some palatability problems at very high levels. It makes an excellent grain ration ingredient when the quality of roughage is low in terms of energy and protein. It should be rolled or coarse-ground except for sheep which can use all cereals as whole grain.

Rye grain is similar to wheat in its nutritive value (80 per cent TDN, 13-14 percent protein) when used at low levels in the feed. Rye should not make up more than 40 per cent of ruminants' grain rations and more than 25 per cent of swine rations due to palatability problems. Also rye is most susceptible to ergot infestation.

Other Feedstuffs

Pea Vines - The residue from production of field peas and lentils is a satisfactory feed that is about equivalent to a low quality grass hay in feeding value. The palatability is quite good.

Brewer's mash - This byproduct from malting barley can be used as a feed in either wet or dry form. It is low in energy (61 per cent TDN of dry matter) but high in protein (25 percent of dry matter). It's an excellent source of B vitamins, but its use for swine may be limited due to its bulkiness in wet form.

Bakery waste - Stale bread and other baking products may be ground and used as a replacement for cereal grains. Because of the fine particle size, it should be mixed with other concentrates and limited to about 10 percent of the total ration.

Bullrushes, willows, buckbrush and other woody material are generally not well digested by cattle or sheep. Limited quantities present in hay are not harmful but enough hay should be provided to allow animals to sort out and reject the woody material. They may, however, be used as bedding, if ground.

Grinding roughages. When hay and straw are scarce, grinding has several advantages. Animals cannot sort as easily and will eat everything, reducing waste. Low quality roughage can be mixed with higher quality in proportions you choose and the cows have to eat it all. Feeds with high nitrate levels can be diluted below the toxic level. Animals can eat more poor quality roughage if it is ground, and therefore grow faster or maintain themselves easier than on the uncut roughage. However, if energy and protein supplementation is not adequate, rumen impaction can be a very real problem. There is no point in grinding forage for beef cows if they can get enough to eat

without grinding. It increases cost, encourages over consumption and could lead to impaction. Grinding might pay if you were mixing quality feeds and limit feeding to prevent waste. If hay or straw is tough or damp, power requirements to grind it go way up. The dryer the better. A 1/2 inch screen is the best size as there is better intake, less bridging and feed particle separation in complete rations. Acidulated fatty acid (AFA), tallow, mineral oil, crude vegetable oil, molasses and water have all been used to cut dust problems. If water is used, the cut feed should be consumed within 24-48 hours to prevent heating.

Feed testing and ration design

Nutrient requirements of livestock vary with age, size, level of production and reproduction. Nutrient utilization is most efficient when nutrient supply in the diet is in balance with nutrient requirements of animals. Feedstuffs vary in their nutrient contents greatly from field to field, year to year, and species to species. The level and type of fertilization, stage of maturity and method of storage and processing, also affect nutrient composition of feeds. To balance rations you must know exactly what nutrients are present and in what amounts. This information is imperative when roughage mixtures of unknown proportions are harvested and unfamiliar materials are going to be used in feeding livestock. The only accurate method of getting precise information is by laboratory analysis of feed samples. Feeds can be analyzed for crude protein, estimated digestible energy, essential minerals and vitamins, and for toxic substances such as nitrates and prussic acid. Fees vary depending on the number and kind of analyses and approximate actual costs involved. Testing also provides a full range of ration balancing and feeding advice based on information provided by the producer. Computerized ration formulations includes "least-costing" whenever possible. This service is included in the cost of the analysis. If laboratory analyses of feeds and advice on their use are to be meaningful it is essential that samples be properly taken, and that they be accompanied by detailed information about the use to which the feeds will be put. Sampling devices and information sheets are available from agricultural representatives, livestock extension specialists, and other persons involved in servicing the livestock industry.

Health Problems

Ration Changes - Animals need time to adapt to changes in feed. Ruminants especially need to gradually switch from high roughage rations to high grain rations. Rapid changes may cause acidosis, or other digestive upsets in cattle or sheep. Feeding hay to cattle and sheep before allowing them to graze green crops or lush pastures can prevent

some of the digestive problems. Or, you might allow the animals to graze only a few hours a day until they have adapted to the new feed. Some animals may develop allergic reactions to substances in fresh, lush, green feeds.

Mold and Ergot - Mold toxins or ergot can cause poisoning in animals. Swine and pregnant animals are most susceptible to these toxins. These toxins, if consumed at high levels, may cause abortion, vaginal or rectal prolapse, internal bleeding or dry gangrene-like symptoms and, even, death. Weak and starving animals are less able to detoxify these toxins. Addition of vitamin, A,D, and E may help the animals tolerate theses toxins. Diluting the moldy feed with clean feed may bring the toxin concentration down to a safe level. Dilute ergoty feeds to less than one ergot body per 1000 kernels.

Rumen Impaction - Feeding excessive levels of low quality hay or straw to cattle without adequate grain supplementation to provide energy and protein can leave the forage undigested and cause rumen impaction. Lack of water may also contribute. Hammering low quality forage can increase the amount of forage eaten but may also lead to impaction if the ration is low in energy and protein content. You must be particularly watchful to ensure adequate energy intake during periods of sever cold.

Problems due to water - While producers have successfully used clean snow as the winter water source for beef cows and sheep, this practice must be used with extreme care as lack of water can lead to rumen impaction or reduced feed intake. If you are concerned about the quality of water for your livestock or have noticed your animals are eating less or drinking less or your animals have scours, you should have a water analysis carried out to determine the level of minerals present in it.

Pesticides and Herbicides - If you intend to salvage cereal crops for feed, ask about pesticide and herbicide applications to make sure restrictions listed have been compiled with. Never feed seed grain treated with chemicals. Awns from wild barley or "foxtail" can lodge in an animal's mouth, sometimes causing an abscess. Hay with a lot of "foxtail" is unpalatable and should be avoided.

Dicoumarol poisoning or "Sweetclover Disease" - Moldy sweetclover hay or silage may contain dicoumarol. This agent prevents blood from clotting, so animals may bleed to death internally or from external wounds. One rule of thumb for safe feeding is: 3 weeks on sweetclover and 3 weeks on another feed. New low-coumarin varieties of sweetclover such as Polara do not become toxic with molding.

Nitrate Poisoning - Frost, drought and weed sprays may be factors in high nitrate accumulation by plants. Oat straw and oat hay are most affected. Green oats should be cut either immediately after a frost

before nitrates build up or after 14 days with no frost to allow the nitrate built up to be cleared by the plant's system. Green feed cut after a frost should be tested for nitrates. Agricultural representatives can do a quick spot test for presence of nitrates. If nitrates are present, the amount should be determined.The rule of thumb for feeding is to dilute the nitrate-containing roughage with nitrate-free roughage so the total feed contains no more than 0.5 percent nitrate. For example if green oats has 1.0 percent nitrate it should be diluted half and half with nitrate free roughage. This should be done with each feeding to prevent over consumption by any individual animal. It does not work if high-nitrate feed is fed one day and nitrate free feed the next. Forages containing nitrates may cause death to cattle and sheep by interfering with oxygen transport by the blood. Symptoms of nitrate poisoning include rapid breathing and pulse as the animal strives for oxygen, frothing from the mouth, blue color of the mucous membranes, muzzle and udder and brown colored blood. Treatment requires early intravenous injection of a 40 percent solution of methylene blue.

Prussic acid (Hydrocyanic Acid) Poisoning - Flax that has been frozen or severely affected by drought may contain toxic quantities of prussic acid (0.03 - 0.04 per cent). Symptoms of prussic acid poisoning are similar to nitrate poisoning except blood remains bright red. Death usually occurs before treatment is possible, although early intravenous injection of sodium nitrate and sodium thiosulfate by a veterinarian may be beneficial. Where prussic acid may be a problem, feed should be analyzed and suitable precautions taken. Prussic acid in cured forage gradually disappears and is seldom a problem in the winter.

Nutritional deficiency diseases - Poor quality feeds supply fiber to the animals, but are low in energy, protein, minerals and vitamins. Inadequate amounts of nutrients may lower conception rate, disease and parasite resistance, and may result in weak calves and lambs and sometimes still-born off-spring. When low quality forages are fed, you must provide mineral and vitamin supplements. Pay particular attention to supplying adequate vitamin A and supplying minerals free-choice or force feeding. It bears repeating, know the quality of your feeds and your animals requirements. Avoid wasting feed or underfeeding by having your feed analyzed. Talk to your Ag Rep, Livestock Specialist or feed company nutritionist about the best rations for your cattle.

The following disease conditions pose higher risks during very dry periods:

- **Pneumonia** - Severe blowing dust can irritate the respiratory tract of cattle and cause an increase in cases of pneumonia.
- **Poisonous Plants** - Poor pasture conditions increase the risk of plant poisoning. A good many poisonous plants are rather unpalatable but when grass is short cattle will eat such things as

choke-cherry leaves, marsh arrow grass, etc. which can result in poisoning.

- **Blackleg** - Soil borne diseases such as Blackleg present a higher risk because cattle are grazing close to ground level.
- **Grass Tetany/AIP** - Severe drought followed by heavy rain may result in rapid, lush growth of cereals and/or seeded pasture. This has the potential of causing grass tetany, a disease somewhat similar to milk fever and a form of pneumonia variously called AIP (atypical interstitial pneumonia) pulmonary emphysema, fog forever, etc. The major symptom of this form of pneumonia is labored breathing. The local practicing veterinarian can provide additional information regarding these and other potential disease conditions. Hungry cattle should be fed before being turned into new pasture. They may eat poisonous plants because they won't selective graze at first. They should be watched carefully the first few days for digestive upsets or AIP (change of pasture pneumonia).

Ammoniation of straw and chaff

It is recommended to leave the straw on the land especially in the brown and dark brown soil zones, and collect chaff for feed. Straw left on the land preserves soil tilth and helps prevent erosion. When a producer is faced with a feed shortage, he must decide whether to remove the straw for feed or look for more feed elsewhere. Ammoniation is a method of treating low-quality hay and crop residues such as straw and chaff to improve their nutrition value as feeds for ruminant animals. The method involves sealing the residue or hay in a gas-tight enclosure and adding anhydrous liquid ammonia supplied by fertilizer dealers. After 21 days, the chemical reaction is complete. Ammoniation improves feeding quality by increasing the amount of digestible energy (TDN) in the residue, the amount of roughage the animal will consume, and the crude protein equivalent (CP). No problems have been reported with the feeding of ammoniated feeds. No abortions, significantly lightweight calves or reproductive problems have been associated with ammoniation. No incidents of impaction should occur provided the total energy intake is adequate. Ammoniation of straw or chaff reduces grain requirements, but does not eliminate it.

Sampling prior to ammoniation - Straw or chaff intended for ammoniation should contain at least 12 per cent moisture, preferably 15 to 20 percent. The feeding quality of straw or chaff should be as follows: wheat straw should have a TDN of at least 33 per cent and barley straw a TDN of at least 38 per cent. To assure that the moisture content and feeding quality of your straw or chaff are adequate for ammoniation, submit a representative sample for analysis. Combine

small amounts of straw taken from different parts of the field or the stack so the analysis will truly represent your material. Your agricultural representative and livestock specialist have the equipment required to sample your residue properly.

When to ammoniate - A minimum moisture level of 12 per cent is necessary for efficient ammoniation. This can be achieved by baling early in the morning after a heavy dew or by baling as soon as possible after a rainfall. Usually chaff collected from combining a swathed cereal crop is very dry, containing 8-10 per cent moisture. The moisture content must be increased to 15-20 per cent, or a satisfactory improvement indigestibility may not be obtained.

Related web pages:

- Cattlemen on the WEB
- Western Producer
- American Beefalo International

Commercial suppliers:

- None identified.

Electronic mailing lists:

- Beef-l listserv address: LISTSERV@WSUVM1.CSC.WSU.EDU
- **BSE: Bovine Spongiform Encephalopathy**

  Subscription address: listserv@listserv.net

  Subscribe to BSE. Type "SUB BSE-L Yourfirstname Yourlastname" in the first line of the body.
- **BEEFTODAY-L: Beef Today Mailing List**

  Subscription address: majordomo@angus.mystery.com

  Topics: A forum for cattle producers to discuss issues, operations, and ideas with each other and the editors of Beef Today. Through this list, producers can gain further insight into past Beef Today articles and help develop future ones. However, discussions are not limited to what has appeared or will appear in the magazine.

  Subscribe to BeefToday-L. Type "subscribe BeefToday-L Your E-mail Address" in the message body. (Not

supported by all browsers.)

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Approved Practices in Beef Cattle Production - by Elwood M Juergenson - Publication Date: February 1980 - List: $26.60
- Beef Cattle Feeding and Nutrition - by Tilden Wayne Perry, Michael J. Cecava (Editor) - Publication Date: July 1, 1995 - List: $74.95
  Booknews, Inc. , 03/01/96:
  Helps ranchers and feedlot managers maximize yields by offering information about feeding and nutrition of beef cattle from breeding to finishing. Describes cattle's requirements for vitamins, minerals, and protein; computer methods for calculating and monitoring rations; feed stuffs, including pasture and forages, hay, silage, and concentrates; the breeding herd; and aspects of the finishing process. Updated and augmented from the 1980 edition. Annotation copyright Book News, Inc. Portland, Or.
- Beef Cattle - by Alvin Ludwig Neuman - Publication Date: July 1986 - List: $80.95
- Beef Housing and Equipment Handbook/Mwps-6 - Publication Date: February 1987 - List: $7.00 + $1.85 special surcharge
- Beef Production and Management Decisions - by Robert E. Taylor - Publication Date: July 1993 - List: $89.00
  The publisher, Prentice-Hall Career & Technology :
  The text examines the primary biological principles that contribute to raising productive beef cattle and discusses the biological and economic principles that serve as the foundation for effective management decisions. The text's integrated approach to the various sectors of the beef industry gives students a more unified perspective. The second edition continues to examine management issues in great depth. Chapters are devoted to topics such as commercial cow-calf management decisions, yearling-stocker management decisions, feedlot management, and retail beef products and consumers.
- Beef Production from Different Dairy Breeds and Beef Crosses - by G.J. More O'Ferrall (Editor) - Publication Date: January 1983 - List: $113.50

- Beef Production from Silage and Other Conserved Forages (Longman Handbooks in Agriculture) - by J.M. Wilkinson - Publication Date: June 1986 - List: $5.95 + $1.85 special surcharge
- Lameness in Cattle - by Paul R. Greenough (Editor), A. David Weaver (Editor) - Publication Date: January 1997 - List: $75.00
- Nutrient Requirements of Beef Cattle (Nutrient Requirements of Domestic Animals (Unnumbered).) - Publication Date: June 1, 1996 - List: $29.95
- The Lasater Philosophy of Cattle Raising - by Laurence M. Lasater - Publication Date: January 1, 1993 - List: $12.00
- Tropical Cattle : Origins, Breeds and Breeding Policies - by W. J. A. Payne, John Hodges - Publication Date: July 1997 - List: $110.00

- Applied Animal Nutrition: Feeds and Feeding - by Peter R. Cheeke - Publication Date: August 1998 - List Price: $92.00
  Booknews, Inc. , June 1, 1991
  Cheeke (Oregon State) discusses the agronomic, nutritional and toxicological properties of temperate and tropical feedstuffs and gives a solid grounding in the fundamentals of feed processing, diet formulation and feed manufacturing. He covers a broad range of species from livestock and poultry to fish and wildlife. Annotation copyright Book News, Inc. Portland, Or. --This text refers to the hardcover edition of this title
  From the Back Cover
  KEY BENEFIT: Suitable as either a book for undergraduate courses in Animal Nutrition or a reference for professional animal nutritionists, extension agents, veterinarians, and livestock producers. KEY TOPICS: This book has a two- fold objective—(1) to describe the properties of feedstuffs used in the feeding of domestic animals and (2) to provide information on feeding practices for a variety of domestic and exotic animal species.

- A Guide to Raising Beef Cattle (Storey Animal Handbook) - by Heather Smith Thomas - Publication Date: June 1998 - List Price: $18.95
- The Use of Drugs in Food Animals : Benefits and Risks - by Subcommittee on Drug Use in Food Animals, National Research Council - Publication Date: November 1998 - List Price: $34.95
  Synopsis
  The book overviews why and how drugs are used in

food-producing industries--poultry, dairy, beef, swine, and aquaculture; discusses the prevalence of human pathogens in foods of animal origin; and addresses the transfer of resistance in animal microbes to human pathogens and the resulting risk of human disease.

Periodicals:

- None identified.

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Corn Silage

Frequently Asked Questions Other Information Sources Return to Beef Contents

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Corn Silage and the Cattle Feeder

Well-eared corn silage has been extensively used in beef cattle feeding for many years. Of all feed crops, it is generally the top producer of nutrients per acre. Thus, a liberal use of corn silage allows the farmer-feeder to market more pounds of beef from his farm than from any other procedure. It makes efficient use of the corn stalks, leaves and cobs which are usually wasted when only the grain is fed.

Corn Easily Ensiled

With its solid stems, high carbohydrate content and generally desirable moisture level, corn can be ensiled with few problems. The primary requirement is that the fermentation take place in the absence of oxygen. This can be accomplished in many types of upright silos, bunker silos and even in stacks covered with plastic when made in large volume. The corn plant should be finely chopped to pack well in the silo. When made in stacks, it is difficult to avoid surface spoilage. They should be used only for large amounts when the weight of the chopped corn is great enough to aid with the packing and the surface area is a relative small percentage of the total. It is also difficult to feed from a stack without undue spoilage. They can best be used to refill upright silos when a large amount is moved at one time.

Variety and Stage of Maturity

Energy is the nutrient required in greatest amounts by finishing cattle. Well-eared corn silage is approximately one half corn grain on a dry matter basis. Corn which will produce the maximum yield of grain per acre should be used for silage production. Practices which increase vegetative growth but interfere with ear development reduce the amount

of feed per acre. Such practices include: planting long season hybrids which are harvested before maturity; planting too thick or mixing with other crops.

The most rapid storage of nutrients in the corn plant occurs when the kernels are filling. If harvested for silage when immature, the yield will not only be reduced but the silage will be less palatable. Research has shown that silage made from well dented corn has a higher feeding value than that from immature corn. Such corn will have nearly all of the husks dry as well as the lower leaves and will contain about 35 percent dry matter.

Dry Matter, Weight, Volume Relationships

Silage yields, silo capacities and silage consumption data are generally expressed in total weight, such as tons per acre or pounds eaten per head daily. Such figures are rather meaningless unless some idea of the dry matter content of the silage is known. For example, the difference between a 25% and a 35% dry matter silage may not seem large but the 35% really contains 40% more dry feed than the 25%. Even between 30 and 35% dry matter silages, the drier silage contains 17% more actual dry feed.

On the other hand, weight of dry matter per unit of volume varies relatively little. This is, wagon loads of chopped corn or silos full of silage will contain about the same weights of dry feed even though their total weights may vary widely due to differences in the amount of water contained. For example: a silo 20 feet in diameter containing 54 feet of settled silage would contain approximately 129 tons of dry matter. This amount of dry matter would represent 258 tons of 50% dry matter material, 387 tons of 33-1 / 3% dry matter material or 516 tons of 25% dry matter material.

Limestone Improves Feeding Value

Since no special problems were encountered during ensiling and a highly nutritious feed was produced, no research on the preservation of corn silage was conducted for many years. Many experiments verified the value of silage but little had been done to explain the high value or determine how it might be further improved.

Cattle and lamb feeding trials have shown the organic acids present in silage to have a high feeding value. This was especially true of lactic acid, the major one found in corn silage. If the amount of lactic acid in corn silage could be increased, would the silage have a higher feeding value?

Fermentation in the silo continues until a certain amount of acid is produced, the amount being directly related to the moisture content of the ensiled material. When this degree of acidity is reached, fermentation stops and the silage is preserved as long as air is kept from it.

Since the acids produced eventually stop the fermentation, it was found through research that the addition of ground limestone would neutralize these acids. This makes fermentation last longer with more total acids being produced. The addition of one percent (20 lbs. per ton) of pulverized limestone approximately doubles the lactic acid content of the resultant silage.

A number of experiments were conducted to determine if this increase in lactic acid content would increase the feeding value of the silage. The results showed that the addition of one percent limestone to chopped corn at time of ensiling reduced the amount of silage required per pound of gain. This increase in feed efficiency averaged 6.5 percent. Although this is not a large increase, limestone is low in cost and its use offers other advantages.

The addition of limestone corrects the normal calcium deficiency of corn silage and the treatment reduces the amount of molding and spoilage which may occur in the feed bunk in warm weather. Another effect of the acid neutralization is that acids are less likely to attack silage walls. The increased fermentation would also tend to increase the breakdown of nitrates should they be present in the ensiled material.

In the experiments discussed above, which were conducted at the Ohio Agricultural Research and Development Center, the ground limestone was added by sprinkling over the top of the loaded wagons of chopped corn. This is a tiring and time consuming procedure, hence, a metering device at the blower which can be filled from the ground is more efficient.

Other Additives

Limestone or a mixture of equal parts limestone and urea were found to be of equal value in producing organic acids in silage. For this purpose, limestone is much cheaper but urea supplies nitrogen, a source of crude protein which is deficient in corn silage for growing-finishing cattle. When corn silage is full fed with little or no grain, 10 lbs. of urea per ton will meet the protein requirement. When corn grain is fed at one percent of body weight per day (about half feed) with corn silage, 20 lbs. of urea are needed per ton. In three experiments conducted at the Ohio Agricultural Research and Development Center, 20 lbs. urea, 10 lbs. of limestone, and 2 lbs. of defluorinated phosphate were added per ton of silage which was fed with a half feed of dry shelled corn. Thus

ration was not improved by adding supplemental natural protein from dehydrated alfalfa meal, soybean meal or a mixed protein supplement, all of which increased the cost of the ration at that time.

Non-protein nitrogen may also be added to corn silage by the use of anhydrous ammonia. Pro-Sil is a proprietary mixture of molasses, anhydrous ammonia and minerals. These materials are handled as a liquid and hence can be pumped.

Recent, marked increases in the cost of all forms of nonprotein nitrogen have removed much of the advantage of adding these materials to corn silage. Relative costs should be checked with other sources of protein in deciding how to correct the protein deficiency of corn silage.

Numerous other additives for corn silage are being marketed. These include fermentation solubles, antibiotics, enzymes, various mixtures, unspecified materials, etc. Some of these have been shown to be of benefit when added to hay crop silage. Unfortunately, sufficient controlled research is not available to evaluate them as additives to corn silage.

Increasing Energy Content

Although well-eared, well-matured corn silage is the top producer of beef per acre, it does not contain sufficient energy to fatten young cattle at light weights. Levels of feeding and types of cattle will be discussed later. However, one rule-of-thumb often used is to feed one pound of grain per hundred pounds of body weight per day, plus all of the corn silage the cattle will eat.

In order to simplify storage and feeding, attempts have been made to produce a complete energy feed that could be stored in a single silo. Investigators at the Michigan Station were successful in producing such a feed by the use of "center-cut" silage. This silage was harvested by cutting higher than normal and by removing the top of the corn plant above the ear. Thus, a silage-containing a higher than normal percentage of grain and hence energy can be produced.

Experiments were conducted at the Ohio Agricultural Research and Development Center to fully utilize the corn plant by feeding growing-finishing cattle and a beef cow breeding herd. Ear corn was picked, processed through a combination chopper and roller mill and added to chopped whole plant corn from a similar area, thus, producing "Double-ear" silage for finishing cattle. The stover remaining after the ears were picked was chopped and ensiled for cow feed. Ten pounds of urea, 10 lbs. of ground limestone and 2 lbs. of dicalcium phosphate per ton were added to both silages. These silages were produced in two consecutive years and fed to growing-finishing calves and mature

Hereford cows, respectively, as their only rations. Results with both silages were very satisfactory.

Other methods of stepping up the energy content of corn silage have been investigated. However, none of them have been adopted on a wide scale. Most of them require either extra machinery, specialized equipment or additional labor at time of harvest. For these reasons, most producers harvest and store corn silage and corn grain separately by conventional means and combine them in desired amounts at feeding time. This simplifies harvesting procedures and allows more flexibility in varying silage to grain ratios at feeding time.

Research is continuing on how best to salvage, for beef cow feed, corn crop residue following harvest with a pickersheller. Numerous methods and machines are being used to salvage a part or all of the residue as silage or dry feed. Although there are problems in keeping harvesting and storage costs in line with the quality of feed produced, the potential volume of materials which might be used is tremendous.

Levels of Feeding

Many experiments have been conducted to study different methods of feeding, levels of silage and combinations of silage and grain for finishing cattle. These have included a large number of general feeding experiments with different weights, ages, sexes and breeds of cattle and also more basic experiments in which the net energy value of the various rations has been determined. In general, it may be said that it takes a definite amount of energy for maintenance and gain of cattle, that is, to finish a specific group of cattle and that, within certain ranges, it doesn't make too much difference whether that energy comes from silage or grain nor what part of the feeding period they are fed. Many combinations and systems have proven to be entirely satisfactory. However, if the silage is not well-cared for and well-matured or is fed with limited or no grain, the length of feeding period will be extended.

The importance of length of feeding period varies with the type of feeder. As stated previously, for the farmer-feeder, a liberal use of corn silage will maximize the pounds of beef which can be marketed from the acreage of corn grown. He may feed only one group of cattle per year and not be concerned with keeping his lot full at all times. Other feeders may not produce enough corn to feed the number of cattle they wish to feed and may have more money invested in their feed lot. In order to maximize returns from the investment in feeding facilities, keeping the lot full at all times becomes of more importance. To such a feeder, the length of feeding period, rate of turnover or dollars invested in facilities per head fed is of considerable importance.

The level of corn silage included in the ration will also be influenced by the type of cattle fed.

Type of Cattle Fed

Some cattle finish more easily than others. Heifers fatten quicker than steers and steers easier than bulls. Small, earlier maturing breeds finish sooner than large, later maturing breeds. These differences in ability to fatten are of importance in determining the level of silage that should be included in the ration. Cattle which finish earlier and at lighter weights will make more efficient use of high silage rations than those that require higher grain rations to finish properly.

Two experiments were conducted at the Northwestern Branch of the Ohio Agricultural Research and Development Center to compare steers and heifers when fed corn silage with no additional grain, a combination of silage and ear corn, or ground ear corn with no silage. Hereford steers and heifers from one source were fed to final average weights of 1,000 and 850 pounds, respectively. Net energy values of the rations were determined by the slaughter method in which representative animals were slaughtered and analyzed at the beginning and end of the experiment.

As expected, heifers reached their final weights sooner than steers. In all cases the heifers consumed more feed per unit of weight and, even though 150 pounds lighter, were fatter than the steers. This resulted in a greater storage of energy by the heifers and, on the average, a higher net energy value of the rations when fed to heifers. There was an interaction among rations and sexes in this regard. The net energy value of the corn silage ration averaged 17% higher when fed to heifers but there was little difference in net energy of the ear corn ration when fed to either sex.

These results indicate that, when fed without additional grain, corn silage has a higher value when fed to heifers than when fed to steers. Evidence is also accumulating that the same may be true when fed to smaller, earlier maturing cattle as compared to larger, later maturing types of either sex.

Summary

Well-eared, well-matured corn silage is the top producer of nutrients per acre of cropland. Its liberal use allows the farmer-feeder to market the most pounds of beef from his farm. Corn planted for silage should be the same as if planted for grain and should be allowed to mature prior to ensiling. Silage yields per acre and silo capacities are rather meaningless unless dry matter content is known. Although corn will

ensile satisfactorily without additives, its value can be profitably improved by adding 20 pounds of ground limestone per ton of chopped corn at time of ensiling. The profitability of other additives will depend upon their effectiveness and, in the case of urea and other sources of NPN, upon their cost relative to other sources of nutients.

A number of methods for increasing the grain content of corn silage can be used. However, harvesting and storing silage and grain separately by conventional means seems most efficient and allows more flexibility in feeding. Many combinations of silage and grain are satisfactory for cattle feeding. Proportions of each included in the ration will be influenced by maximizing pounds of beef sold per acre of cropland or minimizing feedlot investment per head marketed.

When fed without additional grain, corn silage has a higher value when fed to early maturing types of cattle; such as heifers, than when fed to later maturing types, such as steers.

Related web pages:

- Cattlemen on the WEB
- Western Producer
- American Beefalo International

Commercial suppliers:

- None identified.

Electronic mailing lists:

- Beef-l listserv address: LISTSERV@WSUVM1.CSC.WSU.EDU
- **BSE: Bovine Spongiform Encephalopathy**

  Subscription address: listserv@listserv.net

  Subscribe to BSE. Type "SUB BSE-L Yourfirstname Yourlastname" in the first line of the body.
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  Topics: A forum for cattle producers to discuss issues, operations, and ideas with each other and the editors of Beef Today. Through this list, producers can gain further insight into past Beef Today articles and help develop

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Suggested references:

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- Approved Practices in Beef Cattle Production - by Elwood M Juergenson - Publication Date: February 1980 - List: $26.60
- Beef Cattle Feeding and Nutrition - by Tilden Wayne Perry, Michael J. Cecava (Editor) - Publication Date: July 1, 1995 - List: $74.95
  Booknews, Inc. , 03/01/96:
  Helps ranchers and feedlot managers maximize yields by offering information about feeding and nutrition of beef cattle from breeding to finishing. Describes cattle's requirements for vitamins, minerals, and protein; computer methods for calculating and monitoring rations; feed stuffs, including pasture and forages, hay, silage, and concentrates; the breeding herd; and aspects of the finishing process. Updated and augmented from the 1980 edition. Annotation copyright Book News, Inc. Portland, Or.
- Beef Cattle - by Alvin Ludwig Neuman - Publication Date: July 1986 - List: $80.95
- Beef Housing and Equipment Handbook/Mwps-6 - Publication Date: February 1987 - List: $7.00 + $1.85 special surcharge
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  The publisher, Prentice-Hall Career & Technology :
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- Applied Animal Nutrition: Feeds and Feeding - by Peter R. Cheeke - Publication Date: August 1998 - List Price: $92.00
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  Cheeke (Oregon State) discusses the agronomic, nutritional and toxicological properties of temperate and tropical feedstuffs and gives a solid grounding in the fundamentals of feed processing, diet formulation and feed manufacturing. He covers a broad range of species from livestock and poultry to fish and wildlife. Annotation copyright Book News, Inc. Portland, Or. --This text refers to the hardcover edition of this title
  From the Back Cover
  KEY BENEFIT: Suitable as either a book for undergraduate courses in Animal Nutrition or a reference for professional animal nutritionists, extension agents, veterinarians, and livestock producers. KEY TOPICS: This book has a two- fold objective—(1) to describe the properties of feedstuffs used in the feeding of domestic animals and (2) to provide information on feeding practices for a variety of domestic and exotic animal species.

- A Guide to Raising Beef Cattle (Storey Animal Handbook) - by Heather Smith Thomas - Publication Date: June 1998 - List Price: $18.95
- The Use of Drugs in Food Animals : Benefits and Risks - by Subcommittee on Drug Use in Food Animals, National Research

Council - Publication Date: November 1998 - List Price: $34.95

Synopsis

The book overviews why and how drugs are used in food-producing industries--poultry, dairy, beef, swine, and aquaculture; discusses the prevalence of human pathogens in foods of animal origin; and addresses the transfer of resistance in animal microbes to human pathogens and the resulting risk of human disease.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

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Corn Silage and the Cattle Feeder

Well-eared corn silage has been extensively used in beef cattle feeding for many years. Of all feed crops, it is generally the top producer of nutrients per acre. Thus, a liberal use of corn silage allows the farmer-feeder to market more pounds of beef from his farm than from any other procedure. It makes efficient use of the corn stalks, leaves and cobs which are usually wasted when only the grain is fed.

Corn Easily Ensiled

With its solid stems, high carbohydrate content and generally desirable moisture level, corn can be ensiled with few problems. The primary requirement is that the fermentation take place in the absence of oxygen. This can be accomplished in many types of upright silos, bunker silos and even in stacks covered with plastic when made in large volume. The corn plant should be finely chopped to pack well in the silo. When made in stacks, it is difficult to avoid surface spoilage. They should be used only for large amounts when the weight of the chopped corn is great enough to aid with the packing and the surface area is a relative small percentage of the total. It is also difficult to feed from a stack without undue spoilage. They can best be used to refill upright silos when a large amount is moved at one time.

Variety and Stage of Maturity

Energy is the nutrient required in greatest amounts by finishing cattle. Well-eared corn silage is approximately one half corn grain on a dry matter basis. Corn which will produce the maximum yield of grain per acre should be used for silage production. Practices which increase vegetative growth but interfere with ear development reduce the amount of feed per acre. Such practices include: planting long season hybrids which are harvested before maturity; planting too thick or mixing with other crops.

The most rapid storage of nutrients in the corn plant occurs when the kernels are filling. If harvested for silage when immature, the yield will not only be reduced but the silage will be less palatable. Research has shown that silage made from well dented corn has a higher feeding value than that from immature corn. Such corn will have nearly all of the husks dry as well as the lower leaves and will contain about 35 percent dry matter.

Dry Matter, Weight, Volume Relationships

Silage yields, silo capacities and silage consumption data are generally expressed in total weight, such as tons per acre or pounds eaten per head daily. Such figures are rather meaningless unless some idea of the dry matter content of the silage is known. For example, the difference between a 25% and a 35% dry matter silage may not seem large but the 35% really contains 40% more dry feed than the 25%. Even between 30 and 35% dry matter silages, the drier silage contains 17% more actual dry feed.

On the other hand, weight of dry matter per unit of volume varies relatively little. This is, wagon loads of chopped corn or silos full of silage will contain about the same weights of dry feed even though their total weights may vary widely due to differences in the amount of water contained. For example: a silo 20 feet in diameter containing 54 feet of settled silage would contain approximately 129 tons of dry matter. This amount of dry matter would represent 258 tons of 50% dry matter material, 387 tons of 33-1 / 3% dry matter material or 516 tons of 25% dry matter material.

Limestone Improves Feeding Value

Since no special problems were encountered during ensiling and a highly nutritious feed was produced, no research on the preservation of corn silage was conducted for many years. Many experiments verified the value of silage but little had been done to explain the high value or determine how it might be further improved.

Cattle and lamb feeding trials have shown the organic acids present in silage to have a high feeding value. This was especially true of lactic acid, the major one found in corn silage. If the amount of lactic acid in corn silage could be increased, would the silage have a higher feeding value?

Fermentation in the silo continues until a certain amount of acid is produced, the amount being directly related to the moisture content of the ensiled material. When this degree of acidity is reached, fermentation stops and the silage is preserved as long as air is kept from it.

Since the acids produced eventually stop the fermentation, it was found through research that the addition of ground limestone would neutralize these acids. This makes fermentation last longer with more total acids being produced. The addition of one percent (20 lbs. per ton) of pulverized limestone approximately doubles the lactic acid content of the resultant silage.

A number of experiments were conducted to determine if this increase in lactic acid content would increase the feeding value of the silage. The results showed that the addition of one percent limestone to chopped corn at time of ensiling reduced the amount of silage required per pound of gain. This increase in feed efficiency averaged 6.5 percent. Although this is not a large increase, limestone is low in cost and its use offers other advantages.

The addition of limestone corrects the normal calcium deficiency of corn silage and the treatment reduces the amount of molding and spoilage which may occur in the feed bunk in warm weather. Another effect of the acid neutralization is that acids are less likely to attack silage walls. The increased fermentation would also tend to increase the breakdown of nitrates should they be present in the ensiled material.

In the experiments discussed above, which were conducted at the Ohio Agricultural Research and Development Center, the ground limestone was added by sprinkling over the top of the loaded wagons of chopped corn. This is a tiring and time consuming procedure, hence, a metering device at the blower which can be filled from the ground is more efficient.

Other Additives

Limestone or a mixture of equal parts limestone and urea were found to be of equal value in producing organic acids in silage. For this purpose, limestone is much cheaper but urea supplies nitrogen, a source of crude protein which is deficient in corn silage for growing-finishing cattle. When corn silage is full fed with little or no grain, 10 lbs. of urea per ton will meet the protein requirement. When corn grain is fed at one percent of body weight per day (about half feed) with corn silage, 20 lbs. of urea are needed per ton. In three experiments conducted at the Ohio Agricultural Research and Development Center, 20 lbs. urea, 10 lbs. of limestone, and 2 lbs. of defluorinated phosphate were added per ton of silage which was fed with a half feed of dry shelled corn. Thus ration was not improved by adding supplemental natural protein from dehydrated alfalfa meal, soybean meal or a mixed protein supplement, all of which increased the cost of the ration at that time.

Non-protein nitrogen may also be added to corn silage by the use of anhydrous ammonia. Pro-Sil is a proprietary mixture of molasses, anhydrous ammonia and minerals. These materials are handled as a liquid and hence can be pumped.

Recent, marked increases in the cost of all forms of nonprotein nitrogen have removed much of the advantage of adding these materials to corn silage. Relative costs should be checked with other sources of protein in deciding how to correct the protein deficiency of corn silage.

Numerous other additives for corn silage are being marketed. These include fermentation solubles, antibiotics, enzymes, various mixtures, unspecified materials, etc. Some of these have been shown to be of benefit when added to hay crop silage. Unfortunately, sufficient controlled research is not available to evaluate them as additives to corn silage.

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Although well-eared, well-matured corn silage is the top producer of beef per acre, it does not contain sufficient energy to fatten young cattle at light weights. Levels of feeding and types of cattle will be discussed later. However, one rule-of-thumb often used is to feed one pound of grain per hundred pounds of body weight per day, plus all of the corn silage the cattle will eat.

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- None identified.

Electronic mailing lists:

- Beef-l listserv address: LISTSERV@WSUVM1.CSC.WSU.EDU
- **BSE: Bovine Spongiform Encephalopathy**

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from livestock and poultry to fish and wildlife. Annotation copyright Book News, Inc. Portland, Or. --This text refers to the hardcover edition of this title
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KEY BENEFIT: Suitable as either a book for undergraduate courses in Animal Nutrition or a reference for professional animal nutritionists, extension agents, veterinarians, and livestock producers. KEY TOPICS: This book has a two- fold objective—(1) to describe the properties of feedstuffs used in the feeding of domestic animals and (2) to provide information on feeding practices for a variety of domestic and exotic animal species.

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Periodicals:

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Coping With Calving Difficulties

Frequently Asked Questions Other Information Sources Return to Beef Contents

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Coping with Calving Difficulties

Causes of calving difficulty (dystocia) may be separated into two categories. 1) Contributing causes can be identified before the process of giving birth (parturition) begins. 2) Immediate causes are those that can only be recognized after a cow is in labor. At that point dystocia cannot be prevented; only the severity can be minimized. However, the incidence of dystocia *can* be reduced by management decisions based on understanding the contributing causes.

Contributing Causes

The younger a heifer is when she calves, the more difficulty she will have. Regardless of age at calving, the highest incidence of dystocia is in first-calf heifers. Second-calf cows have more dystocias than mature cows.

Birth size and shape are heritable. Sires can be chosen to reduce calving difficulty. Using a sire breed larger than dam breed in a cross-breeding program tends to increase calving difficulty. However, within each breed are bulls that contribute less difficulty than others.
Ease-of-calving data has been tabulated on some bulls used widely in artificial insemination programs.

Level of nutrition plays an important role in determing age and weight at puberty and parturition. Most heifers reach puberty before they are large enough to be bred and calve without experiencing difficulty. Malnutrition may result in an undersized or misshapen skeleton, including the pelvis. Over-feeding heifers during late pregnancy to compensate for small size at breeding may favor growth of the fetus, upsetting the balance between fetal size and pelvic diameter. Excessive energy intake may result in deposition of fat in the pelvic cavity,

favoring dystocia. An increased incidence of calves presented backward in feedlot heifers has been observed. One possible explanation is that abdominal fat prevents repositioning of the fetus after some critical time during gestation.

Diseases that cause late-term abortion or fetal death often result in dystocia. The dead fetus may be presented abnormally or may be distended with fluid or gas. Maternal effects of abortion or fetal death include uterine inertia, failure of the birth canal to dilate, and retained after-birth (placenta). Previous injuries may result in a misshapen birth canal or may produce pain during labor that interferes with delivery.

Immediate Causes

A large fetus relative to the diameter of the birth canal is the greatest cause of dystocia in heifers calving for the first time. This also accounts for many calving difficulties in second-calf cows and small cows bred to bulls of a larger breed. The other major cause of calving difficulty, mal-position of the fetus as it approaches or enters the birth canal, may occur in any cow regardless of age or size. In animals that ordinarily have one offspring, there is only one normal position of the fetus during birth: right side up, front end first, feet and head extended.

Relatively infrequent causes of calving difficulty include abnormalities of fetus or birth canal, failure of birth canel to dilate, or failure of uterus or abdominal muscles to contract effectively. These less frequent situations usually require professional assistance.

Normal Parturition

Normal parturition is arbitrarily described in three stages. ***First stage*** begins with uterine contractions, includes dilatation of the cervix, and ends with entry of the fetus into the birth canal. Restlessness and isolation from the herd may be the only observable signs during this stage. Heifers are generally more restless than older cows. They may appear colicy, lying down and getting up frequently or kicking at their abdomen. The first waterbag may appear toward the end of the first stage. Stage one continues for two to six hours, or sometimes longer in heifers.

Second stage comprises passage of the fetus through the birth canal. During this phase the cow actively participates in delivery. Fetal membranes appear and rupture ahead of the fetus, providing lubrication for its passage. Point pressure exerted in the cow's pelvis successively by the head, shoulders, and hips of the fetus intensify abdominal contractions. Mature cows are normally in second stage parturition less than two hours. Heifers may normally require three or four hours.

Once feet are showing, they should progressively advance and not appear and disappear with each abdominal contraction. If feet are protruding through the vulva with soles down, they are usually front feet. If soles are up, they are usually hind feet. In a normal forward delivery the front feet are side by side with jaws resting on forelimbs and muzzle at about the fetlocks. The calf passes through the birth canal in an arc. As it enters the pelvic inlet, direction of travel is toward the tailhead of the cow, then parallel to the cow's back, then ever more ventrally. As the calf's hips enter the pelvis, direction of travel is toward the cow's rear feet. This arc keeps the calf high in the pelvic inlet and takes advantage of the widest horizontal diameter of the pelvic opening.

Third stage includes passing fetal membranes and closure of the cervix. The placenta is usually expelled within eight hours, after which the cervix secretes a thick mucus that helps prevent infection from entering the uterus. Within 24 to 36 hours a person's hand will not pass through the cervix; by four days only two fingers can be introduced.

Assessing the Need for Intervention

Limit the calving season to as short a period as practical. With a short calving season it becomes more practical to observe cows often enough to provide timely assistance. It is important to have a calving watch so all signs can be observed and help given when needed, without interrupting normal parturitions for unnecessary examinations. Record expected calving dates of individuals; this is practical only with artificial insemination or hand breeding but is very helpful in determining which cows to watch more closely.

Cattlemen should develop a competence and confidence in determining when to intervene, in aiding deliveries, and in assessing the need for professional assistance. A cow should be examined if she has labored two or three hours without progress or if the calf has not been born within two hours after appearance of a waterbag. Overzealous intervention before the cervix is fully dilated may result in severe injury to the cow as well as the calf.

A cow can be more easily examined when she is standing. Lying down forces her abdominal organs and the fetus into or against the pelvic cavity. If a cow will not or cannot rise, it will help to position her upright on her sternum and stifles with her rear legs extended behind her.

The vulva and surrounding area as well as the hands and arms of the person making the examination should be washed thoroughly with warm water and soap. Cleanliness at all times during examination and delivery cannot be over-emphazized. Thoroughly lubricate the arms of the examiner and the birth canal. Lubricating gels are available

commercially, or one can be prepared by dissolving mild soap flakes in a small amount of hot water and allowing the solution to cool.

Carefully examine the birth canal to determine if it is fully dilated and free of twisting and obstruction. Evaluate the size of the fetus in relation to the diameter of the passage. Pull on and pinch a foot of the calf to determine if it is alive. Examine the fetus to determine its position and the presence of any abnormal structures. Normal birth is possible only with the fetus in anterior or posterior presentation, right side up, with head and limbs extended. The possibility of twins should always be considered.

Determine whether the feet presented are front or rear feet. Front limbs have two joints between the hoof and elbow, whereas rear limbs have only one joint between the hoof and hock. A cow is more apt to require assistance with a posterior delivery than with an anterior delivery. Rear limbs are not as effective in initiating dilatation of the birth canal and stimulating abdominal contractions as is the head, the tail head of the calf tends to impact against the cows back bone, the hair of the calf lies the wrong way, and compression of the calf's abdomen causes its rib cage to expand. With posterior presentation, flow of blood through the navel cord is impeded early in delivery, and the calf's head is submerged in fluid. Once the hips enter the birth canal, delivery must be rapid for a live birth.

If examination reveals abnormalities of the fetus or birth canal, failure of the tract to properly dilate, or a calf apparently too large for safe delivery through the birth canal, professional help should be sought at once.

Assisting the Delivery

Provide adequate facilities and equipment for aiding deliveries. A large well-lighted stall should be reserved as a maternity area. It should be sanitized and well bedded each time it is used.

Obstetrical chains are preferred to other traction aids because they are more easily disinfected, and handles are available that may be quickly attached anywhere along their length. Two Chinch chains, one 60-inch chain, and two handles are desirable. Equipment should be cleaned and boiled in mineral oil after use to prevent spread of disease and rusting. Cotton sash cord works well but should be discarded after use. A good mechanical calf puller is needed, not for the amount of pressure it will exert, but for the directions of traction that can be achieved. Other methods of applying traction, such as block and tackle or fence stretchers, apply no opposing force to stabilize the cow and allow pulling parallel to her body only.

Traction should be applied cautiously until the vagina and vulva are fully dilated. Tearing the cervix or vagina may result in sterility or death of the cow. The whole purpose of the procedure is to deliver a healthy calf and prevent injury to the cow.

If forced extraction is required, chains should be placed carefully on the extremities. If fetal membrances interfere, they should be torn away. Place the noose of the chain above the fetlock and a half-hitch around the pastern. This reduces the risk of fracturing a bone or pulling off toenails.

When one or both front or rear limbs or the head is retained in the uterus, manipulation of the fetus is required before traction is applied. Fetal parts must be guarded with the hand to avoid tearing the uterus. Some manipulations can be made with one hand; others require opposing force. Opposing force is accomplished by placing a loop of chain on a foot or the lower jaw and pulling on the chain with one hand while repelling the poll, shoulder, elbow, hip, or hock with the other hand. Care must be taken that the teeth or toes do not tear the uterus.

Anterior Presentation

To apply traction to the head, pass the chain loop over the poll behind the ears and through the mouth. This causes the mouth to open, so care must be taken that the calf's teeth don't lacerate the birth canal. Limit head traction on a live calf to relieving impaction of the head and extending the neck; pulling on the head to move the body may cause injury to the calf's spinal cord.

If the muzzle appears before one or both feet, the elbow(s) may be impacted against the pelvic brim or the forelimb(s) may be retained in the uterus. An impacted elbow can usually be corrected by moderate traction on the foot, however, it may be necessary to apply opposing force to the head to make room for correction. If one or both forelegs are retained in the uterus, it is often necessary to push the head back through the pelvic inlet to correct the problem. If it is very difficult to get the head and both forelegs into the birth canal at the same time, mechanical traction should not be applied. Either the positioning is faulty or the passage is too small to accomodate the calf.

Shoulder lock occurs when the calf's shoulders become impacted at the pelvic inlet. To relieve a shoulder lock, apply moderate traction to the head and alternately apply traction to the forelimbs so the shoulders are "walked" through the bony pelvis one at a time. If the shoulder lock is severe, a caesarian section should be considered; a shoulder lock relieved with difficulty may be followed by a worse hiplock.

Hip lock (calf's hips impacted at pelvic-inlet) should be dealt with

promptly. The calf usually doesn't survive long in hip lock, and the cow may become paralyzed due to excessive pressure on the nerves to her hind limbs. Direction of traction is very important. If a hip lock develops with the cow standing, fasten the forelimbs of the calf together with a short chain, step up in the stirrup formed by the chain, and swing your weight forward between the hind feet of the cow. Hip lock can often be corrected in a cow lying down by repelling the fetus a little, then applying traction over the uppermost rear leg of the cow toward her shoulder. A chain can be placed around the abdomen of the calf and traction applied downward. A 45° rotation of the calf will aid in relieving a hip lock because the vertical diameter of the pelvis is greater than the horizontal diameter.

Posterior Presentation

A calf presented backward must be delivered backward. It is not possible to turn a calf around in a cow. Lubricate the fetus and birth canal before delivery is attempted. Place chains above the calf's hocks and attach the calf puller before applying traction. Once the hips enter the birth canal, traction should be rapid and uninterrupted. Alternating traction on the rear legs and rotating the fetus 45° may help. If it is very difficult to get the hips through the pelvic inlet, a caesarian section may be required. This decision should be made before the hips are forced into the birth canal and the life of the calf jeopardized.

If a calf is presented butt first (breech), the cow often does not enter second-stage labor as point pressure is not exerted within her pelvis to stimulate abdominal contractions. The tip of the calf's tail may be protruding through the vulva or lying in the vagina. The subtle signs of first-stage parturition often go unrecognized, and the cow appears sick or discharges a putrid fluid two or three days later.

A breech presentation may be relatively easy or very difficult to deal with. Important variables include how soon the problem is recognized, whether or not the cow will stand during manipulation of the fetus, the amount of abdominal space for manipulation, how rigidly the calf's hocks are extended, and how hard the cow strains.

The calf's hips must be repelled forward, upward, and toward one flank, the hocks flexed, and the feet extended backward into and through the birth canal. It is very helpful if the cow will stand during manipulation of the fetus. The calf should be repelled between labor pains, and care must be taken not to tear the uterus by pushing too hard on the calf. If manipulation is difficult, epidural anesthesia (a local anesthetic injected into the cow's spinal canal) should be administered to stop straining.

Efforts by the cattleman to assist delivery should be limited to thirty minutes, and should not exceed his technical capabilities. To delay

calling a veterinarian when his help is needed can result in unnecessary injury or death of the cow as well as the calf.

After the Delivery

Provide adequate aftercare for the calf and its mother. Two emergencies may exist upon completion of the delivery: the calf may fail to breathe, and the cow may attempt to prolapse her uterus. The calf can be stimulated to breathe by inserting a straw 2 or 3 inches into the nostril, by brisk massage, and by slapping the chest. Excess mucus should be cleared from the airway, and the head kept lower than the chest until the calf is breathing. Brisk massage with a rough cloth, such as burlap, will also stimulate circulation. Commercial aspirator-respirators are available and are helpful in aspirating mucus and administering oxygen. Directions provided by the manufacturer should be followed.

The cow should be encouraged to get up and move around so her uterus will fall into the abdomen and labor will cease. Straining can sometimes be interrupted by vigorously gripping the cow's spine at the middle of her back. Examine the reproductive tract for tears and the presence of another calf.

After emergencies are averted, saturate the calf's navel with an iodine solution. Within fifteen minutes after birth, the calf should nurse the cow or be given a quart of colostrum by nipple or esophageal feeder. Inject cow and calf with broad spectrum antibiotics. Avoid putting boluses, especially those containing urea, in the uterus. They are irritating to uterine mucosa and may result in delayed conception. If the placenta is retained, continue to administer broad-spectrum antibiotics daily until it is passed. If the cow goes off feed or in any other way appears sick, consult a veterinarian.

Conclusions

The incidence and severity of dystocia *can* be reduced by sound management decisions in breeding, nutrition and herd health. Some calving difficulties will occur regardless of precautions taken. Losses from dystocia can be minimized by:

1. Close observation of cows during calving
2. Recognition of a need for intervention
3. Provision of suitable handling facilities
4. Technical capability to aid delivery
5. Judgement to seek professional assistance promptly when indicated.

Related web pages:

- Cattlemen on the WEB
- Western Producer
- American Beefalo International

Commercial suppliers:

- None identified.

Electronic mailing lists:

- Beef-l listserv address: LISTSERV@WSUVM1.CSC.WSU.EDU
- **BSE: Bovine Spongiform Encephalopathy**

  Subscription address: listserv@listserv.net

  Subscribe to BSE. Type "SUB BSE-L Yourfirstname Yourlastname" in the first line of the body.
- **BEEFTODAY-L: Beef Today Mailing List**

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  Topics: A forum for cattle producers to discuss issues, operations, and ideas with each other and the editors of Beef Today. Through this list, producers can gain further insight into past Beef Today articles and help develop future ones. However, discussions are not limited to what has appeared or will appear in the magazine.

  Subscribe to BeefToday-L. Type "subscribe BeefToday-L Your E-mail Address" in the message body. (Not supported by all browsers.)

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Approved Practices in Beef Cattle Production - by Elwood M Juergenson - Publication Date: February 1980 - List: $26.60

- Beef Cattle Feeding and Nutrition - by Tilden Wayne Perry, Michael J. Cecava (Editor) - Publication Date: July 1, 1995 - List: $74.95
  Booknews, Inc. , 03/01/96:
  Helps ranchers and feedlot managers maximize yields by offering information about feeding and nutrition of beef cattle from breeding to finishing. Describes cattle's requirements for vitamins, minerals, and protein; computer methods for calculating and monitoring rations; feed stuffs, including pasture and forages, hay, silage, and concentrates; the breeding herd; and aspects of the finishing process. Updated and augmented from the 1980 edition. Annotation copyright Book News, Inc. Portland, Or.
- Beef Cattle - by Alvin Ludwig Neuman - Publication Date: July 1986 - List: $80.95
- Beef Housing and Equipment Handbook/Mwps-6 - Publication Date: February 1987 - List: $7.00 + $1.85 special surcharge
- Beef Production and Management Decisions - by Robert E. Taylor - Publication Date: July 1993 - List: $89.00
  The publisher, Prentice-Hall Career & Technology :
  The text examines the primary biological principles that contribute to raising productive beef cattle and discusses the biological and economic principles that serve as the foundation for effective management decisions. The text's integrated approach to the various sectors of the beef industry gives students a more unified perspective. The second edition continues to examine management issues in great depth. Chapters are devoted to topics such as commercial cow-calf management decisions, yearling-stocker management decisions, feedlot management, and retail beef products and consumers.
- Beef Production from Different Dairy Breeds and Beef Crosses - by G.J. More O'Ferrall (Editor) - Publication Date: January 1983 - List: $113.50
- Beef Production from Silage and Other Conserved Forages (Longman Handbooks in Agriculture) - by J.M. Wilkinson - Publication Date: June 1986 - List: $5.95 + $1.85 special surcharge
- Lameness in Cattle - by Paul R. Greenough (Editor), A. David Weaver (Editor) - Publication Date: January 1997 - List: $75.00
- Nutrient Requirements of Beef Cattle (Nutrient Requirements of Domestic Animals (Unnumbered).) - Publication Date: June 1, 1996 - List: $29.95
- The Lasater Philosophy of Cattle Raising - by Laurence M. Lasater - Publication Date: January 1, 1993 - List: $12.00

- Tropical Cattle : Origins, Breeds and Breeding Policies - by W. J. A. Payne, John Hodges - Publication Date: July 1997 - List: $110.00

- Applied Animal Nutrition: Feeds and Feeding - by Peter R. Cheeke - Publication Date: August 1998 - List Price: $92.00
  Booknews, Inc. , June 1, 1991
  Cheeke (Oregon State) discusses the agronomic, nutritional and toxicological properties of temperate and tropical feedstuffs and gives a solid grounding in the fundamentals of feed processing, diet formulation and feed manufacturing. He covers a broad range of species from livestock and poultry to fish and wildlife. Annotation copyright Book News, Inc. Portland, Or. --This text refers to the hardcover edition of this title
  From the Back Cover
  KEY BENEFIT: Suitable as either a book for undergraduate courses in Animal Nutrition or a reference for professional animal nutritionists, extension agents, veterinarians, and livestock producers. KEY TOPICS: This book has a two- fold objective—(1) to describe the properties of feedstuffs used in the feeding of domestic animals and (2) to provide information on feeding practices for a variety of domestic and exotic animal species.

- A Guide to Raising Beef Cattle (Storey Animal Handbook) - by Heather Smith Thomas - Publication Date: June 1998 - List Price: $18.95
- The Use of Drugs in Food Animals : Benefits and Risks - by Subcommittee on Drug Use in Food Animals, National Research Council - Publication Date: November 1998 - List Price: $34.95
  Synopsis
  The book overviews why and how drugs are used in food-producing industries--poultry, dairy, beef, swine, and aquaculture; discusses the prevalence of human pathogens in foods of animal origin; and addresses the transfer of resistance in animal microbes to human pathogens and the resulting risk of human disease.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Coping with Calving Difficulties

Causes of calving difficulty (dystocia) may be separated into two categories. 1) Contributing causes can be identified before the process of giving birth (parturition) begins. 2) Immediate causes are those that can only be recognized after a cow is in labor. At that point dystocia cannot be prevented; only the severity can be minimized. However, the incidence of dystocia *can* be reduced by management decisions based on understanding the contributing causes.

Contributing Causes

The younger a heifer is when she calves, the more difficulty she will have. Regardless of age at calving, the highest incidence of dystocia is in first-calf heifers. Second-calf cows have more dystocias than mature cows.

Birth size and shape are heritable. Sires can be chosen to reduce calving difficulty. Using a sire breed larger than dam breed in a cross-breeding program tends to increase calving difficulty. However, within each breed are bulls that contribute less difficulty than others. Ease-of-calving data has been tabulated on some bulls used widely in artificial insemination programs.

Level of nutrition plays an important role in determing age and weight at puberty and parturition. Most heifers reach puberty before they are large enough to be bred and calve without experiencing difficulty. Malnutrition may result in an undersized or misshapen skeleton, including the pelvis. Over-feeding heifers during late pregnancy to compensate for small size at breeding may favor growth of the fetus, upsetting the balance between fetal size and pelvic diameter. Excessive energy intake may result in deposition of fat in the pelvic cavity, favoring dystocia. An increased incidence of calves presented backward in feedlot heifers has been observed. One possible explanation is that abdominal fat prevents repositioning of the fetus after some critical time during gestation.

Diseases that cause late-term abortion or fetal death often result in dystocia. The dead fetus may be presented abnormally or may be distended with fluid or gas. Maternal effects of abortion or fetal death include uterine inertia, failure of the birth canal to dilate, and retained after-birth (placenta). Previous injuries may result in a misshapen birth canal or may produce pain during labor that interferes with delivery.

Immediate Causes

A large fetus relative to the diameter of the birth canal is the greatest cause of dystocia in heifers

calving for the first time. This also accounts for many calving difficulties in second-calf cows and small cows bred to bulls of a larger breed. The other major cause of calving difficulty, mal-position of the fetus as it approaches or enters the birth canal, may occur in any cow regardless of age or size. In animals that ordinarily have one offspring, there is only one normal position of the fetus during birth: right side up, front end first, feet and head extended.

Relatively infrequent causes of calving difficulty include abnormalities of fetus or birth canal, failure of birth canel to dilate, or failure of uterus or abdominal muscles to contract effectively. These less frequent situations usually require professional assistance.

Normal Parturition

Normal parturition is arbitrarily described in three stages. ***First stage*** begins with uterine contractions, includes dilatation of the cervix, and ends with entry of the fetus into the birth canal. Restlessness and isolation from the herd may be the only observable signs during this stage. Heifers are generally more restless than older cows. They may appear colicy, lying down and getting up frequently or kicking at their abdomen. The first waterbag may appear toward the end of the first stage. Stage one continues for two to six hours, or sometimes longer in heifers.

Second stage comprises passage of the fetus through the birth canal. During this phase the cow actively participates in delivery. Fetal membranes appear and rupture ahead of the fetus, providing lubrication for its passage. Point pressure exerted in the cow's pelvis successively by the head, shoulders, and hips of the fetus intensify abdominal contractions. Mature cows are normally in second stage parturition less than two hours. Heifers may normally require three or four hours.

Once feet are showing, they should progressively advance and not appear and disappear with each abdominal contraction. If feet are protruding through the vulva with soles down, they are usually front feet. If soles are up, they are usually hind feet. In a normal forward delivery the front feet are side by side with jaws resting on forelimbs and muzzle at about the fetlocks. The calf passes through the birth canal in an arc. As it enters the pelvic inlet, direction of travel is toward the tailhead of the cow, then parallel to the cow's back, then ever more ventrally. As the calf's hips enter the pelvis, direction of travel is toward the cow's rear feet. This arc keeps the calf high in the pelvic inlet and takes advantage of the widest horizontal diameter of the pelvic opening.

Third stage includes passing fetal membranes and closure of the cervix. The placenta is usually expelled within eight hours, after which the cervix secretes a thick mucus that helps prevent infection from entering the uterus. Within 24 to 36 hours a person's hand will not pass through the cervix; by four days only two fingers can be introduced.

Assessing the Need for Intervention

Limit the calving season to as short a period as practical. With a short calving season it becomes more practical to observe cows often enough to provide timely assistance. It is important to have a calving watch so all signs can be observed and help given when needed, without interrupting normal parturitions for unnecessary examinations. Record expected calving dates of individuals; this is practical only with artificial insemination or hand breeding but is very helpful in

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A cow can be more easily examined when she is standing. Lying down forces her abdominal organs and the fetus into or against the pelvic cavity. If a cow will not or cannot rise, it will help to position her upright on her sternum and stifles with her rear legs extended behind her.

The vulva and surrounding area as well as the hands and arms of the person making the examination should be washed thoroughly with warm water and soap. Cleanliness at all times during examination and delivery cannot be over-emphazized. Thoroughly lubricate the arms of the examiner and the birth canal. Lubricating gels are available commercially, or one can be prepared by dissolving mild soap flakes in a small amount of hot water and allowing the solution to cool.

Carefully examine the birth canal to determine if it is fully dilated and free of twisting and obstruction. Evaluate the size of the fetus in relation to the diameter of the passage. Pull on and pinch a foot of the calf to determine if it is alive. Examine the fetus to determine its position and the presence of any abnormal structures. Normal birth is possible only with the fetus in anterior or posterior presentation, right side up, with head and limbs extended. The possibility of twins should always be considered.

Determine whether the feet presented are front or rear feet. Front limbs have two joints between the hoof and elbow, whereas rear limbs have only one joint between the hoof and hock. A cow is more apt to require assistance with a posterior delivery than with an anterior delivery. Rear limbs are not as effective in initiating dilatation of the birth canal and stimulating abdominal contractions as is the head, the tail head of the calf tends to impact against the cows back bone, the hair of the calf lies the wrong way, and compression of the calf's abdomen causes its rib cage to expand. With posterior presentation, flow of blood through the navel cord is impeded early in delivery, and the calf's head is submerged in fluid. Once the hips enter the birth canal, delivery must be rapid for a live birth.

If examination reveals abnormalities of the fetus or birth canal, failure of the tract to properly dilate, or a calf apparently too large for safe delivery through the birth canal, professional help should be sought at once.

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in mineral oil after use to prevent spread of disease and rusting. Cotton sash cord works well but should be discarded after use. A good mechanical calf puller is needed, not for the amount of pressure it will exert, but for the directions of traction that can be achieved. Other methods of applying traction, such as block and tackle or fence stretchers, apply no opposing force to stabilize the cow and allow pulling parallel to her body only.

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If forced extraction is required, chains should be placed carefully on the extremities. If fetal membrances interfere, they should be torn away. Place the noose of the chain above the fetlock and a half-hitch around the pastern. This reduces the risk of fracturing a bone or pulling off toenails.

When one or both front or rear limbs or the head is retained in the uterus, manipulation of the fetus is required before traction is applied. Fetal parts must be guarded with the hand to avoid tearing the uterus. Some manipulations can be made with one hand; others require opposing force. Opposing force is accomplished by placing a loop of chain on a foot or the lower jaw and pulling on the chain with one hand while repelling the poll, shoulder, elbow, hip, or hock with the other hand. Care must be taken that the teeth or toes do not tear the uterus.

Anterior Presentation

To apply traction to the head, pass the chain loop over the poll behind the ears and through the mouth. This causes the mouth to open, so care must be taken that the calf's teeth don't lacerate the birth canal. Limit head traction on a live calf to relieving impaction of the head and extending the neck; pulling on the head to move the body may cause injury to the calf's spinal cord.

If the muzzle appears before one or both feet, the elbow(s) may be impacted against the pelvic brim or the forelimb(s) may be retained in the uterus. An impacted elbow can usually be corrected by moderate traction on the foot, however, it may be necessary to apply opposing force to the head to make room for correction. If one or both forelegs are retained in the uterus, it is often necessary to push the head back through the pelvic inlet to correct the problem. If it is very difficult to get the head and both forelegs into the birth canal at the same time, mechanical traction should not be applied. Either the positioning is faulty or the passage is too small to accomodate the calf.

Shoulder lock occurs when the calf's shoulders become impacted at the pelvic inlet. To relieve a shoulder lock, apply moderate traction to the head and alternately apply traction to the forelimbs so the shoulders are "walked" through the bony pelvis one at a time. If the shoulder lock is severe, a caesarian section should be considered; a shoulder lock relieved with difficulty may be followed by a worse hiplock.

Hip lock (calf's hips impacted at pelvic-inlet) should be dealt with promptly. The calf usually doesn't survive long in hip lock, and the cow may become paralyzed due to excessive pressure on the nerves to her hind limbs. Direction of traction is very important. If a hip lock develops with the cow standing, fasten the forelimbs of the calf together with a short chain, step up in the stirrup

formed by the chain, and swing your weight forward between the hind feet of the cow. Hip lock can often be corrected in a cow lying down by repelling the fetus a little, then applying traction over the uppermost rear leg of the cow toward her shoulder. A chain can be placed around the abdomen of the calf and traction applied downward. A 45° rotation of the calf will aid in relieving a hip lock because the vertical diameter of the pelvis is greater than the horizontal diameter.

Posterior Presentation

A calf presented backward must be delivered backward. It is not possible to turn a calf around in a cow. Lubricate the fetus and birth canal before delivery is attempted. Place chains above the calf's hocks and attach the calf puller before applying traction. Once the hips enter the birth canal, traction should be rapid and uninterrupted. Alternating traction on the rear legs and rotating the fetus 45° may help. If it is very difficult to get the hips through the pelvic inlet, a caesarian section may be required. This decision should be made before the hips are forced into the birth canal and the life of the calf jeopardized.

If a calf is presented butt first (breech), the cow often does not enter second-stage labor as point pressure is not exerted within her pelvis to stimulate abdominal contractions. The tip of the calf's tail may be protruding through the vulva or lying in the vagina. The subtle signs of first-stage parturition often go unrecognized, and the cow appears sick or discharges a putrid fluid two or three days later.

A breech presentation may be relatively easy or very difficult to deal with. Important variables include how soon the problem is recognized, whether or not the cow will stand during manipulation of the fetus, the amount of abdominal space for manipulation, how rigidly the calf's hocks are extended, and how hard the cow strains.

The calf's hips must be repelled forward, upward, and toward one flank, the hocks flexed, and the feet extended backward into and through the birth canal. It is very helpful if the cow will stand during manipulation of the fetus. The calf should be repelled between labor pains, and care must be taken not to tear the uterus by pushing too hard on the calf. If manipulation is difficult, epidural anesthesia (a local anesthetic injected into the cow's spinal canal) should be administered to stop straining.

Efforts by the cattleman to assist delivery should be limited to thirty minutes, and should not exceed his technical capabilities. To delay calling a veterinarian when his help is needed can result in unnecessary injury or death of the cow as well as the calf.

After the Delivery

Provide adequate aftercare for the calf and its mother. Two emergencies may exist upon completion of the delivery: the calf may fail to breathe, and the cow may attempt to prolapse her uterus. The calf can be stimulated to breathe by inserting a straw 2 or 3 inches into the nostril, by brisk massage, and by slapping the chest. Excess mucus should be cleared from the airway, and the head kept lower than the chest until the calf is breathing. Brisk massage with a rough cloth, such as burlap, will also stimulate circulation. Commercial aspirator-respirators are available and are

helpful in aspirating mucus and administering oxygen. Directions provided by the manufacturer should be followed.

The cow should be encouraged to get up and move around so her uterus will fall into the abdomen and labor will cease. Straining can sometimes be interrupted by vigorously gripping the cow's spine at the middle of her back. Examine the reproductive tract for tears and the presence of another calf.

After emergencies are averted, saturate the calf's navel with an iodine solution. Within fifteen minutes after birth, the calf should nurse the cow or be given a quart of colostrum by nipple or esophageal feeder. Inject cow and calf with broad spectrum antibiotics. Avoid putting boluses, especially those containing urea, in the uterus. They are irritating to uterine mucosa and may result in delayed conception. If the placenta is retained, continue to administer broad-spectrum antibiotics daily until it is passed. If the cow goes off feed or in any other way appears sick, consult a veterinarian.

Conclusions

The incidence and severity of dystocia *can* be reduced by sound management decisions in breeding, nutrition and herd health. Some calving difficulties will occur regardless of precautions taken. Losses from dystocia can be minimized by:

1. Close observation of cows during calving
2. Recognition of a need for intervention
3. Provision of suitable handling facilities
4. Technical capability to aid delivery
5. Judgement to seek professional assistance promptly when indicated.

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Foot Rot

Foot rot, also called infectious pododermatitis, foul claw, or hoof rot, is an acute or chronic infection of cattle characterized by lameness, swelling, and inflammation of the skin of the coronary band and the skin between the claws. The disease is seen most commonly in feedlot cattle but may also occur in cows, calves, and bulls on pasture. Occasionally, an outbreak affecting 80-90% of the cattle in a feedlot will occur. The disease causes economic loss by reduced body weight, delayed gain, labor, and cost of treatment. Bulls which are affected with foot rot often will not breed because of pain in the affected foot.

Cause

Foot rot is caused, at least in part, by a bacterium known as *Fusiformis necrophorus*. Trauma and irritations caused by small stones, frozen ground, mud, urine, and manure predispose cattle to this infection. Because of occasional explosive outbreaks in feedlots involving a high percentage of the cattle, it is felt that a virus or other primary cause such a laminitis may trigger the infection. The disease is seen most commonly in winter and spring months when mud, urine, and manure are the greatest problem, although it is also seen in warm, dry summer months.

Prevention and Treatment

Clean, well drained lots are important in the prevention of foot rot. Areas around feeders and waterers should be paved and well drained. Liberal use of slaked lime in these areas is helpful. Five to ten percent copper sulfate foot baths in areas where cattle must walk may be

helpful. In severe outbreaks, feeding one mg. of Aureomycin per lb. body weight per head per day for seven days followed by one half this dosage for another seven days is useful. Use of Ethylene Diamine Dihydroiodide (EDDI), a tamed iodine, at the rate of 50 mg. per head-per day is often used as a preventive measure. Early treatment of affected cases is very important. In untreated cases, the infection often invades the coffin and pastern joint, resulting in severe chronic lameness and poor feedlot performance. When this occurs, surgical removal of one entire claw is usually necessary. Penicillin, streptomycin, and tetracyclines are used to treat foot rot. Many veterinarians prefer the intravenous use of one grain per lb. body weight of sulfapyridine in severe cases. The animals may be treated the second and third day at one half this dosage. This drug cannot be given as an intramuscular injection.

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Foot Rot

Foot rot, also called infectious pododermatitis, foul claw, or hoof rot, is an acute or chronic infection of cattle characterized by lameness, swelling, and inflammation of the skin of the coronary band and the skin between the claws. The disease is seen most commonly in feedlot cattle but may also occur in cows, calves, and bulls on pasture. Occasionally, an outbreak affecting 80-90% of the cattle in a feedlot will occur. The disease causes economic loss by reduced body weight, delayed gain, labor, and cost of treatment. Bulls which are affected with foot rot often will not breed because of pain in the affected foot.

Cause

Foot rot is caused, at least in part, by a bacterium known as *Fusiformis necrophorus*. Trauma and irritations caused by small stones, frozen ground, mud, urine, and manure predispose cattle to this infection. Because of occasional explosive outbreaks in feedlots involving a high percentage of the cattle, it is felt that a virus or other primary cause such a laminitis may trigger the infection. The disease is seen most commonly in winter and spring months when mud, urine, and manure are the greatest problem, although it is also seen in warm, dry summer months.

Prevention and Treatment

Clean, well drained lots are important in the prevention of foot rot. Areas around feeders and waterers should be paved and well drained. Liberal use of slaked lime in these areas is helpful. Five to ten percent copper sulfate foot baths in areas where cattle must walk may be helpful. In severe outbreaks, feeding one mg. of Aureomycin per lb. body weight per head per day for seven days followed by one half this dosage for another seven days is useful. Use of Ethylene Diamine Dihydroiodide (EDDI), a tamed iodine, at the rate of 50 mg. per head-per day is often used as a preventive measure. Early treatment of affected cases is very important. In untreated cases, the infection often invades the coffin and pastern joint, resulting in severe chronic lameness and poor feedlot performance. When this occurs, surgical removal of one entire claw is usually necessary. Penicillin, streptomycin, and tetracyclines are used to treat foot rot. Many veterinarians prefer the intravenous use of one grain per lb. body weight of sulfapyridine in severe cases. The animals may be treated the second and third day at one half this dosage. This drug cannot be given as an intramuscular injection.

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Lice on Beef Cattle

Frequently Asked Questions Other Information Sources Return to Beef Contents

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Lice on Beef Cattle

Cattle lice are small but they reduce financial returns of nearly every cattle enterprise. Even moderate louse numbers can cause calves and feeders to grow more slowly and require more feed per pound of gain. Louse-infested cows produce less milk for their calves. Cattle damage fences and bruise or scrape themselves as they rub to relieve the itching caused by millions of lice on their bodies. Blood loss from sucking lice is sometimes severe enough to cause anemia. Louse-induced anemia causes calf abortion and may even result in death of the infested animal.

The five species of cattle lice found in North America include four which feed by sucking blood. These are the *shortnosed cattle louse, longnosed cattle louse, little blue cattle louse,* and the *cattle tail louse*. The fifth species, the *cattle biting louse,* feeds on skin tissue of cattle and does not suck blood.

All cattle lice spend their entire lives as parasites on living cattle. When removed from cattle they live a few days at most. The females lay eggs which they glue to individual cow hairs close to the skin of their host. Immature lice are called nymphs. Each nymph sheds its outer skin three times as it grows to adulthood. Nymphs resemble adults of the same species in feeding habits and appearance.

Shortnosed Cattle Louse, *Haematopinus eurysternus*

Although this species is seldom a problem on young calves, it causes more damage to adult beef cattle in the Great Plains and Rocky Mountain States than do all other lice.

Adult shortnosed cattle lice are slightly over 1/8 inch long and gray-brown in color. The eggs are hard and bone-white to brown. They

require from 9 to 19 days, usually 12 or 13, before hatching. The nymphs become adults within the next 12 days. Females begin laying eggs after about 4 days of adulthood. Thus, this species completes a life cycle in about 28 days, although the time may range from 3 to 6 weeks. About one out of five lice in this species is a male. Males live about 10 days. Females live 15 or 16 days, producing one or two eggs per day.

Longnosed Cattle Louse, *Linognathus vituli*

This species is opposite from the shortnosed cattle louse in that it infests calves most heavily. It is often found on mature cattle, but seldom in great numbers.

Adults are nearly 1/10 inch long. They appear quite slender, being about one-third as wide as they are long. Their head or "nose" is noticeably pointed. Longnosed cattle lice are bluish-black in color. Their eggs, dark blue and soft shelled, require from 8 to 14 days to hatch. The egg-to-egg life cycle requires 21 to 30 days, usually about 25. Females lay about one egg per day.

Little Blue Cattle Louse, *Solenopotes capillatus*

This louse resembles a small longnosed louse. It is similar in color but is slightly less than 1/16 inch long when full grown. The head is bluntly rounded. The eggs are similar to those of the longnosed cattle louse, but smaller. Also, a cow hair on which an egg of this species is laid is characteristically bent at an angle where the egg is attached. Incubation requires from 9 to 13 days. Nymphs mature rapidly, and females begin laying eggs about 11 days after hatching. Few details of the biology of this species are known.

Little blue cattle lice are more common than all other cattle lice in the Delta States, the Southeast, in Oklahoma, and perhaps in east Texas. In other Great Plains States they are present but usually of minor importance except on cattle received from endemic areas.

Cattle Biting Louse, *Bovicola bovis*

Although they do not suck blood, the feeding and movement of biting lice on the skin of cattle cause itching and distress. Cattle biting lice are present on most beef cattle in the Great Plains States. However, they become far more numerous on northern dairy cattle housed for the winter and stanchioned where they cannot lick themselves.

The cattle biting louse is easily distinguished from sucking lice. It is about 1/16 inch in length. The head is large, nearly round, and

two-thirds as wide as the body. The head and thorax of both adults and nymphs are brownish-amber in color. Nymphs have pale cream-colored abdomens. The adult abdomen is darkly outlined and has a series of brown crossbars on a pale background. The eggs are pearly white when freshly laid and become pale brown as the embryos develop within.

Cattle biting louse eggs require from 6 to 11, usually 7 or 8, days to hatch. Nymphs reach adulthood in 12 to 21 days. Females begin producing eggs 3 days after becoming adults. A complete life cycle can occur in as little as 3 weeks, but may require a month or more. Populations of this species are usually from 95 to 99 percent female. Reproduction is accomplished by parthenogenesis, a form of reproduction without mating. Females commonly lay 30 to 35 eggs during a 4 to 6 week period. Adults survive as long as 9 or 10 weeks.

Cattle Tail Louse, *Haematopinus quadripertusus*

Little information is available on the biology of this species. It is closely related to the shortnosed cattle louse and probably has similar rates of reproduction and growth. Cattle tail lice prefer to live on the long-haired portion of the tail, but are also often found on the neck and around the eyes.

Unlike other cattle louse species, tail lice are most abundant in late summer and early fall and are scarce throughout the winter. This is often the most damaging species in coastal areas of the South and Southeast, but it is absent or uncommon in the Great Plains States except for southeastern Texas.

Diagnosing Lousiness In Cattle

Lousiness is primarily a wintertime problem on cattle which are pastured in the open. Direct sunshine, rain, and selfgrooming by cattle keep louse numbers low in the thin summer hair coat.

Often one of the first signs that cattle are lousy is that they rub and scratch themselves against fences, feed bunks, trees, or other objects. In advanced cases, this may result in large patches of bare skin.

Typically one or two percent, or fewer, of the cattle in a herd may carry extremely high numbers of lice even in summertime. Production by such "carriers" as compared to non-carriers, is reduced. In Montana a detailed study from 1956 to 1959 suggested that louse control measures were probably economically justified on five percent, or fewer, of the cattle in that state. For cattle which *do* need treatment against lice, the returns can be substantial.

Bulls are "carriers" in a disproportionately high number of instances. This may be because bulls are housed more often than cows, because their hair is longer and more dense, and because the bull's massive neck and shoulders prevent him from grooming himself as effectively as do females and steers.

Sucking Lice. Cattle sucking lice sometimes congregate in dense patches which may be seen from several feet away. They appear as black or blue-brown spots the size of a quarter or fifty-cent piece. Close inspection of these patches reveals individual lice, both adults and nymphs, as well as eggs. Sucking lice spend most of the time with their heads partly buried in the host's skin as they engorge themselves with blood. In this position, with their abdomens pointing outward from the host's skin, they cling to the animal's hair with all six legs. They are usually difficult to disturb, although they are not so tenacious as ticks.

Cattle severely infested with shortnosed cattle lice take on a characteristic "greasy" appearance. This greasy appearance results from crushed, blood-engorged lice and their feces, from blood and serum oozing from wounds made by the lice in feeding and by the cow's scratching and rubbing, and from the shiny translucence of thousands of living lice packed densely together.

Biting Lice. Cattle biting lice are generally less concentrated into discrete groups. However, in heavy infestations, skin areas may become very densely populated by these small brownish-amber lice. They spend most of their time in a feeding position similar to that of the sucking lice. Biting lice are more readily disturbed and may be quite active, especially when they are numerous and when the weather is mildly warm.

When a cattle biting louse population has been thriving for some time, large areas of a cow's coat may become burdened with several eggs per hair, the basal portions of the hairs glued together in an inseparable mat.

General Observations. Even when cattle are not obviously lousy, it is desirable to inspect them for lice before purchase or as they are handled for branding, vaccination, or other purposes. Parting the cattle hair with his finger tips allows the stockman to see if lice and their eggs are present. With practice, only a few seconds are required to examine each animal in several places— neck, withers, brisket, shoulders, midback, tailhead, and behind the rounds.

Two or more species of cattle lice often occupy the same animal. However, an animal with many sucking lice usually has only a low or moderate number of biting lice, and vice versa.

Louse-Induced Anemia

Several studies have documented severe anemia in cattle as a result of shortnosed sucking louse infestations. Anemic cattle fail to gain weight, or they may slowly lose weight. They appear very weak and have extremely pale skin around the eyes, muzzle, and udder. Their red blood cells may be reduced to as little as one-half or one-fourth the normal number. Extreme louse-induced anemia causes pregnant heifers and cows to abort. Anemic cattle have low resistance to diseases and to stresses caused by bad weather, shipping, or handling. Such cattle become very exhausted and may die if forced to move even 100 to 300 yards.

Ridding anemic cattle of lice usually results in rapid improvement. Complete recovery may be achieved within a month. However, in ridding such cattle of lice one should remember that they must be handled gently and may not be able to withstand the stress of dipping or of crowding in holding pens while sprays are applied. Weakened animals are also more readily poisoned by insecticides, especially those with systemic action.

Controlling Cattle Lice

Sanitation. The primary way in which lice are spread is from animal to animal when cattle are in close contact with one another such as during feeding, breeding, or shipping. However, some lice and louse eggs drop off into bedding or are rubbed off, along with hair, onto fences and feedbunks. These die in a few hours in cold weather; but in warm weather the lice may live for several days if not exposed to direct sunlight, and some of the eggs may hatch. Other cattle may then become infested from contaminated bedding, bunks, sheds, or trucks. For this reason, premises vacated by infested stock should either be disinfected or should stand empty for 10 days before being used by clean stock.

Newly purchased stock should be isolated and treated for lice before being added to the herd.

Chemical Controls. Herds routinely treated against cattle grubs, ticks, horn flies, or face flies, may not develop louse infestations which warrant treatment. When cattle are to be treated for lice, it is important to consider what other insecticides or medications have been, are being, or will be used on the same animals. Multiple treatments or combined effects of different treatments may cause toxic reactions in livestock. This is especially true of the organophosphates with systemic action, which are popular in grub control programs. If grubby cattle are to be treated for lice or other pests, it is wise to do one of the following: 1) treat early in the fall with timing and insecticide selected to kill the

cattle grubs also, or 2) if it is after the safe date for using systemic insecticides against grubs, use only a nonsystemic insecticide against the lice.

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This species is opposite from the shortnosed cattle louse in that it infests calves most heavily. It is often found on mature cattle, but seldom in great numbers.

Adults are nearly 1/10 inch long. They appear quite slender, being about one-third as wide as they

are long. Their head or "nose" is noticeably pointed. Longnosed cattle lice are bluish-black in color. Their eggs, dark blue and soft shelled, require from 8 to 14 days to hatch. The egg-to-egg life cycle requires 21 to 30 days, usually about 25. Females lay about one egg per day.

Little Blue Cattle Louse, *Solenopotes capillatus*

This louse resembles a small longnosed louse. It is similar in color but is slightly less than 1/16 inch long when full grown. The head is bluntly rounded. The eggs are similar to those of the longnosed cattle louse, but smaller. Also, a cow hair on which an egg of this species is laid is characteristically bent at an angle where the egg is attached. Incubation requires from 9 to 13 days. Nymphs mature rapidly, and females begin laying eggs about 11 days after hatching. Few details of the biology of this species are known.

Little blue cattle lice are more common than all other cattle lice in the Delta States, the Southeast, in Oklahoma, and perhaps in east Texas. In other Great Plains States they are present but usually of minor importance except on cattle received from endemic areas.

Cattle Biting Louse, *Bovicola bovis*

Although they do not suck blood, the feeding and movement of biting lice on the skin of cattle cause itching and distress. Cattle biting lice are present on most beef cattle in the Great Plains States. However, they become far more numerous on northern dairy cattle housed for the winter and stanchioned where they cannot lick themselves.

The cattle biting louse is easily distinguished from sucking lice. It is about 1/16 inch in length. The head is large, nearly round, and two-thirds as wide as the body. The head and thorax of both adults and nymphs are brownish-amber in color. Nymphs have pale cream-colored abdomens. The adult abdomen is darkly outlined and has a series of brown crossbars on a pale background. The eggs are pearly white when freshly laid and become pale brown as the embryos develop within.

Cattle biting louse eggs require from 6 to 11, usually 7 or 8, days to hatch. Nymphs reach adulthood in 12 to 21 days. Females begin producing eggs 3 days after becoming adults. A complete life cycle can occur in as little as 3 weeks, but may require a month or more. Populations of this species are usually from 95 to 99 percent female. Reproduction is accomplished by parthenogenesis, a form of reproduction without mating. Females commonly lay 30 to 35 eggs during a 4 to 6 week period. Adults survive as long as 9 or 10 weeks.

Cattle Tail Louse, *Haematopinus quadripertusus*

Little information is available on the biology of this species. It is closely related to the shortnosed cattle louse and probably has similar rates of reproduction and growth. Cattle tail lice prefer to live on the long-haired portion of the tail, but are also often found on the neck and around the eyes.

Unlike other cattle louse species, tail lice are most abundant in late summer and early fall and are scarce throughout the winter. This is often the most damaging species in coastal areas of the South

and Southeast, but it is absent or uncommon in the Great Plains States except for southeastern Texas.

Diagnosing Lousiness In Cattle

Lousiness is primarily a wintertime problem on cattle which are pastured in the open. Direct sunshine, rain, and selfgrooming by cattle keep louse numbers low in the thin summer hair coat.

Often one of the first signs that cattle are lousy is that they rub and scratch themselves against fences, feed bunks, trees, or other objects. In advanced cases, this may result in large patches of bare skin.

Typically one or two percent, or fewer, of the cattle in a herd may carry extremely high numbers of lice even in summertime. Production by such "carriers" as compared to non-carriers, is reduced. In Montana a detailed study from 1956 to 1959 suggested that louse control measures were probably economically justified on five percent, or fewer, of the cattle in that state. For cattle which *do* need treatment against lice, the returns can be substantial.

Bulls are "carriers" in a disproportionately high number of instances. This may be because bulls are housed more often than cows, because their hair is longer and more dense, and because the bull's massive neck and shoulders prevent him from grooming himself as effectively as do females and steers.

Sucking Lice. Cattle sucking lice sometimes congregate in dense patches which may be seen from several feet away. They appear as black or blue-brown spots the size of a quarter or fifty-cent piece. Close inspection of these patches reveals individual lice, both adults and nymphs, as well as eggs. Sucking lice spend most of the time with their heads partly buried in the host's skin as they engorge themselves with blood. In this position, with their abdomens pointing outward from the host's skin, they cling to the animal's hair with all six legs. They are usually difficult to disturb, although they are not so tenacious as ticks.

Cattle severely infested with shortnosed cattle lice take on a characteristic "greasy" appearance. This greasy appearance results from crushed, blood-engorged lice and their feces, from blood and serum oozing from wounds made by the lice in feeding and by the cow's scratching and rubbing, and from the shiny translucence of thousands of living lice packed densely together.

Biting Lice. Cattle biting lice are generally less concentrated into discrete groups. However, in heavy infestations, skin areas may become very densely populated by these small brownish-amber lice. They spend most of their time in a feeding position similar to that of the sucking lice. Biting lice are more readily disturbed and may be quite active, especially when they are numerous and when the weather is mildly warm.

When a cattle biting louse population has been thriving for some time, large areas of a cow's coat may become burdened with several eggs per hair, the basal portions of the hairs glued together in an inseparable mat.

General Observations. Even when cattle are not obviously lousy, it is desirable to inspect them

for lice before purchase or as they are handled for branding, vaccination, or other purposes. Parting the cattle hair with his finger tips allows the stockman to see if lice and their eggs are present. With practice, only a few seconds are required to examine each animal in several places— neck, withers, brisket, shoulders, midback, tailhead, and behind the rounds.

Two or more species of cattle lice often occupy the same animal. However, an animal with many sucking lice usually has only a low or moderate number of biting lice, and vice versa.

Louse-Induced Anemia

Several studies have documented severe anemia in cattle as a result of shortnosed sucking louse infestations. Anemic cattle fail to gain weight, or they may slowly lose weight. They appear very weak and have extremely pale skin around the eyes, muzzle, and udder. Their red blood cells may be reduced to as little as one-half or one-fourth the normal number. Extreme louse-induced anemia causes pregnant heifers and cows to abort. Anemic cattle have low resistance to diseases and to stresses caused by bad weather, shipping, or handling. Such cattle become very exhausted and may die if forced to move even 100 to 300 yards.

Ridding anemic cattle of lice usually results in rapid improvement. Complete recovery may be achieved within a month. However, in ridding such cattle of lice one should remember that they must be handled gently and may not be able to withstand the stress of dipping or of crowding in holding pens while sprays are applied. Weakened animals are also more readily poisoned by insecticides, especially those with systemic action.

Controlling Cattle Lice

Sanitation. The primary way in which lice are spread is from animal to animal when cattle are in close contact with one another such as during feeding, breeding, or shipping. However, some lice and louse eggs drop off into bedding or are rubbed off, along with hair, onto fences and feedbunks. These die in a few hours in cold weather; but in warm weather the lice may live for several days if not exposed to direct sunlight, and some of the eggs may hatch. Other cattle may then become infested from contaminated bedding, bunks, sheds, or trucks. For this reason, premises vacated by infested stock should either be disinfected or should stand empty for 10 days before being used by clean stock.

Newly purchased stock should be isolated and treated for lice before being added to the herd.

Chemical Controls. Herds routinely treated against cattle grubs, ticks, horn flies, or face flies, may not develop louse infestations which warrant treatment. When cattle are to be treated for lice, it is important to consider what other insecticides or medications have been, are being, or will be used on the same animals. Multiple treatments or combined effects of different treatments may cause toxic reactions in livestock. This is especially true of the organophosphates with systemic action, which are popular in grub control programs. If grubby cattle are to be treated for lice or other pests, it is wise to do one of the following: 1) treat early in the fall with timing and insecticide selected to kill the cattle grubs also, or 2) if it is after the safe date for using systemic

insecticides against grubs, use only a nonsystemic insecticide against the lice.

Related web pages:

- Cattlemen on the WEB
- Western Producer
- American Beefalo International

Commercial suppliers:

- None identified.

Electronic mailing lists:

- Beef-l listserv address: LISTSERV@WSUVM1.CSC.WSU.EDU
- **BSE: Bovine Spongiform Encephalopathy**

  Subscription address: listserv@listserv.net

  Subscribe to BSE. Type "SUB BSE-L Yourfirstname Yourlastname" in the first line of the body.
- **BEEFTODAY-L: Beef Today Mailing List**

  Subscription address: majordomo@angus.mystery.com

  Topics: A forum for cattle producers to discuss issues, operations, and ideas with each other and the editors of Beef Today. Through this list, producers can gain further insight into past Beef Today articles and help develop future ones. However, discussions are not limited to what has appeared or will appear in the magazine.

  Subscribe to BeefToday-L. Type "subscribe BeefToday-L Your E-mail Address" in the message body. (Not supported by all browsers.)

Suggested references:

- Approved Practices in Beef Cattle Production - by Elwood M Juergenson - Publication Date: February 1980 - List: $26.60

- Beef Cattle Feeding and Nutrition - by Tilden Wayne Perry, Michael J. Cecava (Editor) - Publication Date: July 1, 1995 - List: $74.95
  Booknews, Inc. , 03/01/96:
  Helps ranchers and feedlot managers maximize yields by offering information about feeding and nutrition of beef cattle from breeding to finishing. Describes cattle's requirements for vitamins, minerals, and protein; computer methods for calculating and monitoring rations; feed stuffs, including pasture and forages, hay, silage, and concentrates; the breeding herd; and aspects of the finishing process. Updated and augmented from the 1980 edition. Annotation copyright Book News, Inc. Portland, Or.
- Beef Cattle - by Alvin Ludwig Neuman - Publication Date: July 1986 - List: $80.95
- Beef Housing and Equipment Handbook/Mwps-6 - Publication Date: February 1987 - List: $7.00 + $1.85 special surcharge
- Beef Production and Management Decisions - by Robert E. Taylor - Publication Date: July 1993 - List: $89.00
  The publisher, Prentice-Hall Career & Technology :
  The text examines the primary biological principles that contribute to raising productive beef cattle and discusses the biological and economic principles that serve as the foundation for effective management decisions. The text's integrated approach to the various sectors of the beef industry gives students a more unified perspective. The second edition continues to examine management issues in great depth. Chapters are devoted to topics such as commercial cow-calf management decisions, yearling-stocker management decisions, feedlot management, and retail beef products and consumers.
- Beef Production from Different Dairy Breeds and Beef Crosses - by G.J. More O'Ferrall (Editor) - Publication Date: January 1983 - List: $113.50
- Beef Production from Silage and Other Conserved Forages (Longman Handbooks in Agriculture) - by J.M. Wilkinson - Publication Date: June 1986 - List: $5.95 + $1.85 special surcharge
- Lameness in Cattle - by Paul R. Greenough (Editor), A. David Weaver (Editor) - Publication Date: January 1997 - List: $75.00
- Nutrient Requirements of Beef Cattle (Nutrient Requirements of Domestic Animals (Unnumbered).) - Publication Date: June 1, 1996 - List: $29.95
- The Lasater Philosophy of Cattle Raising - by Laurence M. Lasater - Publication Date: January 1, 1993 - List: $12.00
- Tropical Cattle : Origins, Breeds and Breeding Policies - by W. J. A. Payne, John Hodges - Publication Date: July 1997 - List: $110.00

- Applied Animal Nutrition: Feeds and Feeding - by Peter R. Cheeke - Publication Date: August 1998 - List Price: $92.00
  Booknews, Inc. , June 1, 1991
  Cheeke (Oregon State) discusses the agronomic, nutritional and toxicological properties of temperate and tropical feedstuffs and gives a solid grounding in the fundamentals of feed processing, diet formulation and feed manufacturing. He covers a broad range of species

from livestock and poultry to fish and wildlife. Annotation copyright Book News, Inc. Portland, Or. --This text refers to the hardcover edition of this title
From the Back Cover
KEY BENEFIT: Suitable as either a book for undergraduate courses in Animal Nutrition or a reference for professional animal nutritionists, extension agents, veterinarians, and livestock producers. KEY TOPICS: This book has a two- fold objective—(1) to describe the properties of feedstuffs used in the feeding of domestic animals and (2) to provide information on feeding practices for a variety of domestic and exotic animal species.

- A Guide to Raising Beef Cattle (Storey Animal Handbook) - by Heather Smith Thomas - Publication Date: June 1998 - List Price: $18.95
- The Use of Drugs in Food Animals : Benefits and Risks - by Subcommittee on Drug Use in Food Animals, National Research Council - Publication Date: November 1998 - List Price: $34.95
  Synopsis
  The book overviews why and how drugs are used in food-producing industries--poultry, dairy, beef, swine, and aquaculture; discusses the prevalence of human pathogens in foods of animal origin; and addresses the transfer of resistance in animal microbes to human pathogens and the resulting risk of human disease.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Nutrient Requirements

Frequently Asked Questions Other Information Sources Return to the Small Farm Resource

Frequently Asked Questions:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Nutrient Requirements & Guidelines for Feeding

The goal of a cow-calf operation should be to produce a calf weighing a minimum of 450 pounds every 12 months from every cow. The key to success in developing a beef cow herd to reach this goal lies in becoming knowledgeable in nutrition, breeding and health management of the beef herd. You must develop economical systems to harvest and utilize roughages for fall and winter feeding and economical pasture or drylot feeding systems for the critical lactating and breeding periods. The good cowman knows the nutrient value of the feeds available and knows how to use these to meet the requirements of the cow at the various stages of her reproductive cycle. Feed costs are over 1/2 of the total cost in producing a calf. This is the area where the greatest reduction in costs can probably be obtained. Under-feeding, however, is false economy.

Nutrient Requirements

Minimum nutrient requirements for various classes of cattle are presented in the tables that follow. Requirements are listed for energy (TDN or total digestible nutrients), crude or total protein, calcium, phosphorus and vitamin A. Along with water and salt, these five nutrients are the ones that are of greatest practical concern to cattlemen. Salt (sodium chloride) and various trace minerals are certainly important, but their requirements are normally met by feeding trace mineralized salt. The vitamin D requirement is met by exposure to direct sunlight or by feeding sun-cured forages. Vitamin E deficiency is found only in young calves in the form of white muscle disease and is best prevented by a vitamin E - selenium injection at birth. Mature ruminants, including cattle, receive adequate amounts of B vitamins and vitamin K through bacterial synthesis in the rumen.

The nutrient requirements are presented in two ways: (1) in pounds, grams or international units (IU) per day; and (2) in percentage of the ration dry matter (DM). In each of the tables, an estimate is made of the animal's maximum possible daily dry matter intake. As a guide to total daily DM consumption, most dry hays and grains contain 85 to 90% dry matter, whereas most silages contain only 30 to 50%. Maximum dry matter intake varies with the moisture content of the ration, season of the year, palatability of the ration, size and age of the animal, and whether or not the animal is lactating. For example, maximum intake is usually higher on dry feeds than on silages; higher in cold weather than in hot; increases with size and age; and is generally higher for the lactating cow than for the dry cow. As can be seen in the tables, the amount of a given nutrient required per day tends to increase as young cattle grow larger, however, the required concentration of that nutrient in the diet tends to decline with age and size.

Other Information Sources:

Effect of Cold Weather on Feed Requirements

Research in Western Canada, Kansas and elsewhere has shown that the stress of extremely cold weather increases the energy requirements of cattle. This can be an important consideration in the wintering of brood cows in the Northern states. The requirements listed in the tables here are valid for a temperature range of 30° to 80° F which is normally considered the comfort zone for most cattle. Energy requirements increase when the temperature goes above or below this range. The increase is especially dramatic for cattle in extremely cold weather with no shelter. Wind, together with cold stress, further increases the need for additional energy to maintain body temperature and body weight. Wind chill factors for beef cattle are given in the following table:

Wind MPH	0F	5F	10F	15F	20F	25F	30F
0	0	5	10	15	20	25	30
5	-5	1	5	10	15	20	25
10	-8	-6	-4	4	9	14	19
15	-16	-11	-6	-1	4	9	14
20	-20	-15	-10	-5	-1	3	8
25	-27	-22	-17	-12	-9	-2	3
30	-36	-31	-26	-21	-16	-11	-6
35	-50	-45	-40	-35	-30	-25	-20
40	-66	-62	-59	-53	-48	-43	-34

Generally speaking, an 1100-lb. dry brood cow in good condition with a full coat of winter hair and no access to shelter will require 13 % more energy or TDN for each 10° decline in the wind chill factor below 30°. For example, if the temperature were 0°F and the wind velocity were 20 mph, the wind chill factor would be -20°, or 50° below the critical temperature of 30°. This means that her maintenance requirement for energy would be increased by 65 %. According to Table 3, an 1100-lb. cow in mid-pregnancy needs 8.6 lb. TDN daily if she is in the comfort zone of 30° to 80°F; therefore, her TDN requirement would be 8.6 x 1.65 = 14.2 lb., or an increase of 5.6 lb. of TDN. If the dry matter in the hay she receives averages 50% TDN, this would require the feeding of 28.4 lb. hay DM, which slightly exceeds her expected maximum daily DM intake of 26 lb. However, cattle consume more DM during cold weather so she would likely meet her requirement. If the wind chill factor were to drop significantly lower, a higher energy feed such as corn silage or grain would probably have to replace some of the hay in order to maintain her body weight. If the wind chill factor fell to -66°, her daily TDN requirement would be increased by 125% or 10.7 lb. This amount added to 8.6 lb. would come to a total of 19.3 lb. TDN or 38.6 lb. of hay dry matter. At this point. she could not consume enough hay to maintain her body weight.

An extremely thin cow with a poor haircoat is stressed even further by cold weather. Her energy requirement increases by about 30% with every 10° drop in wind chill factor below 30°F. On the other hand, cattle on feed are not stressed as much by low temperatures; their TDN needs are increased by about 8% for every 10° decline in wind chill factor below 30°F.

When using the requirements listed in the tables that follow, allowances should be made for cattle that are under extreme cold stress for extended periods of time with no access to shelter or windbreak. One or two days of cold stress are no cause for alarm, but long periods of below zero weather should be accounted for when feeding the cow herd.

Feeding the Cow Herd During A 12 Month Reproductive Cycle

Period 1. Mid-Gestation *(Spring Calving, Nov.-Jan.; Fall Calving, May-July).* During this time, the nutrient requirements of the cow will be at a low point. From weaning up to 2-3 months before calving, the beef cow is fed primarily for maintenance. Grazing crop residues and diverted acres or medium to poor quality hay, straw, chaff or other harvested crop residues can furnish much of the nutrients needed, when properly supplemented. Fat cows can and should lose some weight in early gestation. However, all cows should be maintaining their weight or gaining slightly (1/4 to1/2 lb./day) within 60 days of calving. After calving they should gain weight for at least 90-120 days or until the end of breeding season.

Period 2. 60-90 Days Before Calving *(Spring Calving, Jan.-March; Fall Calving, July-Sept.).* During this time, nutrients are needed for rapid fetal growth, in addition to those needed for maintenance. The nutritional level needed in the ration will depend primarily on the general condition of the cows. Additional silage or some grain may be needed if the cows are too thin. We do not want the cows too fat at calving time, however, as calving difficulties may result. Feeding for fat gain is too expensive. In addition we want her in a gaining condition between calving and re-breeding for best conception. It's difficult to flush a fat cow.

Period 3. Calving Thru Re-breeding *(Spring Calving, Mar.-July; Fall Calving, Sept.-Jan.).* This is the period of greatest nutritional needs. The cow loses about 125 pounds at calving and this weight should be re-gained in 90 to 120 days after calving, with most of it recovered by the start of breeding. In addition, she has to produce milk for a calf and get her reproductive tract in shape for re-breeding and conception besides meeting her maintenance requirements. Proper feeding is important to get the cows re-bred quickly to avoid a strung out calf crop, which results in a lower average weaning weight and some cows not getting re-bred in time to stay within a 12-month calving interval. The bulls should be removed after 60-90 days to prevent late calves next year. Then, pregnancy check and cull those not pregnant.

Period 4. End of Breeding to Weaning *(Spring Calving, July-Nov.; Fall Calving, Jan.-May).* Nutrients for milk production as well as maintenance are still needed, but the critical feeding period is over after the cow is rebred. Also, the calves are consuming other feeds in addition to milk. Use whatever feeds are readily available, such as temporary or permanent pastures.

Feeding Replacement Heifers

The objectives here are to have replacement heifers calve as two-year olds and then calve at the same time as mature cows the following year. This requires having them weigh 600 to 800 pounds at 14-15 months of age when first bred, and then feeding first and second calf heifers separately and at a higher nutritional level than the mature cows. The level of feeding needed from weaning to first breeding depends on their weaning weight and breed. If we want them to weigh 600 to 800 pounds at the start of breeding, which should be 20 to 30 days ahead of the mature cows, they will usually need to gain 200 to 250 pounds in 180-210 days, requiring a gain of 1 to 11/2 pounds per day from weaning to first breeding.

During breeding season (14 to 16 most) heifers should gain about 1.3 lb. per day. After breeding season, up to 120 days prior to calving (16 to 20 mos.), they can afford to gain as little as 1/2 lb. per day. During the last 120 days of gestation (20 to 24 mos.), they should be fed to gain 0.9 to 1.3 lb. per day. After calving, they should continue to gain weight until they are bred.

In order for heifers to obtain the level of feed needed to gain properly, they should ideally be fed separately from the rest of the herd during their first and second winters. If not, the mature cows may consume more than their share of the feed, and the heifers are apt to

suffer. This especially is true in larger herds of cattle and in herds where feeding space is limited. It is also a good idea to winter the coming 3-year-olds separately during their third winter if they are extremely thin from raising their first calf. In fact, many good producers feed their first and second-calf heifers and their old, thin cows all together as one nutritional management group.

Fall Calving vs. Spring Calving

Some producers prefer fall calving since it allows them to wean calves in the spring when feeder cattle prices are often at their peak. They may also use these calves to utilize summer pasture and then sell them in the fall as yearlings, resulting in more pounds of calf being marketed per cow every 12 months. This also avoids calving during the busy spring planting season.

This system requires more intensive management of the cow during the winter in the northern U.S., as harvested feeds must be fed during nearly all of the critical lactation and breeding periods. Good quality spring pasture meets requirements in a spring calving system with little additional feed other than minerals. For most producers, spring calving is the preferred system.

Guideline Rations

In the paragraphs that follow, suggested rations are given for various ages and classes of beef cattle. These rations are based on the requirements listed in Tables 1 through 5.

In addition to the rations presented below, a salt-mineral mix should be offered free-choice at all times. Several possible mixes are listed later. Vitamin A should also be added to the diet or injected intramuscularly if the forage is of low quality and apt to be deficient in this vitamin. If injected. a dose of 1 to 3 million IU is recommended. The injected dose will last for 90 to 100 days.

If you are in doubt about the nutrient content of your feedstuffs. it is probably wise to submit a sample to your local extension agent for analysis of crude protein, estimated energy content, and levels of various mineral elements. He can arrange to have the sample sent to a qualified laboratory with equipment to perform such analysis. The Ohio Livestock Ration Evaluation Program, O.A.R.D.C., Wooster, Ohio is one such laboratory.

Rations for Weaned Heifer Calves

The goal in feeding open heifers is to achieve enough gain in weight so that they may be bred one heat period prior to the main cow herd at about 14 months of age, as mentioned before. Their daily gain from weaning to breeding should average 1.0 to 1.5 lb. per day. The following rations are possibilities.

1. High quality pasture + 5# grain
2. 12# hay (full-feed) + 5# grain
3. 40 # corn silage (30% DM) + 1# soybean meal or equivalent
4. 30# wet haylage (35% DM) + 5# grain
5. 20# dry haylage (50% DM) + 5# grain
6. 5# hay + 30# corn silage + 1/2# soybean meal or equivalent
7. 10# hay + 20# corn silage
8. 40# forage sorghum silage (30% DM) + 21/2# grain + 1 # soybean meal or equivalent
9. 40# oat silage (30% DM) + 21/2# grain + 1/2# soybean meal or equivalent

Rations for Coming 2-Year-Old Pregnant Heifers

The goal in feeding pregnant heifers is to achieve about 1.0 lb. average daily gain for 120 days prior to calving; for example, from 800 lb. to 920 lb. Under-feeding pregnant heifers can be disastrous because they are still growing as well as developing fetus and preparing for the stress of their first lactation. Over-feeding, however, can lead to too much internal fat, resulting in a higher incidence of calving difficulty.

1. High quality pasture
2. 20 to 25# hay (full-feed)
3. 45# corn silage (30% DM) + 11/4# soybean meal or equivalent
4. 55# wet haylage (35% DM)
5. 40# dry haylage (50% DM)
6. 5# hay + 35# corn silage + 3/4# soybean meal or equivalent
7. 10# hay + 25# corn silage + 1/4# soybean meal or equivalent
8. 15#hay + 15#corn silage
9. 55# forage sorghum silage (30% DM) + 1# soybean meal or equivalent
10. 55# oat silage (30% DM)

Rations for Dry 1100-lb. Mature Cow, Middle 1/3 of Pregnancy

The goal here is to maintain the body weight of pregnant mature cows in good condition after their calves have been weaned.

1. Low to medium quality pasture
2. 17 to 25# hay
3. 10#hay + 15# straw
4. 40# corn silage (30% DM)
5. 50# wet haylage (35 % DM)
6. 35# dry haylage (50% DM)
7. 5# hay or 7# straw + 30# corn silage
8. 10# hay or 13# straw + 20# corn silage
9. 15# hay or 21# straw + 10# corn silage
10. 50# forage sorghum silage (30% DM)
11. 50# oat silage (30% DM)
12. 1 to 2 acres cornstalks per cow + hay or supplement as needed
13. Full-feed dry corn refuse(13#DM) + 6# hay
14. Full-feed corn refuse silage (15# DM) + 2# corn + 1/2# soybean meal or equivalent

Rations for Dry 1100-lb. Mature Cow, Last 1/3 of Pregnancy

The goal during the last 90 to 120 days of pregnancy is to achieve an average daily gain of 0.5 to 1.0 lb. per day. Ideally, cows should be on a rising plane of nutrition prior to and after calving so as to be in proper condition for the start of breeding season.

1. Medium to high quality pasture
2. 25 to 30# hay
3. 50# corn silage (30% DM)
4. 60# wet haylage (35 % DM)
5. 40# dry haylage (50% DM)
6. 5# hay + 35# corn silage
7. 10# hay + 25# corn silage

8. 15# hay + 15# corn silage
9. 60# forage sorghum silage (30% DM)
10. 60# oat silage (30% DM)

Rations for 1100-lb. Lactating Cow (Average Milking Ability)

The goal here is to keep the cow in a positive nutritional status so she will conceive by 80 days after calving and average 10 to 12 lb. of milk per day during the first 3 to 4 months of lactation. This level of milk production would be typical of most British beef cows.

1. High quality pasture
2. 25 to 35# hay (full-feed)
3. 60# corn silage (30% DM) + 1 # soybean meal or equivalent
4. 70# wet haylage (35 % DM), full-feed
5. 50# dry haylage (50# DM). full-feed
6. 10# hay + 40# corn silage
7. 15# hay + 30# corn silage
8. 20# hay + 20# corn silage
9. 75# forage sorghum silage (30% DM), full-feed + 1 # soybean meal or equivalent
10. 70# oat silage (30~c DM). full-feed

Rations for 1100-lb. Lactating Cow (Heavy Milker)

The goal is the same as for the average milking cow except that milk production is 20 to 24 lb. per day, which is typical of dairy x beef crossbred females and some dual-purpose exotics. It is difficult for females of this type to consume enough energy to get back in shape for breeding season so as to conceive on schedule.

1. High quality pasture + grain if necessary
2. 30 to 40# hay (full-feed) + grain if necessary
3. 75# corn silage (30% DM), full-feed + 21/4# soybean meal or equivalent
4. 85# wet haylage (35% DM), full-feed + grain if necessary
5. 60# dry haylage (50% DM), full-feed + grain if necessary
6. 90# forage sorghum silage (30% DM), full-feed + 2# soybean meal or equivalent
7. 85# oat silage (30% DM), full feed + 3/~# soybean meal or equivalent

Rations for Mature Herd Sires

The goal is to maintain the weight of mature bulls in good condition and to put weight on thin bulls.

1. High quality pasture + grain to condition
2. 30# hay + grain to condition
3. 70# corn silage (30% DM) + 11/2# soybean meal or equivalent
4. 85# wet haylage (35% DM) + grain to condition
5. 60# dry haylage (50% DM) + grain to condition
6. 90# forage sorghum silage (30% DM) + 1# soybean meal or equivalent
7. 85# oat silage (30% DM)

Rations for Young Herd Sires (Yearlings and 2-Yr.-Olds)

The goal is to provide adequate nutrition to support an average daily gain of 1.5 lb. on yearling bulls and 0.7 lb. on 2-year-old bulls.

1. High quality pasture + 12# grain

2. 20# mixed hay + 12# grain
3. 80# corn silage (30% DM) + 2# soybean meal or equivalent
4. 50# wet haylage (35 SO DM) + 12# grain
5. 35# dry haylage (50% DM) + 12# grain
6. 70# forage sorghum silage (30% DM) + 6# grain mix + 13/4# soybean meal or equivalent
7. 80# oat silage + 3# grain + 1/2# soybean meal or equivalent

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NPN as Supplemental Crude Protein

Non-protein nitrogen (NPN) compounds such as urea, ammonia, etc. are usually more economical sources of crude protein than natural sources such as soybean meal. NPN is particularly well utilized on corn silage based diets. Therefore. treating the silage with NPN or feeding a supplement formulated with NPN as the major contributor of crude protein is often a recommended practice when corn silage is the primary feedstuff.

When treating silage with NPN, care must be taken to apply the correct amount. If in doubt, submit several representative samples of treated silage for crude protein analysis to be certain that the desired level of treatment was attained. Generally, the silage should be treated so that the dry matter contains at least 10.5% crude protein.

Free-choice lick tank supplements are a convenient and popular means of supplementing beef cow herds. However, over-consumption is sometimes a problem, which can result in undue expense. Therefore, lick tanks should be watched closely for signs of over-consumption.

Winter Feed Budgets

Tables 6, 7 and 8 are an attempt to illustrate the total winter feed requirements for a 50-cow beef herd, utilizing various combinations of feed stuffs. In Table 6, hay is the only roughage source, whereas in Table 7, corn silage is the only roughage. In Table 8, about 50% of the roughage dry matter is furnished by hay and 50% by corn silage. In developing these budgets, minimum nutrient requirements for 1100-lb. mature cows were used, and no allowance was made for cold stress. Furthermore, it is assumed that any mineral deficiencies would be offset by free-choice feeding of a salt/mineral mix. In addition, the following assumptions were made:

1. a total winter feeding period of 180 days;
2. on an average, the herd is lactating during the last 60 days of the winter feeding period;
3. half of the cows are average milkers, half are heavy milkers;
4. 13 open yearlings are kept as herd replacements;
5. the pregnant herd consists of 40 mature cows and 10 coming 2-year olds;
6. the mixed hay contains 50% TDN and 10% crude protein.

Free-Choice Mineral Mixtures

Mixture 1. For the cow herd during breeding season to provide extra phosphorus.

	% of Mix	%Ca	%P
Trace mineralized salt	33	--	--
Bonemeal or dicalcium phosphate	67	22-27	13-18

Total in Mix	100	14.7-18.0	8.7-12.8

Mixture 2. For the cow herd before and after breeding season.

	% of Mix	% Ca	% P
Trace mineralized salt	50	--	--
Bonemeal or dicalcium phosphate	50	22-27	13-19
Total in Mix	100	11.0-13.5	6.5-9.5

Mixture 3. For cattle in drylot on grain or other feedstuffs low in calcium content.

	% of Mix	%Ca	% P
Trace mineralized salt	33.3	--	--
Bonemeal or dicalcium phosphate	33.3	22-27	13-19
Ground limestone	33.3	38	--
Total in Mix	100.0	20.0-21.7	4.3-6.3

Mixture 4. For feeding to herds during late winter and early spring in areas where grass tetany (magnesium deficiency) is a problem. No other salt or mineral mixture should be offered, or daily magnesium intake may be too low.

	% of Mix	% Ca	% P	% Mg
Magnesium oxide	25	--	--	60
Trace mineralized salt	25	--	--	--
Bonemeal or dicalcium phosphate	25	22-27	13-19	--
Ground corn	25	--	.35	--
Total in Mix	100	5.5-6.8	3.3-4.8	15.0

Commercial Mixtures. Salt-mineral mixtures comparable to those listed above may be purchased commercially. Beware of mineral blocks that are extremely hard and dense because it is very difficult or impossible for cattle to obtain their daily mineral requirements from such blocks.

Feeding Salt and Mineral Separately. To ensure adequate intake of salt and all other mineral elements, it is often considered preferable to feed Mixture 1, 2 or 3 in one feeder and straight trace mineralized salt in another feeder.

How to Feed Mineral Mixes. All salt or mineral mixes should be fed under cover to keep out rain and/or snow. When fed outside, weather-vane type feeders that rotate with the wind are the most desirable. They may be constructed at home or purchased commercially. Mineral feeders should be located in sites where cattle have daily contact.

How to Budget Mineral Consumption. When fed free-choice, cattle will consume approximately 0.1 to 0.2 lb. of salt-mineral mix per head per day. A figure of 0.15 lb. per day or 55 lb. per cow per year would be a rough average.

Adding Vitamin A to Mineral Mixes. Adding a Vitamin A premix to the mineral mix is a convenient method of providing this vitamin. However, vitamin A loses its potency with time. so these mixes should not be stored for extended periods of time. Enough vitamin A should be added to the mineral mix so that each animal receives its requirement (10.000 to 50.000 IU) in 0.1 to 0.2 lb. of total mix.

Table 1 - Requirements of Weaned Heifer Calves

		TDN		Crude Protein		Calcium		Phosphorus		Vitamin A	
Heifer Wt. lb.	Max Daily DM lb.	lb./day	%DM	lb./day	%DM	g/day	%DM	g/day	%DM	IU/day	IU/lb.
Average Daily Gain of 1.1 lb. per day											
330	9.9	5.7	61	1.00	11.0	14	.34	12	.29	9,000	1000
440	13.2	7.7	58	1.28	9.6	14	.23	13	.22	13,000	1000
550	14.3	8.6	58	1.37	9.5	14	.20	13	.20	14,000	1000
660	16.5	9.9	61	1.48	9.2	14	.19	14	.19	16,000	1000
770	18.3	11.2	61	1.61	8.7	15	.18	15	.18	18,000	1000
avg.	15.0	8.6	60	1.35	9.6	14	.23	13	.22	14,000	1000
Average Daily Gain of 1.5 lb. per day											
330	9.9	6.2	69	1.10	12.4	18	.45	14	.35	9,000	1000
440	13.2	8.4	64	1.37	10.2	18	.30	16	.27	13,000	1000
550	14.3	9.1	72	1.37	10.5	17	.29	15	.26	14,000	1000
660	16.5	10.4	72	1.48	10.1	16	.24	15	.23	16,000	1000
770	18.3	11.9	69	1.61	9.2	15	.19	15	.19	18,000	1000
avg.	15.0	9.2	69	1.40	10.5	17	.29	15	.26	14,000	1000
overall avg.	15.0	8.9	65	1.40	10.0	15	.26	14	.24	14,000	1000

Table 2. Requirements of Coming 2-yr. Old Heifers, Last 3-4 mos. of Pregnancy

		TDN		Crude Protein		Calcium		Phosphorus		Vitamin A	
Heifer Wt. lb.	Max Daily DM lb.	lb./day	% DM	lb./day	% DM	g/day	% DM	g/day	% DM	IU/day	IU/lb.
Average Daily Gain of 0.9 lb. per day											
715	20.7	7.7	52	1.28	8.8	15	.23	15	.23	19,000	1275
770	22.0	8.1	52	1.35	8.8	15	.22	15	.22	19,000	1275
825	24.2	8.4	52	1.39	8.7	15	.21	15	.21	20,000	1275
880	25.6	8.7	52	1.43	8.7	16	.21	16	.21	21,000	1275
935	26.7	9.0	52	1.52	8.8	16	.20	16	.20	22,000	1275
935	26.7	9.0	52	1.52	8.8	16	.20	15	.21	20,000	1275
Avg.	23.8	8.4	52	1.40	8.8	15	.21				
Average Daily Gain of 1.3 lb. per day											
715	20.7	9.9	52	1.65	8.8	18	.21	18	.21	23,000	1275

770	22.0	10.3	52	1.72	8.8	19	.21	19	.21	25,000	1275
825	24.2	10.8	52	1.78	8.7	19	.20	19	.20	26,000	1275
880	25.6	11.3	52	1.85	8.7	19	.20	19	.20	27,000	1275
935	26.7	10.8	52	1.80	8.8	19	.20	19	.20	26,000	1275
Avg.	23.8	10.6	52	1.80	8.8	19	.20	19	.20	26,000	1275
Overall Avg.	23.8	9.6	52	1.60	8.8	17	.21	.7	.21	23,000	1275

Table 3. Requirements of Dry Pregnant Mature Cows

		TDN		**Crude Protein**		**Calcium**		**Phosphorus**		**Vitamin A**	
Cow Wt. lb.	Max Daily DM lb.	lb./day	% DM	lb./day	% DM	g/day	% DM	g/day	% DM	IU/day	IU/lb.
Middle 1/2 of Pregnancy, 0.0 lb. Average Daily Gain											
772	20	6.6	52	.71	5.9	10	.18	10	.18	15,000	1275
882	22	7.3	52	.79	5.9	11	.18	11	.18	17,000	1275
992	24	7.9	52	.86	5.9	12	.18	12	.18	19,000	1275
1002	26	8.6	52	.93	5.9	13	.18	13	.18	20,000	1275
1213	28	9.2	52	.99	5.9	14	.18	14	.18	22,000	1275
1323	30	9.8	52	1.08	5.9	15	.18	15	.18	23,000	1275
1433	32	10.4	52	1.15	5.9	16	.18	16	.18	25,000	1275
1545	34	11.0	52	1.21	5.9	17	.18	17	.18	27,000	1275
Avg.	27	8.9	52	1.00	5.9	14	.18	14	.18	21,000	1275
Last 1/2 of Pregnancy, 0.9 lb. Average Daily Gain											
772	20	8.0	52	.90	5.9	12	.18	12	.18	19,000	1275
882	22	8.7	52	.97	5.9	14	.18	14	.18	21,000	1275
992	24	9.4	52	1.06	5.9	15	.18	15	.18	23,000	1275
1102	26	10.0	52	1.12	5.9	15	.18	15	.18	24,000	1275
1213	28	10.7	52	1.19	5.9	16	.18	16	.18	26,000	1275
1323	30	11.2	52	1.26	5.9	17	.18	17	.18	27,000	1275
1433	32	11.9	52	1.32	5.9	18	.18	18	.18	29,000	1275
1545	34	12.6	52	1.39	5.9	19	.18	19	.18	30,000	1275
Avg.	27	10.3	52	1.20	5.9	16	.18	16	.18	25,000	1275
Overall Avg.	27	9.6	52	1.10	5.9	15	.18	15	.18	23,000	1275

Table 4. Requirements of Lactating Cows, First 3-4 Mos. After Calving

		TDN	**Crude Protein**	**Calcium**	**Phosphorus**	**Vitamin A**

Cow Wt lb.	Max Daily DM lb.	lb./day	% DM	lb./day	% DM	g/day	% DM	g/day	% DM	IU/day	IU/lb.
Average Milking Ability (10-12 lb./day)											
770	25	9.7	52	1.65	9.2	24	.29	24	.29	19,000	1775
880	27	10.4	52	1.79	9.2	25	.28	25	.28	21,000	1775
990	29	11.0	52	1.90	9.2	26	.28	26	.28	23,000	1775
1100	31	11.7	52	1.98	9.2	27	.28	27	.28	24,000	1775
1210	33	12.3	52	2.14	9.2	28	.27	28	.27	26,000	1775
1320	35	13.0	52	2.23	9.2	28	.25	28	.25	27,000	1775
1430	37	13.7	52	2.32	9.2	29	.25	29	.25	29,000	1775
1540	39	14.4	52	2.41	9.2	30	.25	30	.25	31,000	1775
Avg.	32	12.0	52	2.05	9.2	27	.27	27	.27	25,000	1775
Superior Milking Ability (21-23 lb./day)											
770	30	12.8	55	2.45	10.9	45	.44	40	.39	32,000	1775
880	32	13.5	55	2.58	10.9	45	.42	41	.38	34,000	1775
990	34	14.1	55	2.71	10.9	45	.40	42	.37	36,000	1775
1100	36	14.8	55	2.84	10.9	46	.39	43	.36	38,000	1775
1210	38	15.4	55	2.98	10.9	46	.37	44	.35	41,000	1775
1320	40	16.1	55	3.11	10.9	46	.36	44	.34	43,000	1775
1430	42	16.8	55	3.22	10.9	47	.35	45	.33	45,000	1775
1540	44	17.5	55	3.33	10.9	48	.34	46	.32	47,000	1775
Avg.	37	15.1	55	2.90	10.9	46	.38	43	.35	40,000	1775
Overall Avg.	34	13.5	53.5	2.50	10.0	37	.33	35	.31	32,000	1775

Table 5. Requirements of Bulls (Growth + Maintenance, Moderate Activity)

			TDN		Crude Protein		Calcium		Phosphorus		Vitamin A	
Bull Wt lb.	Avg. Daily Gain lb.	Max Daily DM lb.	lb./day	% DM	lb./day	% DM	g/day	% DM	g/day	% DM	IU/day	IU/lb.
660	2.4	19	13.2	**77**	2.16	12	29	.41	23	.32	34,000	1775
880	2.0	24	15.4	64	2.27	22	23	.21	23	.21	43,000	1775
1100	1.5	27	16.5	61	2.36	10	22	.18	22	.18	48,000	1775
1323	1.1	29	16.1	61	2.25	9	22	.18	22	.18	48,000	1775
1543	0.3	31	17.0	55	2.38	8.5	23	.18	23	.18	50,000	1775
1764	0	33	12.8	55	1.96	8.5	19	.18	19	.18	41,000	1775

1984	0	35	13.9	55	2.32	8.5	22	.18	22	.18	48,000	1775
2205	0	37	15.2	55	2.32	8.5	22	.18	22	.18	48,000	1775
2425	0	39	16.4	55	2.40	8.5	23	.18	23	.18	51,000	1775

Table 6. Winter Feed Budget for a 50-Cow Beef Herd Using Hay as Roughage

			Hay			Grain		
Class of Cattle	No. head	No. Days	lb. per head per day	Herd total for winter (T)	Total per cow unit (T)	lb. per head per day	Herd total for winter (lb.)	Total per cow unit (lb.)
Pregnant mature Cows	40	120	25	60.0	1.20	---	---	---
Lactating mature Cows	40	60	35	42.0	0.84	---	---	---
Pregnant 2-yr. Heifers	10	120	25	15.0	0.30	---	---	---
Lactating 2-yr. Heifers	10	60	35	10.5	0.21	---	---	---
Open Yearling Heifers	13	180	12	14.0		5	11,700	234
Mature herd sire	1	180	30	2.7		10	1,800	36
Young herd sire	1	180	20	1.8	0.04	12	2.160	43
Total	---	---	---	146.0	2.92	---	15,660	313

As shown in Table 6, it takes about 3 T. of hay and 300 lbs. of grain per producing female to winter a herd consisting of 50 breeding age females, 13 open yearling replacement heifers and 2 herd sires for 180 days. In addition, it would take a total of about 35 lb. of salt-mineral mix per cow unit, or a total for the entire herd of approximately 1,750 lbs. over the 180 day period.

Table 7. Winter Feed Budget for a 50-cow Beef Herd Using Corn Silage as Roughage

			30% DM Corn Silage			Soybean Meal Equivalent		
Class of Cattle	No. Head	No. Days	lb. per head per day	Herd total for Winter (T)	Total per Cow Unit (T)	lb. per head per day	Herd total for winter (lb.)	Total per Cow unit (lb.)
Pregnant mature cows	40	120	45	108.0	2.16	---	---	---
Lactating mature cows	40	60	65	78.0	1.56	2.0	4,800	96.0
Pregnant 2-yr. heifers	10	120	45	27.0	.54	1.1	1,320	26.4
Lactating 2-yr. heifers	10	60	65	19.5	.39	2.0	1,200	24.0
Open yearling heifers	13	180	40	46.8	.94	1.0	2,340	46.8

Mature herd sire	1	180	70	6.3	.13	1.4	252	5.0
Young herd sire	1	180	80	7.2	.14	2.0	360	7.2
Total	---	---	---	292.8	5.86	---	10,272	205.4

Table 7 shows that it takes slightly over 53/4 T of corn silage and about 200 lbs. of soybean meal equivalent per producing cow to winter a 50-cow herd for 180 days. In many instances, NPN compounds such as urea would be a more economical source of supplemental crude protein than soybean meal, as mentioned previously.

Table 8. Winter Feed Budget for a 50-Cow Beef Herd Using Hay and Corn Silage

Class of Cattle	No. Head	No. Days	lb. per head per day	Herd total for winter (T)	Total per cow unit (T)	lb. per head per day	Herd total for winter (T)	Total per cow unit (T)
Pregnant mature cows	40	120	5	12.0	.24	30	72.0	1.44
Lactating mature cows	40	60	10	12.0	.24	45	54.0	1.08
Pregnant 2-yr. heifers	10	120	15	9.0	.18	15	9.0	.18
Lactating 2-yr. heifers	10	60	10	3.0	.06	45	13.5	.27
Open yearling heifers	13	180	10	11.7	.23	20	23.4	.47
Mature herd sire	1	180	15	1.4	.03	40	3.6	.07
Young herd sire	1	180	10	.9	.02	60	5.4	.11
Total	---	---	---	50.0	1.00	---	108.9	3.62

As shown in Table 8, about 1 T. of hay and 3.6 T. of corn silage per producing cow are required to winter a 50-cow herd for 180 days. With hay at 90% DM and corn silage at 30% DM, approximately half of the total dry matter is supplied by each of these feeds.

Related web pages:

- Cattlemen on the WEB
- Western Producer
- American Beefalo International

Commercial suppliers:

- None identified.

Electronic mailing lists:

- Beef-l listserv address: LISTSERV@WSUVM1.CSC.WSU.EDU
- **BSE: Bovine Spongiform Encephalopathy**

  Subscription address: listserv@listserv.net

  Subscribe to BSE. Type "SUB BSE-L Yourfirstname Yourlastname" in the first line of the body.
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  Topics: A forum for cattle producers to discuss issues, operations, and ideas with each other and the editors of Beef Today. Through this list, producers can gain further insight into past Beef Today articles and help develop future ones. However, discussions are not limited to what has appeared or will appear in the magazine.

  Subscribe to BeefToday-L. Type "subscribe BeefToday-L Your E-mail Address" in the message body. (Not supported by all browsers.)

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Approved Practices in Beef Cattle Production - by Elwood M Juergenson - Publication Date: February 1980 - List: $26.60
- Beef Cattle Feeding and Nutrition - by Tilden Wayne Perry, Michael J. Cecava (Editor) - Publication Date: July 1, 1995 - List: $74.95
  Booknews, Inc. , 03/01/96:
  Helps ranchers and feedlot managers maximize yields by offering information about feeding and nutrition of beef cattle from breeding to finishing. Describes cattle's requirements for vitamins, minerals, and protein; computer methods for calculating and monitoring rations; feed stuffs, including pasture and forages, hay, silage, and concentrates; the breeding herd; and aspects of the finishing process. Updated and augmented from the 1980 edition. Annotation copyright Book News, Inc. Portland, Or.
- Beef Cattle - by Alvin Ludwig Neuman - Publication Date: July 1986 - List: $80.95
- Beef Housing and Equipment Handbook/Mwps-6 - Publication Date: February 1987 - List: $7.00 + $1.85 special surcharge
- Beef Production and Management Decisions - by Robert E. Taylor - Publication Date: July 1993 - List: $89.00
  The publisher, Prentice-Hall Career & Technology :
  The text examines the primary biological principles that contribute to raising productive beef cattle and discusses the biological and economic principles that serve as the foundation for effective management decisions. The text's integrated approach to the various sectors of the beef industry gives students a more unified perspective. The second edition continues to examine management issues in great depth. Chapters are devoted to topics such as commercial cow-calf management

decisions, yearling-stocker management decisions, feedlot management, and retail beef products and consumers.

- Beef Production from Different Dairy Breeds and Beef Crosses - by G.J. More O'Ferrall (Editor) - Publication Date: January 1983 - List: $113.50
- Beef Production from Silage and Other Conserved Forages (Longman Handbooks in Agriculture) - by J.M. Wilkinson - Publication Date: June 1986 - List: $5.95 + $1.85 special surcharge
- Lameness in Cattle - by Paul R. Greenough (Editor), A. David Weaver (Editor) - Publication Date: January 1997 - List: $75.00
- Nutrient Requirements of Beef Cattle (Nutrient Requirements of Domestic Animals (Unnumbered).) - Publication Date: June 1, 1996 - List: $29.95
- The Lasater Philosophy of Cattle Raising - by Laurence M. Lasater - Publication Date: January 1, 1993 - List: $12.00
- Tropical Cattle : Origins, Breeds and Breeding Policies - by W. J. A. Payne, John Hodges - Publication Date: July 1997 - List: $110.00

- Applied Animal Nutrition: Feeds and Feeding - by Peter R. Cheeke - Publication Date: August 1998 - List Price: $92.00
  Booknews, Inc. , June 1, 1991
  Cheeke (Oregon State) discusses the agronomic, nutritional and toxicological properties of temperate and tropical feedstuffs and gives a solid grounding in the fundamentals of feed processing, diet formulation and feed manufacturing. He covers a broad range of species from livestock and poultry to fish and wildlife. Annotation copyright Book News, Inc. Portland, Or. --This text refers to the hardcover edition of this title
  From the Back Cover
  KEY BENEFIT: Suitable as either a book for undergraduate courses in Animal Nutrition or a reference for professional animal nutritionists, extension agents, veterinarians, and livestock producers. KEY TOPICS: This book has a two- fold objective—(1) to describe the properties of feedstuffs used in the feeding of domestic animals and (2) to provide information on feeding practices for a variety of domestic and exotic animal species.

- A Guide to Raising Beef Cattle (Storey Animal Handbook) - by Heather Smith Thomas - Publication Date: June 1998 - List Price: $18.95
- The Use of Drugs in Food Animals : Benefits and Risks - by Subcommittee on Drug Use in Food Animals, National Research Council - Publication Date: November 1998 - List Price: $34.95
  Synopsis
  The book overviews why and how drugs are used in food-producing industries--poultry, dairy, beef, swine, and aquaculture; discusses the prevalence of human pathogens in foods of animal origin; and addresses the transfer of resistance in animal microbes to human pathogens and the resulting risk of human disease.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Nutrient Requirements & Guidelines for Feeding

The goal of a cow-calf operation should be to produce a calf weighing a minimum of 450 pounds every 12 months from every cow. The key to success in developing a beef cow herd to reach this goal lies in becoming knowledgeable in nutrition, breeding and health management of the beef herd. You must develop economical systems to harvest and utilize roughages for fall and winter feeding and economical pasture or drylot feeding systems for the critical lactating and breeding periods. The good cowman knows the nutrient value of the feeds available and knows how to use these to meet the requirements of the cow at the various stages of her reproductive cycle. Feed costs are over 1/2 of the total cost in producing a calf. This is the area where the greatest reduction in costs can probably be obtained. Under-feeding, however, is false economy.

Nutrient Requirements

Minimum nutrient requirements for various classes of cattle are presented in the tables that follow. Requirements are listed for energy (TDN or total digestible nutrients), crude or total protein, calcium, phosphorus and vitamin A. Along with water and salt, these five nutrients are the ones that are of greatest practical concern to cattlemen. Salt (sodium chloride) and various trace minerals are certainly important, but their requirements are normally met by feeding trace mineralized salt. The vitamin D requirement is met by exposure to direct sunlight or by feeding sun-cured forages. Vitamin E deficiency is found only in young calves in the form of white muscle disease and is best prevented by a vitamin E - selenium injection at birth. Mature ruminants, including cattle, receive adequate amounts of B vitamins and vitamin K through bacterial synthesis in the rumen.

The nutrient requirements are presented in two ways: (1) in pounds, grams or international units (IU) per day; and (2) in percentage of the ration dry matter (DM). In each of the tables, an estimate is made of the animal's maximum possible daily dry matter intake. As a guide to total daily DM consumption, most dry hays and grains contain 85 to 90% dry matter, whereas most silages contain only 30 to 50%. Maximum dry matter intake varies with the moisture content of the ration, season of the year, palatability of the ration, size and age of the animal, and whether or not the animal is lactating. For example, maximum intake is usually higher on dry feeds than on silages; higher in cold weather than in hot; increases with size and age; and is generally higher for the lactating cow than for the dry cow. As can be seen in the tables, the amount of a given nutrient required per day tends to increase as young cattle grow larger, however, the required concentration of that nutrient in the diet tends to decline with age and size.

Effect of Cold Weather on Feed Requirements

Research in Western Canada, Kansas and elsewhere has shown that the stress of extremely cold weather increases the energy requirements of cattle. This can be an important consideration in the wintering of brood cows in the Northern states. The requirements listed in the tables here are valid for a temperature range of 30° to 80° F which is normally considered the comfort zone for most cattle. Energy requirements increase when the temperature goes above or below this range. The increase is especially dramatic for cattle in extremely cold weather with no shelter. Wind, together with cold stress, further increases the need for additional energy to maintain body temperature and body weight. Wind chill factors for beef cattle are given in the following table:

Wind MPH	0F	5F	10F	15F	20F	25F	30F
0	0	5	10	15	20	25	30
5	-5	1	5	10	15	20	25
10	-8	-6	-4	4	9	14	19
15	-16	-11	-6	-1	4	9	14
20	-20	-15	-10	-5	-1	3	8
25	-27	-22	-17	-12	-9	-2	3
30	-36	-31	-26	-21	-16	-11	-6
35	-50	-45	-40	-35	-30	-25	-20
40	-66	-62	-59	-53	-48	-43	-34

Generally speaking, an 1100-lb. dry brood cow in good condition with a full coat of winter hair and no access to shelter will require 13 % more energy or TDN for each 10° decline in the wind chill factor below 30°. For example, if the temperature were 0°F and the wind velocity were 20 mph, the wind chill factor would be -20°, or 50° below the critical temperature of 30°. This means that her maintenance requirement for energy would be increased by 65 %. According to Table 3, an 1100-lb. cow in mid-pregnancy needs 8.6 lb. TDN daily if she is in the comfort zone of 30° to 80°F; therefore, her TDN requirement would be 8.6 x 1.65 = 14.2 lb., or an increase of 5.6 lb. of TDN. If the dry matter in the hay she receives averages 50% TDN, this would require the feeding of 28.4 lb. hay DM, which slightly exceeds her expected maximum daily DM intake of 26 lb. However, cattle consume more DM during cold weather so she would likely meet her requirement. If the wind chill factor were to drop significantly lower, a higher energy feed such as corn silage or grain would probably have to replace some of the hay in order to maintain her body weight. If the wind chill factor fell to -66°, her daily TDN requirement would be increased by 125% or 10.7 lb. This amount added to 8.6 lb. would come to a total of 19.3 lb. TDN or 38.6 lb. of hay dry matter. At this point. she could not consume enough hay to maintain her body weight.

An extremely thin cow with a poor haircoat is stressed even further by cold weather. Her energy requirement increases by about 30% with every 10° drop in wind chill factor below 30°F. On the other hand, cattle on feed are not stressed as much by low temperatures; their TDN needs are increased by about 8% for every 10° decline in wind chill factor below 30°F.

When using the requirements listed in the tables that follow, allowances should be made for cattle that are under extreme cold stress for extended periods of time with no access to shelter or

windbreak. One or two days of cold stress are no cause for alarm, but long periods of below zero weather should be accounted for when feeding the cow herd.

Feeding the Cow Herd During A 12 Month Reproductive Cycle

Period 1. Mid-Gestation *(Spring Calving, Nov.-Jan.; Fall Calving, May-July).* During this time, the nutrient requirements of the cow will be at a low point. From weaning up to 2-3 months before calving, the beef cow is fed primarily for maintenance. Grazing crop residues and diverted acres or medium to poor quality hay, straw, chaff or other harvested crop residues can furnish much of the nutrients needed, when properly supplemented. Fat cows can and should lose some weight in early gestation. However, all cows should be maintaining their weight or gaining slightly (1/4 to1/2 lb./day) within 60 days of calving. After calving they should gain weight for at least 90-120 days or until the end of breeding season.

Period 2. 60-90 Days Before Calving *(Spring Calving, Jan.-March; Fall Calving, July-Sept.).* During this time, nutrients are needed for rapid fetal growth, in addition to those needed for maintenance. The nutritional level needed in the ration will depend primarily on the general condition of the cows. Additional silage or some grain may be needed if the cows are too thin. We do not want the cows too fat at calving time, however, as calving difficulties may result. Feeding for fat gain is too expensive. In addition we want her in a gaining condition between calving and re-breeding for best conception. It's difficult to flush a fat cow.

Period 3. Calving Thru Re-breeding *(Spring Calving, Mar.-July; Fall Calving, Sept.-Jan.).* This is the period of greatest nutritional needs. The cow loses about 125 pounds at calving and this weight should be re-gained in 90 to 120 days after calving, with most of it recovered by the start of breeding. In addition, she has to produce milk for a calf and get her reproductive tract in shape for re-breeding and conception besides meeting her maintenance requirements. Proper feeding is important to get the cows re-bred quickly to avoid a strung out calf crop, which results in a lower average weaning weight and some cows not getting re-bred in time to stay within a 12-month calving interval. The bulls should be removed after 60-90 days to prevent late calves next year. Then, pregnancy check and cull those not pregnant.

Period 4. End of Breeding to Weaning *(Spring Calving, July-Nov.; Fall Calving, Jan.-May).* Nutrients for milk production as well as maintenance are still needed, but the critical feeding period is over after the cow is rebred. Also, the calves are consuming other feeds in addition to milk. Use whatever feeds are readily available, such as temporary or permanent pastures.

Feeding Replacement Heifers

The objectives here are to have replacement heifers calve as two-year olds and then calve at the same time as mature cows the following year. This requires having them weigh 600 to 800 pounds at 14-15 months of age when first bred, and then feeding first and second calf heifers separately and at a higher nutritional level than the mature cows. The level of feeding needed from weaning to first breeding depends on their weaning weight and breed. If we want them to weigh 600 to 800 pounds at the start of breeding, which should be 20 to 30 days ahead of the mature cows, they will

usually need to gain 200 to 250 pounds in 180-210 days, requiring a gain of 1 to 11/2 pounds per day from weaning to first breeding.

During breeding season (14 to 16 most) heifers should gain about 1.3 lb. per day. After breeding season, up to 120 days prior to calving (16 to 20 mos.), they can afford to gain as little as 1/2 lb. per day. During the last 120 days of gestation (20 to 24 mos.), they should be fed to gain 0.9 to 1.3 lb. per day. After calving, they should continue to gain weight until they are bred.

In order for heifers to obtain the level of feed needed to gain properly, they should ideally be fed separately from the rest of the herd during their first and second winters. If not, the mature cows may consume more than their share of the feed, and the heifers are apt to suffer. This especially is true in larger herds of cattle and in herds where feeding space is limited. It is also a good idea to winter the coming 3-year-olds separately during their third winter if they are extremely thin from raising their first calf. In fact, many good producers feed their first and second-calf heifers and their old, thin cows all together as one nutritional management group.

Fall Calving vs. Spring Calving

Some producers prefer fall calving since it allows them to wean calves in the spring when feeder cattle prices are often at their peak. They may also use these calves to utilize summer pasture and then sell them in the fall as yearlings, resulting in more pounds of calf being marketed per cow every 12 months. This also avoids calving during the busy spring planting season.

This system requires more intensive management of the cow during the winter in the northern U.S., as harvested feeds must be fed during nearly all of the critical lactation and breeding periods. Good quality spring pasture meets requirements in a spring calving system with little additional feed other than minerals. For most producers, spring calving is the preferred system.

Guideline Rations

In the paragraphs that follow, suggested rations are given for various ages and classes of beef cattle. These rations are based on the requirements listed in Tables 1 through 5.

In addition to the rations presented below, a salt-mineral mix should be offered free-choice at all times. Several possible mixes are listed later. Vitamin A should also be added to the diet or injected intramuscularly if the forage is of low quality and apt to be deficient in this vitamin. If injected. a dose of 1 to 3 million IU is recommended. The injected dose will last for 90 to 100 days.

If you are in doubt about the nutrient content of your feedstuffs. it is probably wise to submit a sample to your local extension agent for analysis of crude protein, estimated energy content, and levels of various mineral elements. He can arrange to have the sample sent to a qualified laboratory with equipment to perform such analysis. The Ohio Livestock Ration Evaluation Program, O.A.R.D.C., Wooster, Ohio is one such laboratory.

Rations for Weaned Heifer Calves

The goal in feeding open heifers is to achieve enough gain in weight so that they may be bred one heat period prior to the main cow herd at about 14 months of age, as mentioned before. Their daily gain from weaning to breeding should average 1.0 to 1.5 lb. per day. The following rations are possibilities.

1. High quality pasture + 5# grain
2. 12# hay (full-feed) + 5# grain
3. 40 # corn silage (30% DM) + 1# soybean meal or equivalent
4. 30# wet haylage (35% DM) + 5# grain
5. 20# dry haylage (50% DM) + 5# grain
6. 5# hay + 30# corn silage + 1/2# soybean meal or equivalent
7. 10# hay + 20# corn silage
8. 40# forage sorghum silage (30% DM) + 21/2# grain + 1 # soybean meal or equivalent
9. 40# oat silage (30% DM) + 21/2# grain + 1/2# soybean meal or equivalent

Rations for Coming 2-Year-Old Pregnant Heifers

The goal in feeding pregnant heifers is to achieve about 1.0 lb. average daily gain for 120 days prior to calving; for example, from 800 lb. to 920 lb. Under-feeding pregnant heifers can be disastrous because they are still growing as well as developing fetus and preparing for the stress of their first lactation. Over-feeding, however, can lead to too much internal fat, resulting in a higher incidence of calving difficulty.

1. High quality pasture
2. 20 to 25# hay (full-feed)
3. 45# corn silage (30% DM) + 11/4# soybean meal or equivalent
4. 55# wet haylage (35% DM)
5. 40# dry haylage (50% DM)
6. 5# hay + 35# corn silage + 3/4# soybean meal or equivalent
7. 10# hay + 25# corn silage + 1/4# soybean meal or equivalent
8. 15#hay + 15#corn silage
9. 55# forage sorghum silage (30% DM) + 1# soybean meal or equivalent
10. 55# oat silage (30% DM)

Rations for Dry 1100-lb. Mature Cow, Middle 1/3 of Pregnancy

The goal here is to maintain the body weight of pregnant mature cows in good condition after their calves have been weaned.

1. Low to medium quality pasture
2. 17 to 25# hay
3. 10#hay + 15# straw
4. 40# corn silage (30% DM)
5. 50# wet haylage (35 % DM)

6. 35# dry haylage (50% DM)
7. 5# hay or 7# straw + 30# corn silage
8. 10# hay or 13# straw + 20# corn silage
9. 15# hay or 21# straw + 10# corn silage
10. 50# forage sorghum silage (30% DM)
11. 50# oat silage (30% DM)
12. 1 to 2 acres cornstalks per cow + hay or supplement as needed
13. Full-feed dry corn refuse(13#DM) + 6# hay
14. Full-feed corn refuse silage (15# DM) + 2# corn + 1/2# soybean meal or equivalent

Rations for Dry 1100-lb. Mature Cow, Last 1/3 of Pregnancy

The goal during the last 90 to 120 days of pregnancy is to achieve an average daily gain of 0.5 to 1.0 lb. per day. Ideally, cows should be on a rising plane of nutrition prior to and after calving so as to be in proper condition for the start of breeding season.

1. Medium to high quality pasture
2. 25 to 30# hay
3. 50# corn silage (30% DM)
4. 60# wet haylage (35 % DM)
5. 40# dry haylage (50% DM)
6. 5# hay + 35# corn silage
7. 10# hay + 25# corn silage
8. 15# hay + 15# corn silage
9. 60# forage sorghum silage (30% DM)
10. 60# oat silage (30% DM)

Rations for 1100-lb. Lactating Cow (Average Milking Ability)

The goal here is to keep the cow in a positive nutritional status so she will conceive by 80 days after calving and average 10 to 12 lb. of milk per day during the first 3 to 4 months of lactation. This level of milk production would be typical of most British beef cows.

1. High quality pasture
2. 25 to 35# hay (full-feed)
3. 60# corn silage (30% DM) + 1 # soybean meal or equivalent
4. 70# wet haylage (35 % DM), full-feed
5. 50# dry haylage (50# DM). full-feed
6. 10# hay + 40# corn silage
7. 15# hay + 30# corn silage
8. 20# hay + 20# corn silage
9. 75# forage sorghum silage (30% DM), full-feed + 1 # soybean meal or equivalent

10. 70# oat silage (30~c DM). full-feed

Rations for 1100-lb. Lactating Cow (Heavy Milker)

The goal is the same as for the average milking cow except that milk production is 20 to 24 lb. per day, which is typical of dairy x beef crossbred females and some dual-purpose exotics. It is difficult for females of this type to consume enough energy to get back in shape for breeding season so as to conceive on schedule.

1. High quality pasture + grain if necessary
2. 30 to 40# hay (full-feed) + grain if necessary
3. 75# corn silage (30% DM), full-feed + 21/4# soybean meal or equivalent
4. 85# wet haylage (35% DM), full-feed + grain if necessary
5. 60# dry haylage (50% DM), full-feed + grain if necessary
6. 90# forage sorghum silage (30% DM), full-feed + 2# soybean meal or equivalent
7. 85# oat silage (30% DM), full feed + 3/~# soybean meal or equivalent

Rations for Mature Herd Sires

The goal is to maintain the weight of mature bulls in good condition and to put weight on thin bulls.

1. High quality pasture + grain to condition
2. 30# hay + grain to condition
3. 70# corn silage (30% DM) + 11/2# soybean meal or equivalent
4. 85# wet haylage (35% DM) + grain to condition
5. 60# dry haylage (50% DM) + grain to condition
6. 90# forage sorghum silage (30% DM) + 1# soybean meal or equivalent
7. 85# oat silage (30% DM)

Rations for Young Herd Sires (Yearlings and 2-Yr.-Olds)

The goal is to provide adequate nutrition to support an average daily gain of 1.5 lb. on yearling bulls and 0.7 lb. on 2-year-old bulls.

1. High quality pasture + 12# grain
2. 20# mixed hay + 12# grain
3. 80# corn silage (30% DM) + 2# soybean meal or equivalent
4. 50# wet haylage (35 SO DM) + 12# grain
5. 35# dry haylage (50% DM) + 12# grain
6. 70# forage sorghum silage (30% DM) + 6# grain mix + 13/4# soybean meal or equivalent
7. 80# oat silage + 3# grain + 1/2# soybean meal or equivalent

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NPN as Supplemental Crude Protein

Non-protein nitrogen (NPN) compounds such as urea, ammonia, etc. are usually more economical sources of crude protein than natural sources such as soybean meal. NPN is particularly well utilized on corn silage based diets. Therefore. treating the silage with NPN or feeding a supplement formulated with NPN as the major contributor of crude protein is often a recommended practice when corn silage is the primary feedstuff.

When treating silage with NPN, care must be taken to apply the correct amount. If in doubt, submit several representative samples of treated silage for crude protein analysis to be certain that the desired level of treatment was attained. Generally, the silage should be treated so that the dry matter contains at least 10.5% crude protein.

Free-choice lick tank supplements are a convenient and popular means of supplementing beef cow herds. However, over-consumption is sometimes a problem, which can result in undue expense. Therefore, lick tanks should be watched closely for signs of over-consumption.

Winter Feed Budgets

Tables 6, 7 and 8 are an attempt to illustrate the total winter feed requirements for a 50-cow beef herd, utilizing various combinations of feed stuffs. In Table 6, hay is the only roughage source, whereas in Table 7, corn silage is the only roughage. In Table 8, about 50% of the roughage dry matter is furnished by hay and 50% by corn silage. In developing these budgets, minimum nutrient requirements for 1100-lb. mature cows were used, and no allowance was made for cold stress. Furthermore, it is assumed that any mineral deficiencies would be offset by free-choice feeding of a salt/mineral mix. In addition, the following assumptions were made:

1. a total winter feeding period of 180 days;
2. on an average, the herd is lactating during the last 60 days of the winter feeding period;
3. half of the cows are average milkers, half are heavy milkers;
4. 13 open yearlings are kept as herd replacements;
5. the pregnant herd consists of 40 mature cows and 10 coming 2-year olds;
6. the mixed hay contains 50% TDN and 10% crude protein.

Free-Choice Mineral Mixtures

Mixture 1. For the cow herd during breeding season to provide extra phosphorus.

	% of Mix	%Ca	%P
Trace mineralized salt	33	--	--
Bonemeal or dicalcium phosphate	67	22-27	13-18
Total in Mix	100	14.7-18.0	8.7-12.8

Mixture 2. For the cow herd before and after breeding season.

	% of Mix	% Ca	% P

Trace mineralized salt	50	--	--
Bonemeal or dicalcium phosphate	50	22-27	13-19
Total in Mix	100	11.0-13.5	6.5-9.5

Mixture 3. For cattle in drylot on grain or other feedstuffs low in calcium content.

	% of Mix	%Ca	% P
Trace mineralized salt	33.3	--	--
Bonemeal or dicalcium phosphate	33.3	22-27	13-19
Ground limestone	33.3	38	--
Total in Mix	100.0	20.0-21.7	4.3-6.3

Mixture 4. For feeding to herds during late winter and early spring in areas where grass tetany (magnesium deficiency) is a problem. No other salt or mineral mixture should be offered, or daily magnesium intake may be too low.

	% of Mix	% Ca	% P	% Mg
Magnesium oxide	25	--	--	60
Trace mineralized salt	25	--	--	--
Bonemeal or dicalcium phosphate	25	22-27	13-19	--
Ground corn	25	--	.35	--
Total in Mix	100	5.5-6.8	3.3-4.8	15.0

Commercial Mixtures. Salt-mineral mixtures comparable to those listed above may be purchased commercially. Beware of mineral blocks that are extremely hard and dense because it is very difficult or impossible for cattle to obtain their daily mineral requirements from such blocks.

Feeding Salt and Mineral Separately. To ensure adequate intake of salt and all other mineral elements, it is often considered preferable to feed Mixture 1, 2 or 3 in one feeder and straight trace mineralized salt in another feeder.

How to Feed Mineral Mixes. All salt or mineral mixes should be fed under cover to keep out rain and/or snow. When fed outside, weather-vane type feeders that rotate with the wind are the most desirable. They may be constructed at home or purchased commercially. Mineral feeders should be located in sites where cattle have daily contact.

How to Budget Mineral Consumption. When fed free-choice, cattle will consume approximately 0.1 to 0.2 lb. of salt-mineral mix per head per day. A figure of 0.15 lb. per day or 55 lb. per cow per year would be a rough average.

Adding Vitamin A to Mineral Mixes. Adding a Vitamin A premix to the mineral mix is a convenient method of providing this vitamin. However, vitamin A loses its potency with time. so these mixes should not be stored for extended periods of time. Enough vitamin A should be added

to the mineral mix so that each animal receives its requirement (10.000 to 50.000 IU) in 0.1 to 0.2 lb. of total mix.

Table 1 - Requirements of Weaned Heifer Calves

		TDN		Crude Protein		Calcium		Phosphorus		Vitamin A	
Heifer Wt. lb.	Max Daily DM lb.	lb./day	%DM	lb./day	%DM	g/day	%DM	g/day	%DM	IU/day	IU/lb.
Average Daily Gain of 1.1 lb. per day											
330	9.9	5.7	61	1.00	11.0	14	.34	12	.29	9,000	1000
440	13.2	7.7	58	1.28	9.6	14	.23	13	.22	13,000	1000
550	14.3	8.6	58	1.37	9.5	14	.20	13	.20	14,000	1000
660	16.5	9.9	61	1.48	9.2	14	.19	14	.19	16,000	1000
770	18.3	11.2	61	1.61	8.7	15	.18	15	.18	18,000	1000
avg.	15.0	8.6	60	1.35	9.6	14	.23	13	.22	14,000	1000
Average Daily Gain of 1.5 lb. per day											
330	9.9	6.2	69	1.10	12.4	18	.45	14	.35	9,000	1000
440	13.2	8.4	64	1.37	10.2	18	.30	16	.27	13,000	1000
550	14.3	9.1	72	1.37	10.5	17	.29	15	.26	14,000	1000
660	16.5	10.4	72	1.48	10.1	16	.24	15	.23	16,000	1000
770	18.3	11.9	69	1.61	9.2	15	.19	15	.19	18,000	1000
avg.	15.0	9.2	69	1.40	10.5	17	.29	15	.26	14,000	1000
overall avg.	15.0	8.9	65	1.40	10.0	15	.26	14	.24	14,000	1000

Table 2. Requirements of Coming 2-yr. Old Heifers, Last 3-4 mos. of Pregnancy

		TDN		Crude Protein		Calcium		Phosphorus		Vitamin A	
Heifer Wt. lb.	Max Daily DM lb.	lb./day	% DM	lb./day	% DM	g/day	% DM	g/day	% DM	IU/day	IU/lb.
Average Daily Gain of 0.9 lb. per day											
715	20.7	7.7	52	1.28	8.8	15	.23	15	.23	19,000	1275
770	22.0	8.1	52	1.35	8.8	15	.22	15	.22	19,000	1275

825	24.2	8.4	52	1.39	8.7	15	.21	15	.21	20,000	1275
880	25.6	8.7	52	1.43	8.7	16	.21	16	.21	21,000	1275
935	26.7	9.0	52	1.52	8.8	16	.20	16	.20	22,000	1275
935	26.7	9.0	52	1.52	8.8	16	.20	15	.21	20,000	1275
Avg.	23.8	8.4	52	1.40	8.8	15	.21				
Average Daily Gain of 1.3 lb. per day											
715	20.7	9.9	52	1.65	8.8	18	.21	18	.21	23,000	1275
770	22.0	10.3	52	1.72	8.8	19	.21	19	.21	25,000	1275
825	24.2	10.8	52	1.78	8.7	19	.20	19	.20	26,000	1275
880	25.6	11.3	52	1.85	8.7	19	.20	19	.20	27,000	1275
935	26.7	10.8	52	1.80	8.8	19	.20	19	.20	26,000	1275
Avg.	23.8	10.6	52	1.80	8.8	19	.20	19	.20	26,000	1275
Overall Avg.	23.8	9.6	52	1.60	8.8	17	.21	.7	.21	23,000	1275

Table 3. Requirements of Dry Pregnant Mature Cows

		TDN		**Crude Protein**		**Calcium**		**Phosphorus**		**Vitamin A**	
Cow Wt. lb.	Max Daily DM lb.	lb./day	% DM	lb./day	% DM	g/day	% DM	g/day	% DM	IU/day	IU/lb.
Middle 1/2 of Pregnancy, 0.0 lb. Average Daily Gain											
772	20	6.6	52	.71	5.9	10	.18	10	.18	15,000	1275
882	22	7.3	52	.79	5.9	11	.18	11	.18	17,000	1275
992	24	7.9	52	.86	5.9	12	.18	12	.18	19,000	1275
1002	26	8.6	52	.93	5.9	13	.18	13	.18	20,000	1275
1213	28	9.2	52	.99	5.9	14	.18	14	.18	22,000	1275
1323	30	9.8	52	1.08	5.9	15	.18	15	.18	23,000	1275
1433	32	10.4	52	1.15	5.9	16	.18	16	.18	25,000	1275
1545	34	11.0	52	1.21	5.9	17	.18	17	.18	27,000	1275
Avg.	27	8.9	52	1.00	5.9	14	.18	14	.18	21,000	1275
Last 1/2 of Pregnancy, 0.9 lb. Average Daily Gain											
772	20	8.0	52	.90	5.9	12	.18	12	.18	19,000	1275

882	22	8.7	52	.97	5.9	14	.18	14	.18	21,000	1275
992	24	9.4	52	1.06	5.9	15	.18	15	.18	23,000	1275
1102	26	10.0	52	1.12	5.9	15	.18	15	.18	24,000	1275
1213	28	10.7	52	1.19	5.9	16	.18	16	.18	26,000	1275
1323	30	11.2	52	1.26	5.9	17	.18	17	.18	27,000	1275
1433	32	11.9	52	1.32	5.9	18	.18	18	.18	29,000	1275
1545	34	12.6	52	1.39	5.9	19	.18	19	.18	30,000	1275
Avg.	27	10.3	52	1.20	5.9	16	.18	16	.18	25,000	1275
Overall Avg.	27	9.6	52	1.10	5.9	15	.18	15	.18	23,000	1275

Table 4. Requirements of Lactating Cows, First 3-4 Mos. After Calving

		TDN		Crude Protein		Calcium		Phosphorus		Vitamin A	
Cow Wt lb.	Max Daily DM lb.	lb./day	% DM	lb./day	% DM	g/day	% DM	g/day	% DM	IU/day	IU/lb.
Average Milking Ability (10-12 lb./day)											
770	25	9.7	52	1.65	9.2	24	.29	24	.29	19,000	1775
880	27	10.4	52	1.79	9.2	25	.28	25	.28	21,000	1775
990	29	11.0	52	1.90	9.2	26	.28	26	.28	23,000	1775
1100	31	11.7	52	1.98	9.2	27	.28	27	.28	24,000	1775
1210	33	12.3	52	2.14	9.2	28	.27	28	.27	26,000	1775
1320	35	13.0	52	2.23	9.2	28	.25	28	.25	27,000	1775
1430	37	13.7	52	2.32	9.2	29	.25	29	.25	29,000	1775
1540	39	14.4	52	2.41	9.2	30	.25	30	.25	31,000	1775
Avg.	32	12.0	52	2.05	9.2	27	.27	27	.27	25,000	1775
Superior Milking Ability (21-23 lb./day)											
770	30	12.8	55	2.45	10.9	45	.44	40	.39	32,000	1775
880	32	13.5	55	2.58	10.9	45	.42	41	.38	34,000	1775
990	34	14.1	55	2.71	10.9	45	.40	42	.37	36,000	1775
1100	36	14.8	55	2.84	10.9	46	.39	43	.36	38,000	1775
1210	38	15.4	55	2.98	10.9	46	.37	44	.35	41,000	1775

1320	40	16.1	55	3.11	10.9	46	.36	44	.34	43,000	1775
1430	42	16.8	55	3.22	10.9	47	.35	45	.33	45,000	1775
1540	44	17.5	55	3.33	10.9	48	.34	46	.32	47,000	1775
Avg.	37	15.1	55	2.90	10.9	46	.38	43	.35	40,000	1775
Overall Avg.	34	13.5	53.5	2.50	10.0	37	.33	35	.31	32,000	1775

Table 5. Requirements of Bulls (Growth + Maintenance, Moderate Activity)

			TDN		**Crude Protein**		**Calcium**		**Phosphorus**		**Vitamin A**	
Bull Wt lb.	Avg. Daily Gain lb.	Max Daily DM lb.	lb./day	% DM	lb./day	% DM	g/day	% DM	g/day	% DM	IU/day	IU/lb.
660	2.4	19	13.2	**77**	2.16	12	29	.41	23	.32	34,000	1775
880	2.0	24	15.4	64	2.27	22	23	.21	23	.21	43,000	1775
1100	1.5	27	16.5	61	2.36	10	22	.18	22	.18	48,000	1775
1323	1.1	29	16.1	61	2.25	9	22	.18	22	.18	48,000	1775
1543	0.3	31	17.0	55	2.38	8.5	23	.18	23	.18	50,000	1775
1764	0	33	12.8	55	1.96	8.5	19	.18	19	.18	41,000	1775
1984	0	35	13.9	55	2.32	8.5	22	.18	22	.18	48,000	1775
2205	0	37	15.2	55	2.32	8.5	22	.18	22	.18	48,000	1775
2425	0	39	16.4	55	2.40	8.5	23	.18	23	.18	51,000	1775

Table 6. Winter Feed Budget for a 50-Cow Beef Herd Using Hay as Roughage

			Hay			Grain		
Class of Cattle	No. head	No. Days	lb. per head per day	Herd total for winter (T)	Total per cow unit (T)	lb. per head per day	Herd total for winter (lb.)	Total per cow unit (lb.)
Pregnant mature Cows	40	120	25	60.0	1.20	---	---	---
Lactating mature Cows	40	60	35	42.0	0.84	---	---	---
Pregnant 2-yr. Heifers	10	120	25	15.0	0.30	---	---	---

Lactating 2-yr. Heifers	10	60	35	10.5	0.21	---	---	---
Open Yearling Heifers	13	180	12	14.0		5	11,700	234
Mature herd sire	1	180	30	2.7		10	1,800	36
Young herd sire	1	180	20	1.8	0.04	12	2.160	43
Total	---	---	---	146.0	2.92	---	15,660	313

As shown in Table 6, it takes about 3 T. of hay and 300 lbs. of grain per producing female to winter a herd consisting of 50 breeding age females, 13 open yearling replacement heifers and 2 herd sires for 180 days. In addition, it would take a total of about 35 lb. of salt-mineral mix per cow unit, or a total for the entire herd of approximately 1,750 lbs. over the 180 day period.

Table 7. Winter Feed Budget for a 50-cow Beef Herd Using Corn Silage as Roughage

			30% DM Corn Silage			Soybean Meal Equivalent		
Class of Cattle	No. Head	No. Days	lb. per head per day	Herd total for Winter (T)	Total per Cow Unit (T)	lb. per head per day	Herd total for winter (lb.)	Total per Cow unit (lb.)
Pregnant mature cows	40	120	45	108.0	2.16	---	---	---
Lactating mature cows	40	60	65	78.0	1.56	2.0	4,800	96.0
Pregnant 2-yr. heifers	10	120	45	27.0	.54	1.1	1,320	26.4
Lactating 2-yr. heifers	10	60	65	19.5	.39	2.0	1,200	24.0
Open yearling heifers	13	180	40	46.8	.94	1.0	2,340	46.8
Mature herd sire	1	180	70	6.3	.13	1.4	252	5.0
Young herd sire	1	180	80	7.2	.14	2.0	360	7.2
Total	---	---	---	292.8	5.86	---	10,272	205.4

Table 7 shows that it takes slightly over 53/4 T of corn silage and about 200 lbs. of soybean meal equivalent per producing cow to winter a 50-cow herd for 180 days. In many instances, NPN compounds such as urea would be a more economical source of supplemental crude protein than soybean meal, as mentioned previously.

Table 8. Winter Feed Budget for a 50-Cow Beef Herd Using Hay and Corn Silage

Class of Cattle	No. Head	No. Days	lb. per head per day	Herd total for winter (T)	Total per cow unit (T)	lb. per head per day	Herd total for winter (T)	Total per cow unit (T)
Pregnant mature cows	40	120	5	12.0	.24	30	72.0	1.44
Lactating mature cows	40	60	10	12.0	.24	45	54.0	1.08
Pregnant 2-yr. heifers	10	120	15	9.0	.18	15	9.0	.18
Lactating 2-yr. heifers	10	60	10	3.0	.06	45	13.5	.27
Open yearling heifers	13	180	10	11.7	.23	20	23.4	.47
Mature herd sire	1	180	15	1.4	.03	40	3.6	.07
Young herd sire	1	180	10	.9	.02	60	5.4	.11
Total	---	---	---	50.0	1.00	---	108.9	3.62

As shown in Table 8, about 1 T. of hay and 3.6 T. of corn silage per producing cow are required to winter a 50-cow herd for 180 days. With hay at 90% DM and corn silage at 30% DM, approximately half of the total dry matter is supplied by each of these feeds.

Related web pages:

- Cattlemen on the WEB
- Western Producer
- American Beefalo International

Commercial suppliers:

- None identified.

Electronic mailing lists:

- Beef-l listserv address: LISTSERV@WSUVM1.CSC.WSU.EDU
- **BSE: Bovine Spongiform Encephalopathy**

  Subscription address: listserv@listserv.net

  Subscribe to BSE. Type "SUB BSE-L Yourfirstname Yourlastname" in the first line of the body.

- **BEEFTODAY-L: Beef Today Mailing List**

  Subscription address: majordomo@angus.mystery.com

  Topics: A forum for cattle producers to discuss issues, operations, and ideas with each other and the editors of Beef Today. Through this list, producers can gain further insight into past Beef Today articles and help develop future ones. However, discussions are not limited to what has appeared or will appear in the magazine.

  Subscribe to BeefToday-L. Type "subscribe BeefToday-L Your E-mail Address" in the message body. (Not supported by all browsers.)

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Approved Practices in Beef Cattle Production - by Elwood M Juergenson - Publication Date: February 1980 - List: $26.60
- Beef Cattle Feeding and Nutrition - by Tilden Wayne Perry, Michael J. Cecava (Editor) - Publication Date: July 1, 1995 - List: $74.95
  Booknews, Inc. , 03/01/96:
  Helps ranchers and feedlot managers maximize yields by offering information about feeding and nutrition of beef cattle from breeding to finishing. Describes cattle's requirements for vitamins, minerals, and protein; computer methods for calculating and monitoring rations; feed stuffs, including pasture and forages, hay, silage, and concentrates; the breeding herd; and aspects of the finishing process. Updated and augmented from the 1980 edition. Annotation copyright Book News, Inc. Portland, Or.
- Beef Cattle - by Alvin Ludwig Neuman - Publication Date: July 1986 - List: $80.95
- Beef Housing and Equipment Handbook/Mwps-6 - Publication Date: February 1987 - List: $7.00 + $1.85 special surcharge
- Beef Production and Management Decisions - by Robert E. Taylor - Publication Date: July 1993 - List: $89.00
  The publisher, Prentice-Hall Career & Technology :
  The text examines the primary biological principles that contribute to raising productive beef cattle and discusses the biological and economic principles that serve as the foundation for effective management decisions. The text's integrated approach to the various sectors of the beef industry gives students a more unified perspective. The second edition continues to examine management issues in great depth. Chapters are devoted to topics such as commercial cow-calf management decisions, yearling-stocker management decisions, feedlot management, and retail beef products and consumers.
- Beef Production from Different Dairy Breeds and Beef Crosses - by G.J. More O'Ferrall

(Editor) - Publication Date: January 1983 - List: $113.50

- Beef Production from Silage and Other Conserved Forages (Longman Handbooks in Agriculture) - by J.M. Wilkinson - Publication Date: June 1986 - List: $5.95 + $1.85 special surcharge
- Lameness in Cattle - by Paul R. Greenough (Editor), A. David Weaver (Editor) - Publication Date: January 1997 - List: $75.00
- Nutrient Requirements of Beef Cattle (Nutrient Requirements of Domestic Animals (Unnumbered).) - Publication Date: June 1, 1996 - List: $29.95
- The Lasater Philosophy of Cattle Raising - by Laurence M. Lasater - Publication Date: January 1, 1993 - List: $12.00
- Tropical Cattle : Origins, Breeds and Breeding Policies - by W. J. A. Payne, John Hodges - Publication Date: July 1997 - List: $110.00

- Applied Animal Nutrition: Feeds and Feeding - by Peter R. Cheeke - Publication Date: August 1998 - List Price: $92.00
  Booknews, Inc. , June 1, 1991
  Cheeke (Oregon State) discusses the agronomic, nutritional and toxicological properties of temperate and tropical feedstuffs and gives a solid grounding in the fundamentals of feed processing, diet formulation and feed manufacturing. He covers a broad range of species from livestock and poultry to fish and wildlife. Annotation copyright Book News, Inc. Portland, Or. --This text refers to the hardcover edition of this title
  From the Back Cover
  KEY BENEFIT: Suitable as either a book for undergraduate courses in Animal Nutrition or a reference for professional animal nutritionists, extension agents, veterinarians, and livestock producers. KEY TOPICS: This book has a two- fold objective—(1) to describe the properties of feedstuffs used in the feeding of domestic animals and (2) to provide information on feeding practices for a variety of domestic and exotic animal species.

- A Guide to Raising Beef Cattle (Storey Animal Handbook) - by Heather Smith Thomas - Publication Date: June 1998 - List Price: $18.95
- The Use of Drugs in Food Animals : Benefits and Risks - by Subcommittee on Drug Use in Food Animals, National Research Council - Publication Date: November 1998 - List Price: $34.95
  Synopsis
  The book overviews why and how drugs are used in food-producing industries--poultry, dairy, beef, swine, and aquaculture; discusses the prevalence of human pathogens in foods of animal origin; and addresses the transfer of resistance in animal microbes to human pathogens and the resulting risk of human disease.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Orchard/Fruit Crops

Return to the Small Farm Resource

- Apples
- Blackberries
- Blueberries
- Cranberries
- Grapes
- Hops
- Pumpkins
- Raspberries

If you have a question, we will post the question in the appropriate contents page to get suggestions from our site visitors.

Questions and suggestions can be sent to us via our Feedback form.

Visitor Questions:

Go to Other Crops

Go to Forage Crops

General crops related links and mailing lists

Growing Apples

Frequently Asked Questions Other Information Sources Return to Orchard/Fruit Crops

Frequently Asked Questions:

Other Information Sources:

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Growing Apples in North Dakota

Growing apples can be fascinating and fun. Selecting a variety suited to the climate, and planting where it is protected from wind, is important in North Dakota. The short growing season places a limit on planting late-season varieties. Most apple trees do well on any good garden soil. But fruit trees do not like "wet feet," so good drainage is necessary. Early spring planting is recommended.

Buy fruit trees from your area nursery. Normally they handle trees propagated on hardy rootstocks. To date none of the dwarfing rootstocks have proved reliably hardy under North Dakota conditions. Therefore, we do not recommend planting dwarf apple trees.

Select apple varieties that are hardy, disease-resistant and that will mature their fruit before October 10th. It is necessary to plant two varieties of apples for cross pollination. The varieties Red Duchess, Hazen, and Haralson are the best varietal choices for general planting in North Dakota. For a crabapple, Chestnut is superb.

How to Prune Apple Trees

You can prune most apple trees during the fall or winter months, whenever weather permits.

Pruning renews tree growth and health, and encourages better production of high quality fruit. There are two main factors to keep in mind as you prune. First, prune the trees so more light will get through the leaf cover during the next growing season. This means "opening up" the tree canopy.

Follow these steps when you prune:

- Cut off water sprouts (shoots rising upward) growing on the

trunk and main branches. You might occasionally leave a water spout to fill an open area.

- Remove broken and diseased branches.
- Remove the weakest of any crossing or closely parallel growing limbs.
- Remove limbs growing toward the center of the tree. They generally originate on scaffold limbs. You can easily see them when you stand next to the trunk and look upward.

If the tree needs thinning, remove the weak spindly branches. You will usually find them in the lower and outer part of the tree beneath the more dense growth.

Fire Blight of Apples and Crabapples

Fireblight is a serious disease of apples, crabapples and pears. Blossoms, blossom spurs, and branch tips are infected, turning brown and dying rapidly. The tips of branches often curl to form what resembles a shepherd's crook, or the curved end of a walking cane. The dead leaves remain brown to almost black and may remain on the branch all winter. The disease is caused by a bacterium that lives in the conducting or vascular tissues of the plant. The bacterium progresses down the diseased shoots and spurs, and sometimes reaches a larger branch where a dark or discolored area is formed. This discolored area is called a canker. The bacterium lives over the winter in young cankers with smooth, indefinite margins. In the spring, bacteria ooze from the canker, forming a sticky, thick liquid that insects feed on. These insects transmit the bacteria to blossoms, where new infections start. Later, the disease may spread from infected blossoms and old cankers to the shoots. Rain, wind, and hail help spread the disease.

Successful fireblight control requires a combination of actions. For the first step, overwintering cankers should be pruned away by cutting at least six to ten inches below the edge of the canker. Smaller diseased branches should be pruned about ten inches below the edge of the diseased area. Pruning is best done in late fall after leaf drop, when the diseased shoots can be readily seen since they retain their leaves. Or, pruning can be done in late February to early March. Pruning tools should be sterilized between each cut, Lysol diluted 3/4 cup per gallon of water, or household bleach diluted 1 cups in each gallon of water. Household bleach works very well, but corrodes tools, which must be carefully washed and oiled after use to prevent rusting. For the second step, apples or pears can be sprayed with streptomycin at blossom time. Use streptomycin at 50-100 parts per million every 3-5 days during blossoming. It can also be used every 14 days after blossoming, but streptomycin is not as effective for control of shoot blight as it is for

control of blossom blight. After a hail storm, streptomycin should be sprayed immediately to reduce infection in the hail-induced wounds. Uptake of streptomycin is improved if applied during the evening. Streptomycin should not be applied within 50 days of harvest for apples or within 30 days of harvest for pears. It is not registered for use on crabapple, cotoneaster, or mountain ash.

Fireblight is most severe on succulent shoots. Avoid overfertilizing trees, and do not fertilize in late spring or early summer.

Apple Maggot Control

If you have apple trees, one insect that can cause considerable damage to the fruit is the apple maggot. These maggots bore through the flesh of the apple, creating brown winding galleries.

Apple maggots will reduce early apple varieties to a brown rotten mass if the infestation is heavy. In later varieties the injury consists of corky streaks. When the fruit is slightly infested, there is no external indication of the presence of maggots. But when the fruit becomes ripe, the burrows show as dark lines under the skin.

Good sanitation will go a long way in controlling apple maggots. Pick up and destroy dropped apples once a week beginning in mid-July. This will help eliminate the maggots before they burrow out of the apples into the soil. As the last apples of the season are harvested, clean all fallen apples and other litter from under trees.

For effective apple maggot control, spray apple trees during the time that apple maggot flies appear in midsummer. Make the first spray application in early July followed by repeat spray applications at intervals of 7-10 days through August. Wettable powder formulations of Sevin or Malathion applied according to label directions can be used for apple tree spraying. If a spray application is followed by a heavy rain, you should respray.

Why Fruit Trees Fail to Bear

A fruit tree normally begins to bear fruit after it becomes old enough to blossom freely, provided other conditions are favorable. Tree health and environment, bearing habit, and the cultural practices used can all directly influence its ability to produce fruit.

Most nursery-produced fruit trees have tops that are one to two years old. The length of time required for them to bear fruit after planting varies with the kind of fruit. Apples usually bear fruit in 4-7 years while plums may bear as early as the third season after planting.

All fruit trees require pollination to produce fruit. Unless pollination takes place, trees can blossom abundantly but not bear. Bees are necessary for cross-pollination between two different tree fruit varieties. High winds, steady rainfall or cold temperatures can reduce bee movement during the flowering period. Consequently, poor pollination may occur under adverse weather conditions, resulting in poor fruit set. Cross-pollination is required for most tree fruits; therefore, it is essential to plant two or three different varieties to insure fruitfulness.

Extremely low temperatures during winter dormancy may kill or damage fruit buds. In addition, spring frosts during the flowering period may also drastically reduce fruit set.

Fruit trees that are grown near large shade trees are often poor producers. They are best planted in an area that receives full sun and less root competition from other trees.

Over fertilization (especially nitrogen fertilizers) will cause fruit trees to grow vigorously with delayed flowering. This can be overcome by allowing grass or weeds to compete with your trees for soil nutrients. Weeds should be mowed before going to seed.

Preventing Mouse and Rabbit Damage to Fruit Trees

Mice and rabbits can do considerable damage to fruit trees in your yard or orchard.

No single control procedure will get the job done. Nor is fall the only or best time to control these pests. Meadow mice and rabbit control should be as much a part of garden and orchard management as insect and disease control.

The following control procedures are offered as suggestions. You can use one or more of these measures depending upon your situation.

- Guards. Use one-quarter inch mesh hardware cloth around the base of fruit and ornamental trees. Set the guards about three to four inches in the ground at the base of the tree trunk. Extend them about 18 inches above the ground. Wire mesh will protect your trees for many years and reduce total labor and material costs.
- Habitat destruction is the elimination of high grass cover through repeated mowing or the use of grass-killing chemicals in and around trees and shrubs. This will reduce the mice population. It is particularly important to have a grass free area immediately surrounding the main stem of the tree or shrub.
- Trapping. This is also a safe and practical way to eliminate meadow mice and rabbits from small areas such as the yard. If

you place wooden snaptraps in runways you can control mice well. Peanut butter, oatmeal, or small slices of apple make the best bait. Rabbits are easy to catch in wire or wooden box traps.

- Repellents. There are several repellents on the market. When you apply them in the fall, they will last throughout the winter. Thiram is an excellent repellent on both rabbits and mice. If you apply it with a latex or resin adhesive, Thiram will protect woody plants from fall to spring. Use commercially prepared repellents containing Thiram as directed by the manufacturer. You can usually buy them at a garden center or farm supply store.

Storing Apples

The storage life of home grown apples is dependent upon the variety grown, the stage of maturity at harvest time, care in handling and storage temperatures. Early maturing varieties are not generally considered as long keepers. They should be utilized or processed within one or two months after harvest. A good storage apple such as Haralson, will keep for six months or more when cared for properly.

Apples remain alive after they are picked and they continue to respire or "breathe." The higher the storage temperature, the more rapid is the respiration and the more rapidly the apple fruit spoils. Apples keep best when stored near 32 F and at 85 to 90 percent relative humidity. Home storages have difficulty maintaining high humidity. In these cases, store small quantities of fruit in plastic bags.

Store only perfect fruits that are free from punctures or bruises. Check stored fruit periodically. One rotten apple can spoil the barrel if not removed. Light frosts are not harmful to apples while still on the tree. Do not harvest apples when temperatures are below freezing. Allow them to warm before picking to prevent bruise injury.

Related web pages:

- The Northwest Berry & Grape Information Net: http://osu.orst.edu/dept/infonet/

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- The Apple Grower : A Guide for the Organic Orchardist (Chelsea Green's Master Grower Gardening Series)
  by Michael Phillips - List Price: $35.00 - Publication Date: September 1998

Periodicals:

- None identified.

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Frequently Asked Questions:

Other Information Sources:

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Extremely low temperatures during winter dormancy may kill or damage fruit buds. In addition, spring frosts during the flowering period may also drastically reduce fruit set.

Fruit trees that are grown near large shade trees are often poor producers. They are best planted in an area that receives full sun and less root competition from other trees.

Over fertilization (especially nitrogen fertilizers) will cause fruit trees to grow vigorously with delayed flowering. This can be overcome by allowing grass or weeds to compete with your trees for soil nutrients. Weeds should be mowed before going to seed.

Preventing Mouse and Rabbit Damage to Fruit Trees

Mice and rabbits can do considerable damage to fruit trees in your yard or orchard.

No single control procedure will get the job done. Nor is fall the only or best time to control these pests. Meadow mice and rabbit control should be as much a part of garden and orchard management as insect and disease control.

The following control procedures are offered as suggestions. You can use one or more of these measures depending upon your situation.

- Guards. Use one-quarter inch mesh hardware cloth around the base of fruit and ornamental trees. Set the guards about three to four inches in the ground at the base of the tree trunk. Extend them about 18 inches above the ground. Wire mesh will protect your trees for many years and reduce total labor and material costs.

- Habitat destruction is the elimination of high grass cover through repeated mowing or the use of grass-killing chemicals in and around trees and shrubs. This will reduce the mice population. It is particularly important to have a grass free area immediately surrounding the main stem of the tree or shrub.
- Trapping. This is also a safe and practical way to eliminate meadow mice and rabbits from small areas such as the yard. If you place wooden snaptraps in runways you can control mice well. Peanut butter, oatmeal, or small slices of apple make the best bait. Rabbits are easy to catch in wire or wooden box traps.
- Repellents. There are several repellents on the market. When you apply them in the fall, they will last throughout the winter. Thiram is an excellent repellent on both rabbits and mice. If you apply it with a latex or resin adhesive, Thiram will protect woody plants from fall to spring. Use commercially prepared repellents containing Thiram as directed by the manufacturer. You can usually buy them at a garden center or farm supply store.

Storing Apples

The storage life of home grown apples is dependent upon the variety grown, the stage of maturity at harvest time, care in handling and storage temperatures. Early maturing varieties are not generally considered as long keepers. They should be utilized or processed within one or two months after harvest. A good storage apple such as Haralson, will keep for six months or more when cared for properly.

Apples remain alive after they are picked and they continue to respire or "breathe." The higher the storage temperature, the more rapid is the respiration and the more rapidly the apple fruit spoils. Apples keep best when stored near 32 F and at 85 to 90 percent relative humidity. Home storages have difficulty maintaining high humidity. In these cases, store small quantities of fruit in plastic bags.

Store only perfect fruits that are free from punctures or bruises. Check stored fruit periodically. One rotten apple can spoil the barrel if not removed. Light frosts are not harmful to apples while still on the tree. Do not harvest apples when temperatures are below freezing. Allow them to warm before picking to prevent bruise injury.

Related web pages:

- The Northwest Berry & Grape Information Net: http://osu.orst.edu/dept/infonet/

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- The Apple Grower : A Guide for the Organic Orchardist (Chelsea Green's Master Grower Gardening Series)
  by Michael Phillips - List Price: $35.00 - Publication Date: September 1998

Periodicals:

- None identified.

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Growing Blackberries

Frequently Asked Questions Other Information Sources Return to Orchard/Fruit Crops

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Blackberries

There are two types of blackberries-erect, and trailing (dew berries). When properly pruned the erect varieties don't usually need to be trellised, but trailing varieties must be trellised. Construct a trellis of posts spaced 10 to 15 feet apart, with wires attached at 3 and 5 foot heights. The plants are then attached to these wires with soft string.

Planting

Set blackberry plants at the same depth as they were grown at the nursery. Space erect varieties 5 feet apart in a row, and trailing types 6 feet apart. Allow 10 feet between rows for working and picking. After planting erect varieties, cut them back to a height of 30 to 36 inches. The lateral shoots should also be tipped back to a length of 18 to 20 inches. After the canes have borne fruit they will never bear again and should be removed. Suckers which develop between the rows should be pulled up, not cut out. Cutting off a sucker does not delay its regrowth much. After removing the fruited canes at harvest time, thin the other plants so that there is only one plant for every 10 inches in a row.

One of the most important advances in the blackberry industry was the development of thornless varieties, which need to be trellised. New shoots are tied to the wires with soft string as they grow. Pruning is fairly simple since you keep only 4 to 8 canes per plant. All weak canes and suckers are removed.

Varieties

Erect: Darrow

Thornless: Black Satin, Dirksen, Hull.

Harvest

Most gardeners don't leave blackberries on the vine long enough to develop properly. When harvested too early the berries are sour. Ripe fruit lose their shiny color and start to turn a dull black. As with raspberries, fruit should be picked in the morning for better quality.

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- Raspberries and Blackberries : Their Breeding, Diseases, and Growth (Applied Botany and Crop Science Series) - by D.L. Jennings - Publication Date: April 1988 - List: $69.00

- Bramble Production : The Management and Marketing of Raspberries and Blackberries - by Perry C. Crandall - Publication Date: March 1995 - List: $39.95
  Booknews, Inc. , 08/01/95:
  Covers classification of raspberries and blackberries; growth and development; climatic requirements; site and plant selection; soil preparation and management; planting, pruning, training, and propagation; fruit production; harvesting and marketing;

insects and diseases; and pest control. Emphasizes American bramble production but grower practices in other parts of the world are included as well. Includes b&w photographs. Annotation copyright Book News, Inc. Portland, Or.

- The Backyard Berry Book : A Hands-On Guide to Growing Berries, Brambles, and Vine Fruit in the Home Garden by Stella B. Otto - Publication Date: April 1995 - List Price: $15.95
- Fruits and Berries for the Home Garden - by Lewis Hill, Gwen Steege (Editor) - Publication Date: April 1992 - List: $16.95
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Growing Blueberries

Frequently Asked Questions Other Information Sources Return to Orchard/Fruit Crops

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Highbush Blueberries

Blueberry bushes not only provide fresh fruit but also can be used as a source of fall color in a backyard planting. Blueberries are relatively easy to grow, provide about eight quarts of berries per bush at maturity, and the fruits are versatile and high in vitamin C.

Varieties

There are several blueberry varieties that are suitable for Massachusetts. Especially cold areas, like regions of Berkshire, Franklin and Hampshire counties, should not be planted to the earliest or latest-ripening varieties. Midseason varieties are more suited to these areas. Purchase two-year-old plants from a reputable nursery. Plants this size are easy to handle, become established quickly and bear fruit within a year or two after planting. Recommended blueberry varieties include:

- Early - Earliblue, Bluetta, Collins, Blueray
- Midseason - Bluecrop, Berkeley, Darrow, Herbert
- Late - Jersey, Coville, Lateblue

Other varieties that may be worth growing on a trial basis only are Elizabeth, Elliott, Northland, and Patriot. For adequate cross-pollination be sure to plant at least two varieties that overlap in time of bloom.

Soil Preparation

Blueberry plants are shallow rooted and require soils that hold moisture well, but are also well-drained. Dry, sandy soils and heavy wet soils can be improved by adding a source of organic matter such as peat moss,

well-rotted manure, compost, aged sawdust, or leafmold. Blueberries grow best in soils with a pH range of 4.6 to 4.8 but should do well in soils with a pH ranging from 4.0 to 5.2. An area where plants like laurel, huckleberry, wild blueberry, or pines are growing is usually suitable for highbush blueberries.

Soils should be prepared, and all preparations should be completed two weeks ahead of planting. Rows can be rototilled, or individual holes (two feet across by two feet deep) can be dug as early in the spring as possible. A mixture of equal parts of loam, sand, and organic matter should be placed in the holes before planting.

Fertilizing

Before planting. Since blueberries require acid soils, lime is not needed in a blueberry planting. Often, sulfur, sulfate of ammonia, or another acidic material must be added to lower pH (and increase soil acidity). Well-aged manure can be worked into the soil in the fall before planting.

After planting. About a month after setting out plants, apply one-half to one ounce of 10-10-10 (one to two ounces of 5-10-10 or equivalent) in a band around the base of the plant.

Following years. Increase rate of fertilizer by one to two ounces (of 10-10-10 or equivalent) per year until mature. When mature, blueberry bushes require about one-half pound of 10-10-10 (or equivalent) per year applied in April. In larger plantings, 40 to 50 pounds of actual nitrogen should be applied per acre.

Planting

Blueberry bushes should be planted in full sunlight for maximum fruit production. Set out plants as early in the spring as possible. Plant bushes one to two inches deeper in the soil than they were in the nursery, six to eight feet apart, in rows spaced eight to ten feet apart. After plants have been set in the holes, fill the holes three-fourths full with soil mixture (see "soil preparation"), and then flood the hole. After the water has drained, fill in the holes with soil and tamp it down.

Mulching

Mulching the plants with clean straw, sawdust, or wood chips will help conserve moisture as well as aid in weed control. A three to four inch layer of the above materials should be suitable. Generally, grass is allowed to grow between the rows of bushes, as long as the grass can be

mowed frequently.

Watering

Mature blueberry bushes require one to two inches of water each week for best growth and productivity, especially during the harvest season.

Weed Control

Blueberry bushes, especially young ones, suffer starvation if weeds or lawn are allowed to grow too close. Blueberry roots are close to the soil surface and need to be protected against competing weeds. Mulching is the recommended method of weed control around plants.

First-Season Care

Blossoms should be removed from newly-set-out plants to encourage maximum growth. Extra water and/or additional fertilizer applications may be necessary if plants are not making much growth.

Pruning

Pruning is the most important aspect of blueberry culture. Annual pruning is necessary to invigorate the bushes, encourage annual fruit production, and prevent the bushes from overbearing. Until the bushes reach maturity (at about eight years old) remove only dead, broken, short or weak shoots. On mature bushes remove one-third of the oldest shoots each year, as well as any broken or diseased branches. Prune in late winter or early spring before growth begins.

Flower buds are produced on the end of a shoot's growth. The flower buds are plump and rounded, leaf buds are small and pointed. Each flower bud may produce a cluster of five to eight berries. If all flower buds are left on, too many berries will be produced and many will be small and worthless. Also, short, thin shoots will grow resulting in poor fruiting wood for the following year's crop. Bushes need little pruning during the first two or three years after planting; only short, weak twiggy growth need be removed.

After two summers in the field, all the plants should be ready to prune for a small crop (1/2 to 1 pint per bush). Remove the thin, twiggy growth and concentrate the potential crop on a small number of stout, fruiting shoots. By limiting the cropping to only the strong shoots, the bush will continue to grow rapidly. A heavy crop at this time dwarfs the bush.

Pruning Mature Bushes

After the fourth summer in the field, some canes may show a weakening due to heavy bearing. From this time on, the first step in pruning is to remove canes which have only small weak, fruiting twigs. They may be cut to the ground or to a strong side shoot near the ground. This will stimulate the sprouting of new canes from the base, which keeps a plant relatively "young." It also allows adequate sunlight to penetrate the bush and promote the setting of fruit buds.

With enough sunlight, the new canes will start producing fruiting laterals in the second year at a relatively low level in the bush and will be able to develop a large zone of fruiting wood in the third and fourth years. In a dense, crowded bush a new cane will take three or four years to produce nothing more than a tuft of fruiting twigs at the very top of the bush.

The number of old canes to be removed depends on the rate of growth over the past several years and varies considerably over six years old; it may be necessary to remove two canes annually due to changing growth rates.

After removing the older canes, the small twiggy growth is eliminated in favor of the stronger shoots. A limited amount of twiggy growth may be left in the lower portion of the bush. At this level shading is not a factor, and the fruit production from these twigs will add to the total crop.

Pruning Weakened Bushes

Blueberry bushes are often weakened by: overbearing due to improper pruning, poor soil drainage, insufficient fertilizer, drought injury, crowding, scale injury, and grubs feeding on the roots. After the undesirable conditions have been corrected, it is possible to rejuvenate the plants by removing 1/3 to 1/2 of the old bush. This is accomplished by making large cuts at ground level. The remaining portion of the plant is allowed to bear heavily. The remaining old canes are removed the following spring.

Pests and Diseases

Birds are a major problem with blueberry growing. Bushes often must be covered with netting to protect developing berries from birds. The major insect pests on blueberries are apple maggot, fruit worms, and Japanese beetles. The major diseases are mummy berry, twig blights (caused by several different fungi), and viruses.

Disease prevention is a good rule to follow when growing any small

fruit. With blueberry growing, the following cultural practices will help prevent serious problems with most diseases.

1. Plant disease resistant varieties when possible. Purchase healthy plants.
2. Regular pruning helps to increase production, removes diseased plant parts, increases air circulation within the plants, and helps initiate fruit bud formation.
3. Prune out all diseased and insect-infested wood. Remove any wood that is broken or damaged. All diseased wood should be burned to prevent reinfestation of healthy plants. Keep plants free from weeds and debris. Rake under the bushes.

Disease Symptoms

"Mummy berry" is the most serious blueberry disease in Massachusetts. It is a fungus which first appears on newly emerging stems and flower clusters causing them to blacken and die. Later, spores infect blossoms. Developing fruit become tan and hard. These "mummified" berries eventually fall to the ground. Fungal spores overwinter inside the mummified berries. Removing infected berries is essential in preventing the disease from reoccurring. Raking and shallow cultivating between plants helps remove mummified berries. Applying 50 percent urea prills in the spring reduces spores from the mummified berries thereby reducing infections on plant growth.

"Fusicoccom (Godronia) canker" begins on plant parts near the ground, and appears as small reddish spots on the canes, often around a leafscar. These spots enlarge, forming a bullseye pattern. Fusicoccum cankers eventually girdle canes causing wilting and die-back.

"Phomopsis twig blight" causes symptoms very similar to those caused by Fusicoccum canker. Spores from infected plant parts are released in the spring and infect smaller twigs. Flagging and dieback follow initial twig infections. Leaf spots as well as crown infections can also occur.

Planting blueberries in optimal sites and proper pruning practices help to prevent these diseases. Winter cold encourages both Fusicoccum and Phomopsis. Practices which reduce winter damage, such as fertilizing in spring rather than fall, will decrease chances of encountering these diseases.

"**Anthracnose"** is often a problem on developing fruit. This fungus also overwinters in diseased twigs, spurs, and stem cankers. The spores are spread by rain and wind. Infected fruit bear bright pink spore clusters. Proper pruning practices help control this disease.

"Botrytis" causes rotting on ripening fruit under moist conditions.

Encouraging good air circulation and frequent picking reduce this problem.

Nutritional problems: Often, blueberry leaves show a yellowing, or chlorosis, especially between the leaf veins. This is usually a result of the blueberry roots being unable to take up iron from the soil. This "iron deficiency" is more often than not related to soil pH, or acidity. Blueberries should be grown in a pH range of 4.2 to 5.0. Above pH 5.0 the plants show this typical deficiency symptom. If your plants show yellow leaves (as described above), please have your soil tested to determine if the problem is pH related.

For chemical control recommendations, please refer to the current small fruit pest control guide.

Other Problems

Problem: The leaves on my blueberry bushes are turning yellow.

Cause: Interveinal yellowing (chlorosis) of blueberry leaves is most often caused by iron deficiency. When the soil pH is too high, blueberry roots cannot take up iron, and the plant appears to be iron deficient. Have your soil tested for pH level before you apply iron. Often, correcting the pH level is all that's needed.

Harvesting

Highbush blueberries are often harvested too early. After the berries turn blue, they should be left on the bushes for three to seven days to ripen and develop their full flavor and sugar content.

Berries should be harvested at two to three day intervals to discourage Japanese beetles, other insects, and fruit rots from entering ripening fruit.

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Suggested references:

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- Blueberries : A Century of Research - by Robert E. Gough (Editor), Ronald F. Korcak (Editor), North American Blueberry Research - Publication Date: March 1996 - List: $49.95
  Booknews, Inc. , 10/01/96:
  Comprises the proceedings of the North American Blueberry Research-Extension Workers Conference held in July 1994 in Beltsville, Maryland. The volume's 22 contributions include technical reports on genetics, nutrition, physiology, culture, and harvesting of several blueberry species. Also published as the Journal of Small Fruit & Viticulture, v.3, nos.2/3 and 4, 1995. Lacks an index. Annotation c. by Book News, Inc., Portland, Or.

- The Highbush Blueberry and Its Management - by Robert E., Ph.D. Gough - Publication Date: January 1994 - List: $49.95
  Booknews, Inc. , 03/01/94:
  A complete guide for growers of highbush blueberries, from the homeowner with a single bush in the backyard to large scale commercial berry farms. The topics include selecting cultivars, soil preparation and management, planting, pruning, pest control, and marketing. Paper edition (022-8), $32.95. Annotation copyright Book News, Inc. Portland, Or.

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1. Plant disease resistant varieties when possible. Purchase healthy plants.
2. Regular pruning helps to increase production, removes diseased plant parts, increases air circulation within the plants, and helps initiate fruit bud formation.
3. Prune out all diseased and insect-infested wood. Remove any wood that is broken or damaged. All diseased wood should be burned to prevent reinfestation of healthy plants. Keep plants free from weeds and debris. Rake under the bushes.

Disease Symptoms

"Mummy berry" is the most serious blueberry disease in Massachusetts. It is a fungus which first appears on newly emerging stems and flower clusters causing them to blacken and die. Later, spores infect blossoms. Developing fruit become tan and hard. These "mummified" berries eventually fall to the ground. Fungal spores overwinter inside the mummified berries. Removing infected berries is essential in preventing the disease from reoccurring. Raking and shallow cultivating between plants helps remove mummified berries. Applying 50 percent urea prills in the spring reduces spores from the mummified berries thereby reducing infections on plant growth.

"Fusicoccom (Godronia) canker" begins on plant parts near the ground, and appears as small reddish spots on the canes, often around a leafscar. These spots enlarge, forming a bullseye pattern. Fusicoccum cankers eventually girdle canes causing wilting and die-back.

"Phomopsis twig blight" causes symptoms very similar to those caused by Fusicoccum canker. Spores from infected plant parts are released in the spring and infect smaller twigs. Flagging and dieback follow initial twig infections. Leaf spots as well as crown infections can also occur.

Planting blueberries in optimal sites and proper pruning practices help to prevent these diseases. Winter cold encourages both Fusicoccum and Phomopsis. Practices which reduce winter damage, such as fertilizing in spring rather than fall, will decrease chances of encountering these diseases.

"**Anthracnose"** is often a problem on developing fruit. This fungus also overwinters in diseased twigs, spurs, and stem cankers. The spores are spread by rain and wind. Infected fruit bear bright pink spore clusters. Proper pruning practices help control this disease.

"Botrytis" causes rotting on ripening fruit under moist conditions. Encouraging good air circulation and frequent picking reduce this problem.

Nutritional problems: Often, blueberry leaves show a yellowing, or chlorosis, especially between the leaf veins. This is usually a result of the blueberry roots being unable to take up iron from the soil. This "iron deficiency" is more often than not related to soil pH, or acidity. Blueberries should be grown in a pH range of 4.2 to 5.0. Above pH 5.0 the plants show this typical deficiency symptom. If your plants show yellow leaves (as described above), please have your soil tested to determine if the problem is pH related.

For chemical control recommendations, please refer to the current small fruit pest control guide.

Other Problems

Problem: The leaves on my blueberry bushes are turning yellow.

Cause: Interveinal yellowing (chlorosis) of blueberry leaves is most often caused by iron deficiency. When the soil pH is too high, blueberry roots cannot take up iron, and the plant appears to be iron deficient. Have your soil tested for pH level before you apply iron. Often, correcting the pH level is all that's needed.

Harvesting

Highbush blueberries are often harvested too early. After the berries turn blue, they should be left on the bushes for three to seven days to ripen and develop their full flavor and sugar content.

Berries should be harvested at two to three day intervals to discourage Japanese beetles, other insects, and fruit rots from entering ripening fruit.

Related web pages:

- The Northwest Berry & Grape Information Net: http://osu.orst.edu/dept/infonet/

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Blueberries : A Century of Research - by Robert E. Gough (Editor), Ronald F. Korcak (Editor), North American Blueberry Research - Publication Date: March 1996 - List: $49.95
  Booknews, Inc. , 10/01/96:
  Comprises the proceedings of the North American Blueberry Research-Extension Workers Conference held in July 1994 in Beltsville, Maryland. The volume's 22 contributions include technical reports on genetics, nutrition, physiology, culture, and harvesting of several blueberry species. Also published as the Journal of Small Fruit & Viticulture, v.3, nos.2/3 and 4, 1995. Lacks an index. Annotation c. by Book News, Inc., Portland, Or.

- The Highbush Blueberry and Its Management - by Robert E., Ph.D. Gough - Publication Date: January 1994 - List: $49.95
  Booknews, Inc. , 03/01/94:
  A complete guide for growers of highbush blueberries, from the homeowner with a single bush in the backyard to large scale commercial berry farms. The topics include selecting cultivars, soil preparation and management, planting, pruning, pest control, and marketing. Paper edition (022-8), $32.95. Annotation copyright Book News, Inc. Portland, Or.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Growing Cranberries

Frequently Asked Questions Other Information Sources Return to Orchard/Fruit Crops

Frequently Asked Questions:

Other Information Sources:

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Cranberry Production

Massachusetts is the leading state in cranberry production, followed by Wisconsin, New Jersey, Washington, and Oregon. There is significant production in Canada, particularly in Nova Scotia, Quebec, and British Columbia.

Preparing the Land

Before planting a new cranberry bed, the land is leveled with laser guided equipment to provide optimum water management. Dikes are constructed around the edges of individual beds to allow for flooding. Drainage ditches and canals are also constructed to allow for efficient water management. In older plantings (some are 100 years old and still in production) the beds follow the contours of the land.

Establishing

Cranberries are established vegetatively from stem cuttings. In the spring, established cranberry vines are mown and collected into bales for transport to the new cranberry bog. The cuttings are spread on the ground and worked into the soil by dull discs. By the end of the summer the vines have produced roots and are on their way to becoming established. It takes three to five years after planting for a cranberry bed to begin producing commercial quantities of fruit.

Water Management

Water management is very important in cranberry production because it is used for frost protection and to protect the vines from winter injury. Solid-set sprinklers are used both for irrigation and frost protection. In

the late fall, after the ground has frozen, the beds are slowly flooded. As the flood freezes more water is added until the vines are encased in ice. This insulates the buds from serious winter injury.

The use of laser guided leveling equipment also allows more mechanization in the cranberry bog, especially at harvest. Each bed must be surrounded by a dike to contain the flood. With laser leveling these dikes can be straight, rather than crooked to follow the contour of the land. This allows for the use of larger equipment.

Tending the Fields

Two procedures which are done periodically are mowing and sanding. Mowing the vines stimulates them to produce new, vigorous uprights which produce more fruit. Mowing also provides cuttings for new plantings. Mowing is done in the spring, and mowed beds produce no yield in the year they are mowed. Sanding is done in the winter after the flood is frozen. Spreader trucks are driven onto the ice and a two inch layer of sand is put on the ice. After the spring thaw the sand sinks, covering the runners. This promotes rooting of the runners, which produces healthier plants and more uprights.

Harvesting

Harvest is accomplished in two ways. For the fresh market the berries are harvested dry with machines that resemble blueberry rakes. For the processing industry (mainly juice) the beds are flooded and the berries are mechanically beaten from the vines. The berries float to the surface and are driven by the wind or a mechanical boom system to one end of the bed. Here the berries are raked onto elevators which raise them into waiting trucks. If water harvest is used for fresh market berries there is more chance of rot diseases occurring, and the berries must be dried before they can be packaged. For processing, rots are avoided by freezing the berries until they are required by the processing plant.

Cranberries as a Crop

A new cranberry product is the "craisin", which is a dried cranberry. It is presently being used in breakfast cereals and other fruit mixes.

Cranberries can be a very lucrative crop to grow. Unfortunately, not everyone can grow cranberries because of the large water demand. Many areas that are suitable for cranberry production are also environmentally sensitive areas, so there is not a great deal of new land going into production.

Cranberry growers have never been able to satisfy the public demand for the fruit. This helps to keep the price growers receive high. Ocean Spray Cranberries, Inc. is a growers' cooperative that markets about 90 percent of the cranberries grown in the United States.

Related web pages:

- The Cape Cod Cranberry Growers' Association at: www.cranberries.org includes general information about cranberry growing, The Massachusetts Cranberry Harvest Festival, press releases, recipes and links.
- Cranberry Stressline covers the cranberry industry and has an active forum.
  They can be seen at: http://www.cranberrystressline.com
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Commercial suppliers:

- None identified.

Electronic mailing lists:

- cranberry-list@wisplan.uwex.edu

Suggested references:

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- The American Cranberry - by Paul Eck - Publication Date: June 1990 - List: $50.00

Periodicals:

- None identified.

This page was last updated on August 02, 2002

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Growing Grapes

Frequently Asked Questions Other Information Sources Return to Orchard/Fruit Crops

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Other Information Sources:

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Grapes

With newer, hardier varieties of grapes developed each year, more people are growing grapes in the home garden or in small scale plantings. Newer, seedless grape varieties that should do well in Massachusetts are now available.

Varieties

Varieties of red, blue, and white grapes are adapted to many areas of Massachusetts, some for fresh fruit, others suitable for wines. The limiting factor in grape-growing is our relatively short growing season and corresponding low degree-day heat units.

Recommended seedless varieties include:

- Himrod and seedless Concord.

Other recommended varieties include:

- RED--Delaware, Brighton
- BLUE (black)--Fredonia, Worden, Blue Boy, Concord
- WHITE--Ontario, Seneca, Niagara

Refer also to recommended variety lists for Massachusetts available from your local county Cooperative Extension office.

Soil Preparation

Grapes prefer deep, well-drained, sandy, or gravelly loam soils. Excessively wet or dry soils should be avoided. Adequate soil preparation is essential since grapes are deep-rooted, long-lived plants. Work soil to remove perennial weeds, and add humus (peat moss,

compost, aged manure) to improve soil quality.

Select sites with full sunlight and good air drainage--preferably a hill side that faces south. Frost-free sites are essential.

Lime and Fertilizer Requirements

Before Planting: Grapes prefer acid soils with a pH between 5.0 and 5.5. Thoroughly work in sulfur or ammonium sulfate (or similar material) as suggested by soil test results before planting. Well-aged manure at two to five bushels per 100 square feet can also be worked into the soil before planting.

After Vines are Planted: Commercial fertilizers are generally not necessary the year vines have been planted. Four to six ounces of 5-10-10 may be applied to poorly-growing, newly planted vines.

When Vines are Bearing: Each year, double the rate listed above until plants reach maturity. Three to four pounds of 5-10-10 (or equivalent) per vine per year is the recommended rate for mature vines.

Planting

Plant vines eight feet apart in rows that are eight to ten feet apart. Rows should run at right angles to the slope. In an area that normally is very windy, plant in the direction of the wind to minimize damage.

Purchase one or two-year-old vines. First grade, one-year-old vines are preferable. Vines should be planted at about the depth they were grown in the nursery. Grafted vines should be planted with the graft union about two inches above ground level. Roots should be spread out in the planting hole. After the vine is planted, remove all but the most vigorous cane, and cut back this cane to one or two buds.

Mulching

Mulching an area about two feet wide with grass clippings, straw, or other suitable material will help keep young vines free from competing weeds and will also help to conserve soil moisture.

Weed Control

Removing perennial weeds from planting sites and keeping growing vines free of competing weeds are essential aspects of grape growing. Mulching is a valuable way to eliminate many problem weeds.

Pruning and Training

The spring after planting, remove all but the most vigorous cane on each vine. Cut back the remaining cane to a height of between three and four feet. If the vine did not make sufficient growth the year it was planted, cut the vine back to two buds and treat it as a newly-planted vine.

The second year, trellis or stake the vine. If a trellis system is used, end posts should be eight to nine feet long and four to six inches in diameter. Set end posts three feet into the ground. Trellis wiring can be No. 9 or No. 10 galvanized wire or newer nylon-type lines.

There are many different systems for training and pruning grapes, depending on types of grapes planted and available space. For additional information, contact the Cooperative Extension office in your county.

Pruning is one of the most important cultural operations in grape production because it regulates both vegetative growth and fruit production.

To properly prune a vine, you should know something about its growth and fruiting habit. The vines should be pruned during the dormant season, preferably in March. Some things you must keep in mind are:

- The fruit is borne on shoots rising from one-year-old wood (canes).
- The most productive canes are about pencil thickness (0.25 inch to 0.30 inch) and have an internodal length of five to eight inches between the fifth and sixth nodes or buds.
- The most productive buds are in the mid-portion of the cane; therefore it is best to leave canes of 8 to 16 buds in length. Thin canes should carry fewer buds than thicker canes.
- To keep the fruiting wood close to the main trunk, leave one or two renewal spurs on or near each arm.

Prune the vine so you will maintain a balance between vegetative growth and fruit productions. Where a vine is underpruned, (too many buds left) the vine will produce many small clusters of small grapes that may fail to ripen properly. If the vine is overpruned, (too few buds left) the yield will be low and the vegetative growth excessive. To "balance prune" a vine, the number or buds left is adjusted according to the amount of one-year-old wood removed in pruning.

The following is a procedure you can use for balance pruning a vine:

- Estimate the weight of the one-year-old wood that is to be removed. If the estimate is two pounds, a Concord vine would be

pruned to 40 buds or nodes (30+10). If the estimate was three pounds, 50 buds would be retained (30+10+10).

- You then select four to six canes to be retained for fruiting, but leave an extra number of buds in case you have underestimated the vine's growth.
- Prune the vine. Weigh the one-year-old wood and adjust the number of canes and buds to be retained to the weight of the wood removed. After pruning a number of vines, you may be able to balance prune without weighing or counting.

Suggested pruning severity for balanced pruning of mature vigorous vines of some major varieties.

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Concord	30	10	60
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Catawba	25	10	60
Foch	20	10	50
Leon Millet	20	10	50
Aurore	10	10	40
Cascade	10	10	40
Chelois	10	10	40
Syvol	20	10	45
De Chaunac	20	10	45
Chancellor	20	10	45

Pruning French Hybrids

There are several differences between the American and the French hybrid varieties in regard to growth and fruiting habit.

- A normal plant of one of the hybrid varieties will produce a large number of shoots from buds which would not normally be considered "count buds."
- Shoots which develop from old wood, or from secondary positions on normal canes, tend to be fruitful, unlike similar shoots on a labrusca variety.
- The shoots which emerge will have a larger number of flower clusters than our standard labrusca varieties.
- Several of the hybrids tend to set far more fruit than they can

properly mature, even if the plant has already been balanced pruned.

French-American varieties - require severe "suckering" of the trunk, head, and cordons during spring and early summer for satisfactory growth, plus crop and vine maturity. Use the formulas suggested in the above table.

Pests and Diseases

Birds can be troublesome, and netting may be necessary to protect developing clusters of berries. Major insect pests include Japanese beetles, sap beetles, grape phylloxera, and grape berry moth. Major disease pests include black rot, downy mildew, and powdery mildew.

"Black Rot" is a fungus disease which first infects grapes in the spring. The youngest plant tissue is most susceptible, but the disease also attacks leaves, young canes, tendrils, and fruit. Usually two weeks elapse between initiation of the infection and the appearance of symptoms -- spots on the leaves and vines. About midsummer, symptoms appear on the fruit. Light brown circular spots form and rapidly enlarge. Within seven to ten days, the berries shrivel and become black, dry and wrinkled. Spores of the disease overwinter in these mummified berries, in diseased leaves, and tendrils that have fallen to the ground. Good sanitary practices must be maintained to prevent the reoccurence of black rot next year. Remove and destroy all fallen, infected debris. Rake and remove plant litter under the vines.

"Downy Mildew" is another fungus disease which attacks grape leaves. There are two infection periods during the season, one in June, the other during late summer as nights begin to cool. Older leaves in the center of the vine are first infected. Light yellow spots appear on the upper surface. On the under surface, white, moldy spots develop. Eventually the leaves dry and crumble. As leaves mature, the disease spreads to the end of the canes. Because the leaves no longer offer protection from the sun, sunscald damage develops on exposed grapes causing them to ripen abnormally. During a June infection, fruit becomes soft and a downy mold develops. If infection occurs during late summer, the fruit turns brown, withers and shatters readily. Other effects include: malformation of tendrils, water-soaked depressions on shoots, and later, development of white mold. Again, sanitary cultural practices are good protective measures against this disease.

NOTE: From midseason to harvest the possibility of downy mold infection increases while the potential for black rot infection decreases.

Although not as important as Downy Mildew and Black Rot, **"Powdery Mildew"** also infects grapes. This disease usually attacks

foliage and cluster stems, leaving a white, powdery growth. Eventually leaves turn brown and fall off. Berries turn rusty or scaly, fail to mature and split.

Other Problems

Problem: My grapes blossom heavily but never set fruit. Cause: Occasionally, a vine may have only male or female flowers.

Harvesting

Grapes should be harvested when fully ripe. Color does not always indicate maturity, so taste-testing is often the best method. Grape clusters should be cut from the vines with a sharp knife. Handle the clusters by their stems whenever possible. Grapes do not handle or store well, so use them as quickly as possible.

Related web pages:

- The Northwest Berry & Grape Information Net: http://osu.orst.edu/dept/infonet/

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- General Viticulture - by Albert Julius Winkler - Publication Date: March 1975 - List: $55.00
  A Reader, 06/25/97, rating = 8:
  Excellent general overview of viticulture
  Although this book could use an update, it is an excellent general

reference on U.S. grape growing practices and common problems, written by experts in the field. It is a well written technical book with many black and white photos and a good bibliography. I found the style very readable and not too difficult for a novice to follow, though some sections (e.g. the section about diseases) needed a little extra time. A must for anyone seriously thinking of putting in a vinyard.

- Harvesting and Handling California Table Grapes for Market - by Klayton E. Nelson - Publication Date: June 1979 - List: $10.00

Periodicals:

- None identified.

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Pruning French Hybrids

There are several differences between the American and the French hybrid varieties in regard to growth and fruiting habit.

- A normal plant of one of the hybrid varieties will produce a large number of shoots from buds which would not normally be considered "count buds."
- Shoots which develop from old wood, or from secondary positions on normal canes, tend to be fruitful, unlike similar shoots on a labrusca variety.
- The shoots which emerge will have a larger number of flower clusters than our standard labrusca varieties.
- Several of the hybrids tend to set far more fruit than they can properly mature, even if the plant has already been balanced pruned.

French-American varieties - require severe "suckering" of the trunk, head, and cordons during spring and early summer for satisfactory growth, plus crop and vine maturity. Use the formulas suggested in the above table.

Pests and Diseases

Birds can be troublesome, and netting may be necessary to protect developing clusters of berries. Major insect pests include Japanese beetles, sap beetles, grape phylloxera, and grape berry moth. Major disease pests include black rot, downy mildew, and powdery mildew.

"Black Rot" is a fungus disease which first infects grapes in the spring. The youngest plant tissue is most susceptible, but the disease also attacks leaves, young canes, tendrils, and fruit. Usually two weeks elapse between initiation of the infection and the appearance of symptoms -- spots on the leaves and vines. About midsummer, symptoms appear on the fruit. Light brown circular spots form and rapidly enlarge. Within seven to ten days, the berries shrivel and become black, dry and wrinkled. Spores of the disease overwinter in these mummified berries, in diseased leaves, and tendrils that have fallen to the ground. Good sanitary practices must be maintained to prevent the reoccurence of black rot next year. Remove and destroy all fallen, infected debris. Rake and remove plant litter under the vines.

"Downy Mildew" is another fungus disease which attacks grape leaves. There are two infection periods during the season, one in June, the other during late summer as nights begin to cool. Older leaves in the center of the vine are first infected. Light yellow spots appear on the upper surface.

On the under surface, white, moldy spots develop. Eventually the leaves dry and crumble. As leaves mature, the disease spreads to the end of the canes. Because the leaves no longer offer protection from the sun, sunscald damage develops on exposed grapes causing them to ripen abnormally. During a June infection, fruit becomes soft and a downy mold develops. If infection occurs during late summer, the fruit turns brown, withers and shatters readily. Other effects include: malformation of tendrils, water-soaked depressions on shoots, and later, development of white mold. Again, sanitary cultural practices are good protective measures against this disease.

NOTE: From midseason to harvest the possibility of downy mold infection increases while the potential for black rot infection decreases.

Although not as important as Downy Mildew and Black Rot, **"Powdery Mildew"** also infects grapes. This disease usually attacks foliage and cluster stems, leaving a white, powdery growth. Eventually leaves turn brown and fall off. Berries turn rusty or scaly, fail to mature and split.

Other Problems

Problem: My grapes blossom heavily but never set fruit. Cause: Occasionally, a vine may have only male or female flowers.

Harvesting

Grapes should be harvested when fully ripe. Color does not always indicate maturity, so taste-testing is often the best method. Grape clusters should be cut from the vines with a sharp knife. Handle the clusters by their stems whenever possible. Grapes do not handle or store well, so use them as quickly as possible.

Related web pages:

- The Northwest Berry & Grape Information Net: http://osu.orst.edu/dept/infonet/

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- General Viticulture - by Albert Julius Winkler - Publication Date: March 1975 - List: $55.00
  A Reader, 06/25/97, rating = 8:
  Excellent general overview of viticulture
  Although this book could use an update, it is an excellent general reference on U.S. grape growing practices and common problems, written by experts in the field. It is a well written technical book with many black and white photos and a good bibliography. I found the style very readable and not too difficult for a novice to follow, though some sections (e.g. the section about diseases) needed a little extra time. A must for anyone seriously thinking of putting in a vinyard.
- Harvesting and Handling California Table Grapes for Market - by Klayton E. Nelson - Publication Date: June 1979 - List: $10.00

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Growing Hops

Frequently Asked Questions Other Information Sources Return to Orchard/Fruit Crops

Frequently Asked Questions:

- What is question 1?

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

What is Question One?

I don't know but the answer would go here.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Homegrown Hops : An Illustrated How to Do It Manual - by David R. Beach - List: $8.00 - Publication date: December 1988
- Hops - by R.A. Neve - List: $79.95 - Publication date: March 1991

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Growing Pumpkins

Frequently Asked Questions Other Information Sources Return to Orchard/Fruit Crops

Frequently Asked Questions:

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Starting the giant pumpkin seedling

The first 9-10 days of the giant pumpkin plant's development requires special attention to insure a good start of a properly grown seedling. An understanding, by the grower, of the development and growth of the pumpkin seedling (and the entire plant & fruit) is necessary in an effort to eliminate any variables and set goals. This is most often gained by experience as in the case of the consistent competitor, although a first time grower can conquer these "variables" and show very well.

SEED SELECTION - it is imperative to select a variety with the genetic potential capable of producing a specimen sizeable for the competition you wish to enter. My suggestion for "World Class" competition is the Atlantic Giant. Select only full, mature, viable seed.

TARGETING SEED PLANTING - to set a seed planting date, one must review the plant's stages of growth, day length and the date of the competition (harvest). An understanding of local weather patterns may also be an influential factor for determining when to plant the seed or better to say, when to mature the seedling to the three (3) leaf stage for transplanting. Let's say there are three stages of the plants development to consider when targeting the seed planting date:

1. Seedling stage - seed planting to 3 leaf stage (9-10 days).
2. Plant growth stage - 3 leaf to fruit set date (60-70 days).
3. Fruiting stage - fruit set to harvest date (last 70-80+ days - fruit development)

To capsulate the all this targeting by example, we will say that the target date for competition is October 12. Count back 70-80+ days to the fruit set date of July 24 to August 3. Then count back 60-70 days to the planting date of May 15-25 and 9-10 back to the seed planting date (May 5-10). In reverse - 9-10 days to 3 leaf, +60-70 days to fruit set and

+70-80 days to harvest (total days seed to harvest 130-150). Too often growers start too early!

PLANTING MEDIUM - it is most advantageous to use a light medium. The giant pumpking seed is one of the largest of the vegetable seeds, as it it is the larget vegetable plant fruit. The seed hasmuch organic matter and will take a great amount of moisturetherefore have the potential to damp off (rot). This single factor is the reason for much seed failure when planting giant pumpkin seed. Use a mix similar to this:

1/3 vermiculite
1/3 perlite
1/3 peat moss (add fungicide to mix)

A 9-10 day old seedling has few nutrient requirements but a small amount a water soluable fertilizer won't hurt.

PEAT POT - use 4 inch peat pots. Plant the peat pot and all when planting the seedling (this reduces root damage). Poke holes in the peat pot in several places at or near the bottom if no hole. The pot will hold an excessive amount of moisture if this not done. Fill the peat pot with the dry soil mix. Keep settling to a minimum.

FUNGICIDE - seed and potting mixture treatment are very important. This procedure will help control damping off, but alone without proper room temperature. moisture, and bottom heat, etc. may not be effective. Dampen the seed, then apply dry powder fungicide. Coat to the point of good coverage. When adding to the potting soil mix follow recommendations on the label; or just add a small amount.

PLANTING THE SEED - moisten the pot and medium. Initial moisture is essential to the seed, therefore moisten well the first time. The pot itself will take on much moisture (it's actually peat - sponge), this time it should be saturated. From then on let the moisture decrease, not to show through the peat pot after watering. Plant the seed 1/2 inch below the surface with the rooting end down, crown end up.

BOTTOM HEAT - is necessary for 4-5 days to give the seed enough heat to germinate. When the main root is 1 inch long STOP BOTTOM HEATING (it will destroy roots greater than 1 inch long). Suggest you use a plastic plant flat without holes. Jugs of warm water may be the most economical way to add heat. Remember to water individual pots and keep proper moisture.

ROOM TEMPERATURE - a temperature of 75-85 degrees F. is necessary. Most ideal being 85 degrees. Please understand a higher temperature has more moisture holding capacity.

VENTILATION - air movement is necessary to help control fungus growth and supply fresh air components to the seedling. Keep in mind that the ideal conditions for seedling growth are are also ideal for fungus growth.

LIGHTING - use "artificial lighting". Flourescent tubes 2-3 inches above the potting mixture surface and maintained at 2-3 inches above seedling stage will result in a sturdy not spindly (light starved) plant. It is not necessary to use a "Grow Lite", as a regular "Cool White" flourescent tube is just fine. Full light (24 hr.) will provide the seedling with the quantity of light required. The quality of the light is maintained by the closeness of the bulb to the plant. Continue to check regularly. Be careful not to over water.

PLANTING THE SEEDLING - It is not necessary to temper or acclimate the seedling over a period of time. It is important to plant on or near the target date, when the seedling is at the early 3 leaf stage. Planting should be under a hot-tent or miniature greenhouse.

Growing Pumpkins and Winter Squash

SOILS. The soil should be well-drained. The optimum pH is 6.0 to 6.5. Take a soil test to determine pH and fertilizer requirements. Do not use fields that have had other vine crops (melons, cucumbers, etc.) during the past 2 years.

FERTILIZER. Follow suggestions from soil test report. Otherwise, broadcast 1000 pounds of 5-10-10 per acre before planting (10 pints per 100 feet of row). Sidedress at 3 and 6 wk after seeding with 20 to 30 pounds per acre of nitrogen and 60 to 100 pounds per acre of potassium (1 pint 13-0-44 per 100 ft of row). Processing types may require more potassium for good dry matter production. Place sidedress fertilizer 6 to 8 inches from the plants on both sides of the row.

Pumpkins for processing should be seeded in spring as soon as the soil temperature at 4-inch depth has reached 60 to 65 F. Pumpkins for ornamental purposes may be seeded as late as June to early July in the lower piedmont and eastern N.C. The later planted pumpkins will be more subject to increased diseases and insects than an earlier planted crop. However, regardless of planting date, both require insecticide and fungicide applications. Spacing varies with variety and vine size.

ROW SPACING IN FEET

Variety	Between Rows	Within row
Bush or short vine	3-5 feet	2-3 feet
Small fruited/large vine	6-8 feet	3-5 feet

Large fruited/large vine	6-8 feet	3-5 feet

Plant 2 to 3 seeds per hill and thin to one plant per hill. For large commercial acreage, seed 4 seeds per ft of row and thin. Use per acre rates of 2 to 3 lb of seed for large vine types and 3 to 4 lb of seed for bush types.

VARIETIES

SMALL (2-8 lb)
Small Sugar
Spookie

MEDIUM (8-12 lb)
Autumn Gold
Ghost Rider
Jackpot (compact vine)
Spirit

LARGE (12-20 lb)
Connecticut Field
Howden
Big Max
Mammoth Gold

EXTRA LARGE (20+ lb)
DECORATIVE TYPE
Big Mac

PROCESSING TYPES
Dickinson
Golden Delicious
NK 530
Pink Banana Jumbo
Ultra (Butternut)

NAKED SEED PUMPKINS
Trick or Treat
Triple Treat

WINTER SQUASH
Butternut Burgess Strain (butternut)
Gold Nugget (compact vine)
Puritan (butternut)
Table Queen (acorn)
Tay Belle (acorn)
Vegetable Spaghetti (spaghetti)

Waltham Butternut (butternut)

WEED CONTROL. Apply a preemergence herbicide immediately after seeding or use a stall bed system. Caution! Some varieties (i.e., Boston Marrow) are more sensitive to some herbicides and may be injured. Practice shallow cultivation. Pumpkins have many important feeder roots near the surface and roots grow to about the same spread as vines.

INSECT CONTROL. Common insects of pumpkins are: seed corn maggot, spotted and striped cucumber beetle, squash vine borer, pickleworm (after mid July), and squash bugs (mountains only).

DISEASE CONTROL. The most common diseases for pumpkins are bacterial wilt (spread by cucumber beetles), powdery mildew, downy mildew and anthracnose. Fungigation is application of fungicides through the irrigation system. This may be the best way to get fungicides applied without damage to foliage.

POLLINATION. Pumpkins are insect-pollinated, and require bees for pollination. Inadequate pollination results in poor fruit shape and excessive blossom drop. At least one strong colony of bees per 2 acres is recommended.

HARVESTING AND CURING. Pumpkins should be harvested only after the shell has completely hardened. Care should be taken not to damage or break off the stem. Stemless pumpkins have a lower value as jack-o-lanterns and make it easier for rotting organisms to gain entrance. Pumpkins should never be stacked more than 2 to 4 deep, depending on their size. Also, all trucks and trailers should be well padded. When pumpkins are harvested a long time before sale they should be washed or dipped in a 10% Chlorox solution (1 part Chlorox to 9 parts water) and stored in a dry cool place to reduce the chance of postharvest rots. Storage in the open sun causes excessive spoilage.

YIELD. Good yields of smaller varieties are 5 to 7 tons per acre or 2000 to 4000 fruit. The large types (fresh market) may yield up to 10 to 30 tons per acre or 1000 to 2000 fruit. The yield of seed of the hullless or naked seeded types should range from 800 to 1500 lb per acre.

GROWING LARGE PUMPKINS. There is always much interest in growing BIG pumpkins for exhibition. To do this, select one of the large varieties mentioned earlier. Prepare a seedbed (50 to 60 ft per plant) by deeply incorporating into the soil 4 to 6 bushels of manure or compost and 1 to 2 lb of 8-8-8 per hill. Mix well. Plant 3 to 5 seeds per hill and thin to a single plant. Apply 1/2 to 1 cup of nitrogen fertilizer near the perimeter of the vine every 2 to 3 weeks beginning 3 weeks after seeding. Keep plants watered and allow only one fruit to develop

on each plant.

How To Grow A Giant Pumpkin

If you ask 10 competitive pumpkin growers how to grow a giant pumpkin, you're likely to get 10 different answers. It seems everyone has his or her own way of coaxing the most weight out of these giants. But there is a thread of consistency that runs throughout all the instructions, and adhering to three basic tenets will get you well on the way to a world record. Above all else, you need good seed, good soil and good luck.

Good seed. If you want to grow a world-record pumpkin, you can forget about every variety of pumpkin out there except Howard Dill's patented Atlantic Giant. Since 1979, no other pumpkin variety has been a world champion. Good soil Pumpkins are large consumers of all the major plant nutrients (nitrogen, phosphorus and potassium), as well as many minor nutrients like calcium and magnesium and other trace elements. The key for big growth is soil well amended with organic matter. In the fall or early spring, add two to five yards per plant of compost and rotted manures. Cow and horse manures are best. Use chicken manure sparingly and only in the fall. Cover crops of winter rye, plowed down in the spring, are fabulous. The soil pH should be between 6.5 and 6.8.

Good luck. If you can grow a good vegetable garden, you have the skill to grow a world-record pumpkin. I've seen newcomers grow 500-pound pumpkins their first year with good seed, some rudimentary help from an experienced grower and a lot of luck. With the right preparation and strategy now and in the spring (see the text on page 40 for tips on planning your assault on the world record), next year you might just be a contender for the world championship!

1. **PREPARE THE SOIL**. Start with a pH test in fall and adjust your pH to between 6.5 and 6.8 by adding sulfur to lower the pH or lime to raise it. Apply three to five yards of composted manure per 30-foot-diameter circle where you expect to plant next spring. Plant a cover crop of winter rye in fall to be turned under in early spring, broadcasting one to two pounds per 1,000-square-foot area.
2. **SOW SEEDS**. Start seed indoors in six-inch peat pots about four weeks before your last spring frost date. Plant the seed with the pointed end of the seed facing down. Keep the soil temperature at 85 to 90 degrees F. Most seeds will emerge within five days.
3. **TRANSPLANT SEEDLINGS**. Transplant seedlings into the garden once the first true leaves appear or when roots begin to

grow through the peat pot (usually seven to 10 days after germination). Handle with care because pumpkins are easily set back during transplanting.

4. **PROTECT SEEDLINGS.** Place a "mini-greenhouse" over the seedlings for six weeks to shield plants from wind and frost. These mini-greenhouses can be as simple as two storm windows nailed together to form a teepee or as elaborate as a four- by four-foot wooden structure made from 1x2 lumber nailed together with 6-mil clear plastic stapled to cover the frame. Once seedlings outgrow the mini-greenhouse, use a temporary fence to screen wind. I use "conservation" fence, which is bought with wood end stakes attached and is commonly used at new construction sites. A 100-foot roll cut into three pieces is enough for three 11-foot-diameter areas.
5. **POLLINATE FLOWERS.** Eight to 10 weeks after seed starting, the first female flowers will appear. They're easy to distinguish because they have a small pumpkin at their base. If you want to get a jump on your rival, you'll need to hand-pollinate the flowers. In the early morning, locate a freshly opened male flower. Pick it and remove the outer flower petals, exposing the stamen and fresh pollen. Locate a newly opened female flower and gently swab the stigma (internal parts) of the female flower with the pollen-laden stamen.

   Getting a pumpkin set as early as possible, preferably before July 10, is key. The earlier you set a pumpkin, the longer it has to grow until harvest. Since these monsters can gain 25 pounds a day, losing 10 days in the early part of the season could put you well down the list at your local pumpkin weigh-off.
6. **REPOSITION SET PUMPKINS**. Once a pumpkin has set, its position on the vine becomes extremely important. Most often the stem grows at a very acute angle to the vine. However, for optimal long-term growth, the best position is to have the stem perpendicular to the vine. If yours is not at right angles to the vine naturally, coax it gradually, over about a week's time, until it is in that position. Be careful, because at this early stage pumpkins may still abort or you may injure the fragile stem.
7. **SELECT THE MOST PROMISING PUMPKIN**. If one plant has three strong vines, you could have as many as seven or eight pumpkins set and growing by July 20. Now you must choose the best pumpkin and remove most of the rest. Measure each pumpkin's circumference at the widest point weekly or daily with a cloth measuring tape. Choose the one that's growing fastest. Also, keep an eye out for the optimum shape. Young pumpkins that are round and especially tall grow the largest.
8. **PRUNE VINES**. Begin pruning vines early in the season to

discourage random growth and an out-of-control patch. Prune each main vine when it has reached 10 to 12 feet beyond a set fruit. If you have a pumpkin on a vine that is 10 feet from the main root, cut the end of that vine once it is 20 to 24 feet long. Let side shoots off the main vines get no longer than eight feet before cutting off tips. Train side shoots so they are perpendicular to the main vine to accommodate access to the vines and pumpkins. Bury the ends of cut vines to reduce water loss.

9. **FERTILIZE**. During the growing season, most fertility needs of pumpkins can be met by applying water-soluble plant foods once or twice a week over the entire plant area. Give seedlings a fertilizer that stresses phosphorus, such as 15-30-15. Shift to a more balanced formula, such as 20-20-20, once fruits are set.

   By late July, use a formula that stresses potassium, such as 15-11-29. I apply water-soluble fertilizer at the rate of one to two pounds per week per plant from fruit set until the end of the growing season. Some competitive growers will err on the side of overfertilization. But too much fertilizer can hurt more than help. If the pumpkins start growing too fast, they will literally tear themselves from the vine and explode. A very fine grower in New England told me, "Slow and easy wins the race." Remember this whenever you feel the urge to overfertilize.

10. **KEEP TRACK**. Measure your pumpkins at least weekly. Gains in circumference can average four to six inches in a 24 hour period. Measure the circumference of your pumpkins first parallel to the ground around the entire pumpkin, from blossom end to stem. Next, measure over the top in both directions: from ground to ground along the axis from stem to blossom end, then perpendicular to the stem-blossom-end axis. Add these three measurements together, then multiply by 1.9 to give an estimate of the pumpkin's weight.

Growing Giant Pumpkins In The Home Garden

General

Growing giant pumpkins can be a fascinating experience. Before you can master the art of growing a giant, however, you must be familiar with the basic principles of growing pumpkins.

Fertilizer and Lime

Always apply lime and fertilizers based on soil test recommendations. Providing adequate nutrients throughout the growing season will insure healthy, vigorous vines, not

to mention large pumpkins. Granular fertilizers should be applied as a broadcast application over the soil surface and incorporated into the soil 4 to 6 inches deep a few days ahead of setting out your transplants. Giant pumpkin vines require approximately 2 pounds nitrogen (N), 3 pounds phosphorous (P2O2) and 6 pounds potash (K2O) per 1,000 square feet of growing space. The addition of organic matter (manure, etc.) to the garden is important to establish good soil tilth.

A foliar feeding program should be started after pollination and fruit set have occurred. There are several foliar fertilizers available. Follow label directions and continue application throughout the growing season.

Planting and Space Requirements

Growing giant pumpkins requires an early start. Seeds should be sown individually and started indoors in 12-inch peat pots about the end of April. A well balanced potting medium is recommended. Plants are ready for transplanting when the first true leaf is fully expanded. This is usually 10 to 14 days after seeding. Transplants can be protected from late spring frost using a floating row cover.

Growing space in the garden is important. Each plant should be allowed approximately 2,500 square feet. This area may sound quite large, but it is essential for vine growth. Pumpkins prefer long hours of sunlight, so select your garden site accordingly. Avoid shaded areas and select an area with good surface and internal drainage.

Irrigation

Pumpkins are shallow rooted, so water slowly with at least one inch of water per week if rainfall is not adequate. More water may be required during hot, windy summer days. Water during morning or early afternoon hours so foliage dries by evening. This helps prevent the spread of leaf diseases.

Trickle irrigation is best, but soaker hoses also work well. Overhead sprinklers are effective; however, wet foliage increases the chance of disease, especially mildew.

Cultural

If planting is done in a well-prepared bed, weeds will

seldom be a problem and can be controlled by hand-weeding or hoeing. Continue to remove weeds until the vines cover the ground. At this time, the dense foliage will shade out most weeds.

Plastic mulches are very effective for controlling weeds. Plastic mulches also warm the soil, and can maintain good soil moisture levels. The plastic can be installed when the soil is in good planting condition, any time from a few days to 2 to 3 weeks before planting. If you do not use plastic, pumpkins will benefit from organic mulches applied in the summer after the soil has warmed.

When summer mulching materials are used, such as straw, additional nitrogen is recommended. Mix one tablespoon of ammonium sulfate, calcium nitrate, or nitrate of soda per one bushel of mulch. Apply once or twice during the early growing season. A complete fertilizer that is high in nitrogen may be substituted for any of the above. Apply the fertilizer when the mulch is moist.

Herbicides are also available for weed control. However, only a trained and licensed applicator should apply these materials.

Windbreaks

Windbreaks are necessary to protect young plants that are not fully rooted. Windbreaks should be positioned on plants most susceptible to southwest winds until late June when side-runners are 3 to 4 feet long. The use of a snow fence and burlap can make an excellent windbreak. Covering the vines at each node with soil will help anchor vines down and promote secondary root development.

Insects and Diseases

The planting site of your plants should be rotated each year to reduce the incidence of insect and disease pressure. Without a regular spray program for insects and diseases, your success rate for producing a giant pumpkin can be significantly reduced. An insect and disease control program must be initiated at transplanting. Insects are the primary vectors for transmitting viruses. Once a viral infection has occurred, there is no way to stop it. There are several pesticides recommended for insect and disease control. Check with your local Extension agent for current rates and compounds. The licensed pesticide applicator

will have more options regarding insecticides and fungicides available to them.

Pollination

Although hand pollination is the preferred method to fruit setting, natural pollination by bees will work well. Hand pollination allows for a more controlled genetic cross. Do not begin pollinating until the plant has approximately 200 leaves. Initially it is recommended to allow only 4 to 6 pumpkins per plant. Once pumpkins reach volleyball size, trim back to one pumpkin. The more you reduce the competition for nutrients, the greater your success rate will be for achieving a giant size pumpkin.

Stem Stress

Because of the size and fast growth of these pumpkins, training vines and root pruning is important. This will prevent stem breakage and splitting. While the pumpkin is basketball size, curve the vine 80 to 90 degrees away from the fruit. About 3 feet out from the fruit, curve the vine back in the general direction it was headed. Clip roots 3 feet out on the vine. This will allow the vine to easily move upward as the pumpkin grows. Pumpkins long in shape tend to push the vine forward, resulting in a kink. If this happens, slide the pumpkin back about 4 to 5 inches - this is usually necessary when the pumpkin is about 300 pounds. Pumpkins round in shape are difficult to rotate without damaging the stem.

Shade

To protect the pumpkin from direct sunlight, construct a shade out of burlap or other lightweight material. This will prevent premature hardening of the outer skin and will allow the pumpkin to reach its full genetic potential in terms of physical size.

Cultivars

Be sure to select plant varieties that have the genetics to attain large size. Check seed catalogs and garden centers for possible giant pumpkin seed cultivars.

Harvest/Storing

Pumpkins should be harvested when they have a deep, solid color and the rind is hard. The vines are usually dying back at this time. Cover during a light frost and avoid leaving pumpkins out during a hard freeze to prevent

softening.

Compost Feeding

Getting Started:

Assuming you are starting in September, you need to start right away so you will have plenty of partially decomposed compost for next year. That's right "partially decomposed." The reason being if it was completely broken down its nutrients would be lost to leaching long before the next growing season was complete. You do not need anything elaborate to start your compost pile. A piece of fence wire made into a circle will do just fine. In your pile put every piece of organic matter you can find. Some good sources are: grass clippings, all plant matter from your garden, maple leaves and fallen fruit of all kinds. Care should be given to the type of leaves used. Some leaves contain a growth inhibitor that will actually reduce your pumpkin's growth. Others may be very acidic like oak leaves and take too long to break down. Maple leaves are a good choice if you have them in your area. If maple leaves are unavailable check with your local University Extension Service for another type of leaf that could be used. Layer your ingredients with grass clippings to supply a natural source of nitrogen to aid in decomposition. A layer of manure will also be a big boost but avoid any mixed with sawdust, if possible. Sawdust consumes much of the nitrogen as it breaks down. Another very important ingredient is red wiggler worms. They will eat plant matter as soon as it starts to cool, unlike earthworms that will only eat compost that is almost completely broken down. Red wigglers are a reddish brown small to medium sized worm. Many bait stores carry them in the summer when regular earthworms are scarce. You can also buy them from garden supply houses. Place them near the bottom in your new compost pile when it is cool enough to touch. You do not need to turn your compost because the worms will eat their way right up through it. Place bags of leaves all around your compost pile before the weather becomes too cold, to keep it active well into the winter season.

Preparing Your Planting Spot Next Season:

Prepare your garden soil as usual by adjusting the PH and over all nutrient levels. This is important because this soil will have to feed the pumpkin plant until the roots reach the compost. Prepare your garden soil then mark out a spot four feet by five feet. Your pumpkin mound will be located here. Along side each of the five foot sides, mark a spot three feet by five feet. Then remove the top soil in both areas to a depth of one foot, (if you have it), and pile it on the pumpkin mound area. If you do not have one foot of top soil remove what is available down to the sub-soil. Then remove and discard enough sub-soil until you have a

one foot deep hole. Pile the soil up on the mound and let it slide down all four edges to form slanted sides. When all soil is piled up in the mound area flatten the top into a rectangle that's smaller than the base of the pile. Smooth out the sides so they have enough slope to stay together and absorb the warm sunlight. Then place a board on one of the slopes so you can kneel and reach the top of the mound without compacting the soil. In the top of the mound dig another rectangle four to six inches deep by mounding the soil removed around the edges of the hole. Compact the sides slightly to prevent them from falling apart. Later this hole is where you will plant your seeds about two inches from the edges. You are now ready to add your compost. Loosen the soil or sub-soil at the bottom of your three by five holes. Then start adding layers of your compost from last fall's pile. Cover each layer, (about six inches), with a layer of leaves, (about one inch), from one of the leaf bags you placed around your compost pile. On top of that add a one inch layer of manure. Continue until you have one and a half foot of compost overflowing the hole. This will settle down during the summer. Check for red wigglers in the compost as you go and add some more if needed. You will find that over time they will multiply like crazy and you will never have to buy any again. To aid in early season growth you can add some porous black plastic around the outside of the mound to help in absorbing sunlight. Make sure you do not go any farther down than the top of the compost to avoid blocking root growth. You are now ready to plant your seeds. Plant several, then thin to the best looking one when they start to send out a runner. As the pumpkin plant develops the roots will search out the compost that is being broken down by the red wigglers. They turn compost into food that the plant can readily use. This will supply a steady flow of nutrients throughout the season. Watch for a nitrogen deficiency, a condition that is more prevalent in a rainy season. This can be monitored by checking the terminal growth on the vines. This should be done on a warm sunny day late in the afternoon. A cloudy or cold day (below 80 degrees) can give you a false reading. The leaves should be a rich green color. If they are not for several days in a row, a nitrogen fix should be considered. Put one of the following on the compost and in the mound hole "VERY SPARINGLY." Manure tea, or Urea (45-0-0) will work very well. If you use Urea, water it in and be careful not to get the granules on the plant or it will burn it. Check the leaves again in a couple of days to see if the color is back. Your efforts will help produce a strong steady growth that should persist throughout the growing season. At the end of the season check and see if the root system grew into your compost. Make note of the success and/or failures and make the appropriate changes for next season.

Closing Thoughts and Precautions:

With any new process or seed variety you try in garden never rely on that one new thing. Try compost feeding on one of your plants next

year to see how it works for you and gain the experience with this new method. This also applies to your seed stock as well. Always use several different seed stocks of Atlantic Giant Pumpkin. If the seed does not have the genetics needed to produce a big one, all your hard work will not produce a monster.

Steps for profitable pumpkin production

1. Find a market.
2. Use well-drained soils.
3. Use raised beds.
4. Soil test for lime, fertilizer and nematicide needs.
5. Lime to pH 6.0 to 6.5.
6. Choose a variety that sells in your area.
7. Allow soil to warm to 60 F before planting.
8. Space plants for harvest purposes.
9. Plant for harvest time, not too early.
10. Provide bees.
11. Control cucumber beetles and other insects.
12. Control weeds.
13. Spray for mildew
14. Prune for large fruit if market demands.
15. Allow skin to harden before harvest.

Pumpkin and Winter Squash - Post Harvest Rots

Pumpkins, gourds and other cucurbit fruits with ‘hard skins’ and firm starchy rinds may rot while still on the vine, after harvest, and in storage. In North Carolina these rots are typically caused by fungi such as Fusarium, Alternia, Pythium and the anthracnose, Colletotrichum, and gummy stem blight, Mycosphaerella fungi. On occasion, other fungi and soft rot bacteria may cause rots, especially during hot, wet weather. Infection of fruit usually starts in injuries on young or mature fruit. In the fall, growers often inquire about methods to control these rots. The following suggestions and comments come to mind to minimize rots.

1. Maintain a good fungicide and insecticide spray program during the growing season to manage foliar diseases and insect problems.
2. Avoid blossom-end rot of fruit by fertilizing and liming fields according to recommendations from soil test reports.

3. Do not injure fruit while on the vine.
4. Harvest the fruit when it is mature and the rind is hard but before night temperatures are below 40 degrees F and well before frost or a hard freeze.
5. Harvest fruit when it is dry. Do not handle wet fruit.
6. Harvest fruit by cutting the peduncle, (leave 3-4 inches) with pruning shears or loppers.
7. Harvest, handle and store fruit carefully to avoid injuries.
8. Discard all fruit that is immature, injured or has rots or blemishes. These fruit should not be harvested or stored.
9. Do not pick up freshly harvested fruit by the stem since many will separate from the stem.
10. Do not stack fruit higher than 3 feet.
11. Do not permit harvested or stored fruit to get wet.
12. Usually these fruit are not washed, but if washing is necessary, be sure the water is chlorinated (at least 50 ppm).
13. For better keeping, some growers cure pumpkins for 10 to 20 days at 80-85 degrees F with good ventilation.
14. Harvested fruit should be stored with good ventilation at temperatures from 50 to 55 degrees and relative humidity between 50 to 75%. Refrigeration temperatures (35-40 F) may cause chilling injury and shorten shelf life. High temperature storage will result in excessive loss of weight, color and culinary qualities. High humidities may promote rots.
15. Storage life without significant loss in quality is typically two or three months.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- How-To-Grow World Class Giant Pumpkins by Don Langevin - List: $14.95 - Publication date: October 1993

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Starting the giant pumpkin seedling

The first 9-10 days of the giant pumpkin plant's development requires special attention to insure a good start of a properly grown seedling. An understanding, by the grower, of the development and growth of the pumpkin seedling (and the entire plant & fruit) is necessary in an effort to eliminate any variables and set goals. This is most often gained by experience as in the case of the consistent competitor, although a first time grower can conquer these "variables" and show very well.

SEED SELECTION - it is imperative to select a variety with the genetic potential capable of producing a specimen sizeable for the competition you wish to enter. My suggestion for "World Class" competition is the Atlantic Giant. Select only full, mature, viable seed.

TARGETING SEED PLANTING - to set a seed planting date, one must review the plant's stages of growth, day length and the date of the competition (harvest). An understanding of local weather patterns may also be an influential factor for determining when to plant the seed or better to say, when to mature the seedling to the three (3) leaf stage for transplanting. Let's say there are three stages of the plants development to consider when targeting the seed planting date:

1. Seedling stage - seed planting to 3 leaf stage (9-10 days).
2. Plant growth stage - 3 leaf to fruit set date (60-70 days).
3. Fruiting stage - fruit set to harvest date (last 70-80+ days - fruit development)

To capsulate the all this targeting by example, we will say that the target date for competition is October 12. Count back 70-80+ days to the fruit set date of July 24 to August 3. Then count back 60-70 days to the planting date of May 15-25 and 9-10 back to the seed planting date (May 5-10). In reverse - 9-10 days to 3 leaf, +60-70 days to fruit set and +70-80 days to harvest (total days seed to harvest 130-150). Too often growers start too early!

PLANTING MEDIUM - it is most advantageous to use a light medium. The giant pumpking seed is one of the largest of the vegetable seeds, as it it is the larget vegetable plant fruit. The seed hasmuch organic matter and will take a great amount of moisturetherefore have the potential to damp off (rot). This single factor is the reason for much seed failure when planting giant pumpkin seed. Use a mix similar to this:

1/3 vermiculite
1/3 perlite
1/3 peat moss (add fungicide to mix)

A 9-10 day old seedling has few nutrient requirements but a small amount a water soluable

fertilizer won't hurt.

PEAT POT - use 4 inch peat pots. Plant the peat pot and all when planting the seedling (this reduces root damage). Poke holes in the peat pot in several places at or near the bottom if no hole. The pot will hold an excessive amount of moisture if this not done. Fill the peat pot with the dry soil mix. Keep settling to a minimum.

FUNGICIDE - seed and potting mixture treatment are very important. This procedure will help control damping off, but alone without proper room temperature. moisture, and bottom heat, etc. may not be effective. Dampen the seed, then apply dry powder fungicide. Coat to the point of good coverage. When adding to the potting soil mix follow recommendations on the label; or just add a small amount.

PLANTING THE SEED - moisten the pot and medium. Initial moisture is essential to the seed, therefore moisten well the first time. The pot itself will take on much moisture (it's actually peat - sponge), this time it should be saturated. From then on let the moisture decrease, not to show through the peat pot after watering. Plant the seed 1/2 inch below the surface with the rooting end down, crown end up.

BOTTOM HEAT - is necessary for 4-5 days to give the seed enough heat to germinate. When the main root is 1 inch long STOP BOTTOM HEATING (it will destroy roots greater than 1 inch long). Suggest you use a plastic plant flat without holes. Jugs of warm water may be the most economical way to add heat. Remember to water individual pots and keep proper moisture.

ROOM TEMPERATURE - a temperature of 75-85 degrees F. is necessary. Most ideal being 85 degrees. Please understand a higher temperature has more moisture holding capacity.

VENTILATION - air movement is necessary to help control fungus growth and supply fresh air components to the seedling. Keep in mind that the ideal conditions for seedling growth are are also ideal for fungus growth.

LIGHTING - use "artificial lighting". Flourescent tubes 2-3 inches above the potting mixture surface and maintained at 2-3 inches above seedling stage will result in a sturdy not spindly (light starved) plant. It is not necessary to use a "Grow Lite", as a regular "Cool White" flourescent tube is just fine. Full light (24 hr.) will provide the seedling with the quantity of light required. The quality of the light is maintained by the closeness of the bulb to the plant. Continue to check regularly. Be careful not to over water.

PLANTING THE SEEDLING - It is not necessary to temper or acclimate the seedling over a period of time. It is important to plant on or near the target date, when the seedling is at the early 3 leaf stage. Planting should be under a hot-tent or miniature greenhouse.

Growing Pumpkins and Winter Squash

SOILS. The soil should be well-drained. The optimum pH is 6.0 to 6.5. Take a soil test to determine pH and fertilizer requirements. Do not use fields that have had other vine crops (melons, cucumbers, etc.) during the past 2 years.

FERTILIZER. Follow suggestions from soil test report. Otherwise, broadcast 1000 pounds of 5-10-10 per acre before planting (10 pints per 100 feet of row). Sidedress at 3 and 6 wk after seeding with 20 to 30 pounds per acre of nitrogen and 60 to 100 pounds per acre of potassium (1 pint 13-0-44 per 100 ft of row). Processing types may require more potassium for good dry matter production. Place sidedress fertilizer 6 to 8 inches from the plants on both sides of the row.

Pumpkins for processing should be seeded in spring as soon as the soil temperature at 4-inch depth has reached 60 to 65 F. Pumpkins for ornamental purposes may be seeded as late as June to early July in the lower piedmont and eastern N.C. The later planted pumpkins will be more subject to increased diseases and insects than an earlier planted crop. However, regardless of planting date, both require insecticide and fungicide applications. Spacing varies with variety and vine size.

ROW SPACING IN FEET

Variety	Between Rows	Within row
Bush or short vine	3-5 feet	2-3 feet
Small fruited/large vine	6-8 feet	3-5 feet
Large fruited/large vine	6-8 feet	3-5 feet

Plant 2 to 3 seeds per hill and thin to one plant per hill. For large commercial acreage, seed 4 seeds per ft of row and thin. Use per acre rates of 2 to 3 lb of seed for large vine types and 3 to 4 lb of seed for bush types.

VARIETIES

SMALL (2-8 lb)
Small Sugar
Spookie

MEDIUM (8-12 lb)
Autumn Gold
Ghost Rider
Jackpot (compact vine)
Spirit

LARGE (12-20 lb)
Connecticut Field
Howden
Big Max
Mammoth Gold

EXTRA LARGE (20+ lb)
DECORATIVE TYPE
Big Mac

PROCESSING TYPES

Dickinson
Golden Delicious
NK 530
Pink Banana Jumbo
Ultra (Butternut)

NAKED SEED PUMPKINS
Trick or Treat
Triple Treat

WINTER SQUASH
Butternut Burgess Strain (butternut)
Gold Nugget (compact vine)
Puritan (butternut)
Table Queen (acorn)
Tay Belle (acorn)
Vegetable Spaghetti (spaghetti)
Waltham Butternut (butternut)

WEED CONTROL. Apply a preemergence herbicide immediately after seeding or use a stall bed system. Caution! Some varieties (i.e., Boston Marrow) are more sensitive to some herbicides and may be injured. Practice shallow cultivation. Pumpkins have many important feeder roots near the surface and roots grow to about the same spread as vines.

INSECT CONTROL. Common insects of pumpkins are: seed corn maggot, spotted and striped cucumber beetle, squash vine borer, pickleworm (after mid July), and squash bugs (mountains only).

DISEASE CONTROL. The most common diseases for pumpkins are bacterial wilt (spread by cucumber beetles), powdery mildew, downy mildew and anthracnose. Fungigation is application of fungicides through the irrigation system. This may be the best way to get fungicides applied without damage to foliage.

POLLINATION. Pumpkins are insect-pollinated, and require bees for pollination. Inadequate pollination results in poor fruit shape and excessive blossom drop. At least one strong colony of bees per 2 acres is recommended.

HARVESTING AND CURING. Pumpkins should be harvested only after the shell has completely hardened. Care should be taken not to damage or break off the stem. Stemless pumpkins have a lower value as jack-o-lanterns and make it easier for rotting organisms to gain entrance. Pumpkins should never be stacked more than 2 to 4 deep, depending on their size. Also, all trucks and trailers should be well padded. When pumpkins are harvested a long time before sale they should be washed or dipped in a 10% Chlorox solution (1 part Chlorox to 9 parts water) and stored in a dry cool place to reduce the chance of postharvest rots. Storage in the open sun causes excessive spoilage.

YIELD. Good yields of smaller varieties are 5 to 7 tons per acre or 2000 to 4000 fruit. The large

types (fresh market) may yield up to 10 to 30 tons per acre or 1000 to 2000 fruit. The yield of seed of the hullless or naked seeded types should range from 800 to 1500 lb per acre.

GROWING LARGE PUMPKINS. There is always much interest in growing BIG pumpkins for exhibition. To do this, select one of the large varieties mentioned earlier. Prepare a seedbed (50 to 60 ft per plant) by deeply incorporating into the soil 4 to 6 bushels of manure or compost and 1 to 2 lb of 8-8-8 per hill. Mix well. Plant 3 to 5 seeds per hill and thin to a single plant. Apply 1/2 to 1 cup of nitrogen fertilizer near the perimeter of the vine every 2 to 3 weeks beginning 3 weeks after seeding. Keep plants watered and allow only one fruit to develop on each plant.

How To Grow A Giant Pumpkin

If you ask 10 competitive pumpkin growers how to grow a giant pumpkin, you're likely to get 10 different answers. It seems everyone has his or her own way of coaxing the most weight out of these giants. But there is a thread of consistency that runs throughout all the instructions, and adhering to three basic tenets will get you well on the way to a world record. Above all else, you need good seed, good soil and good luck.

Good seed. If you want to grow a world-record pumpkin, you can forget about every variety of pumpkin out there except Howard Dill's patented Atlantic Giant. Since 1979, no other pumpkin variety has been a world champion. Good soil Pumpkins are large consumers of all the major plant nutrients (nitrogen, phosphorus and potassium), as well as many minor nutrients like calcium and magnesium and other trace elements. The key for big growth is soil well amended with organic matter. In the fall or early spring, add two to five yards per plant of compost and rotted manures. Cow and horse manures are best. Use chicken manure sparingly and only in the fall. Cover crops of winter rye, plowed down in the spring, are fabulous. The soil pH should be between 6.5 and 6.8.

Good luck. If you can grow a good vegetable garden, you have the skill to grow a world-record pumpkin. I've seen newcomers grow 500-pound pumpkins their first year with good seed, some rudimentary help from an experienced grower and a lot of luck. With the right preparation and strategy now and in the spring (see the text on page 40 for tips on planning your assault on the world record), next year you might just be a contender for the world championship!

1. **PREPARE THE SOIL**. Start with a pH test in fall and adjust your pH to between 6.5 and 6.8 by adding sulfur to lower the pH or lime to raise it. Apply three to five yards of composted manure per 30-foot-diameter circle where you expect to plant next spring. Plant a cover crop of winter rye in fall to be turned under in early spring, broadcasting one to two pounds per 1,000-square-foot area.
2. **SOW SEEDS**. Start seed indoors in six-inch peat pots about four weeks before your last spring frost date. Plant the seed with the pointed end of the seed facing down. Keep the soil temperature at 85 to 90 degrees F. Most seeds will emerge within five days.
3. **TRANSPLANT SEEDLINGS**. Transplant seedlings into the garden once the first true leaves appear or when roots begin to grow through the peat pot (usually seven to 10 days after germination). Handle with care because pumpkins are easily set back during transplanting.

4. **PROTECT SEEDLINGS.** Place a "mini-greenhouse" over the seedlings for six weeks to shield plants from wind and frost. These mini-greenhouses can be as simple as two storm windows nailed together to form a teepee or as elaborate as a four- by four-foot wooden structure made from 1x2 lumber nailed together with 6-mil clear plastic stapled to cover the frame. Once seedlings outgrow the mini-greenhouse, use a temporary fence to screen wind. I use "conservation" fence, which is bought with wood end stakes attached and is commonly used at new construction sites. A 100-foot roll cut into three pieces is enough for three 11-foot-diameter areas.
5. **POLLINATE FLOWERS.** Eight to 10 weeks after seed starting, the first female flowers will appear. They're easy to distinguish because they have a small pumpkin at their base. If you want to get a jump on your rival, you'll need to hand-pollinate the flowers. In the early morning, locate a freshly opened male flower. Pick it and remove the outer flower petals, exposing the stamen and fresh pollen. Locate a newly opened female flower and gently swab the stigma (internal parts) of the female flower with the pollen-laden stamen.

   Getting a pumpkin set as early as possible, preferably before July 10, is key. The earlier you set a pumpkin, the longer it has to grow until harvest. Since these monsters can gain 25 pounds a day, losing 10 days in the early part of the season could put you well down the list at your local pumpkin weigh-off.
6. **REPOSITION SET PUMPKINS**. Once a pumpkin has set, its position on the vine becomes extremely important. Most often the stem grows at a very acute angle to the vine. However, for optimal long-term growth, the best position is to have the stem perpendicular to the vine. If yours is not at right angles to the vine naturally, coax it gradually, over about a week's time, until it is in that position. Be careful, because at this early stage pumpkins may still abort or you may injure the fragile stem.
7. **SELECT THE MOST PROMISING PUMPKIN**. If one plant has three strong vines, you could have as many as seven or eight pumpkins set and growing by July 20. Now you must choose the best pumpkin and remove most of the rest. Measure each pumpkin's circumference at the widest point weekly or daily with a cloth measuring tape. Choose the one that's growing fastest. Also, keep an eye out for the optimum shape. Young pumpkins that are round and especially tall grow the largest.
8. **PRUNE VINES**. Begin pruning vines early in the season to discourage random growth and an out-of-control patch. Prune each main vine when it has reached 10 to 12 feet beyond a set fruit. If you have a pumpkin on a vine that is 10 feet from the main root, cut the end of that vine once it is 20 to 24 feet long. Let side shoots off the main vines get no longer than eight feet before cutting off tips. Train side shoots so they are perpendicular to the main vine to accommodate access to the vines and pumpkins. Bury the ends of cut vines to reduce water loss.
9. **FERTILIZE**. During the growing season, most fertility needs of pumpkins can be met by applying water-soluble plant foods once or twice a week over the entire plant area. Give seedlings a fertilizer that stresses phosphorus, such as 15-30-15. Shift to a more balanced formula, such as 20-20-20, once fruits are set.

   By late July, use a formula that stresses potassium, such as 15-11-29. I apply water-soluble

fertilizer at the rate of one to two pounds per week per plant from fruit set until the end of the growing season. Some competitive growers will err on the side of overfertilization. But too much fertilizer can hurt more than help. If the pumpkins start growing too fast, they will literally tear themselves from the vine and explode. A very fine grower in New England told me, "Slow and easy wins the race." Remember this whenever you feel the urge to overfertilize.

10. **KEEP TRACK**. Measure your pumpkins at least weekly. Gains in circumference can average four to six inches in a 24 hour period. Measure the circumference of your pumpkins first parallel to the ground around the entire pumpkin, from blossom end to stem. Next, measure over the top in both directions: from ground to ground along the axis from stem to blossom end, then perpendicular to the stem-blossom-end axis. Add these three measurements together, then multiply by 1.9 to give an estimate of the pumpkin's weight.

Growing Giant Pumpkins In The Home Garden

General

Growing giant pumpkins can be a fascinating experience. Before you can master the art of growing a giant, however, you must be familiar with the basic principles of growing pumpkins.

Fertilizer and Lime

Always apply lime and fertilizers based on soil test recommendations. Providing adequate nutrients throughout the growing season will insure healthy, vigorous vines, not to mention large pumpkins. Granular fertilizers should be applied as a broadcast application over the soil surface and incorporated into the soil 4 to 6 inches deep a few days ahead of setting out your transplants. Giant pumpkin vines require approximately 2 pounds nitrogen (N), 3 pounds phosphorous (P2O2) and 6 pounds potash (K2O) per 1,000 square feet of growing space. The addition of organic matter (manure, etc.) to the garden is important to establish good soil tilth.

A foliar feeding program should be started after pollination and fruit set have occurred. There are several foliar fertilizers available. Follow label directions and continue application throughout the growing season.

Planting and Space Requirements

Growing giant pumpkins requires an early start. Seeds should be sown individually and started indoors in 12-inch peat pots about the end of April. A well balanced potting medium is recommended. Plants are ready for transplanting when the first true leaf is fully expanded. This is usually 10 to 14 days after seeding. Transplants can be protected from late spring frost using a floating row cover.

Growing space in the garden is important. Each plant should be allowed approximately 2,500 square feet. This area may sound quite large, but it is essential for vine growth. Pumpkins prefer long hours of sunlight, so select your garden site

accordingly. Avoid shaded areas and select an area with good surface and internal drainage.

Irrigation

Pumpkins are shallow rooted, so water slowly with at least one inch of water per week if rainfall is not adequate. More water may be required during hot, windy summer days. Water during morning or early afternoon hours so foliage dries by evening. This helps prevent the spread of leaf diseases.

Trickle irrigation is best, but soaker hoses also work well. Overhead sprinklers are effective; however, wet foliage increases the chance of disease, especially mildew.

Cultural

If planting is done in a well-prepared bed, weeds will seldom be a problem and can be controlled by hand-weeding or hoeing. Continue to remove weeds until the vines cover the ground. At this time, the dense foliage will shade out most weeds.

Plastic mulches are very effective for controlling weeds. Plastic mulches also warm the soil, and can maintain good soil moisture levels. The plastic can be installed when the soil is in good planting condition, any time from a few days to 2 to 3 weeks before planting. If you do not use plastic, pumpkins will benefit from organic mulches applied in the summer after the soil has warmed.

When summer mulching materials are used, such as straw, additional nitrogen is recommended. Mix one tablespoon of ammonium sulfate, calcium nitrate, or nitrate of soda per one bushel of mulch. Apply once or twice during the early growing season. A complete fertilizer that is high in nitrogen may be substituted for any of the above. Apply the fertilizer when the mulch is moist.

Herbicides are also available for weed control. However, only a trained and licensed applicator should apply these materials.

Windbreaks

Windbreaks are necessary to protect young plants that are not fully rooted. Windbreaks should be positioned on plants most susceptible to southwest winds until late June when side-runners are 3 to 4 feet long. The use of a snow fence and burlap can make an excellent windbreak. Covering the vines at each node with soil will help anchor vines down and promote secondary root development.

Insects and Diseases

The planting site of your plants should be rotated each year to reduce the incidence of insect and disease pressure. Without a regular spray program for insects and diseases, your success rate for producing a giant pumpkin can be significantly reduced. An insect and disease control program must be initiated at transplanting. Insects are the primary vectors for transmitting viruses. Once a viral infection has occurred, there is

no way to stop it. There are several pesticides recommended for insect and disease control. Check with your local Extension agent for current rates and compounds. The licensed pesticide applicator will have more options regarding insecticides and fungicides available to them.

Pollination

Although hand pollination is the preferred method to fruit setting, natural pollination by bees will work well. Hand pollination allows for a more controlled genetic cross. Do not begin pollinating until the plant has approximately 200 leaves. Initially it is recommended to allow only 4 to 6 pumpkins per plant. Once pumpkins reach volleyball size, trim back to one pumpkin. The more you reduce the competition for nutrients, the greater your success rate will be for achieving a giant size pumpkin.

Stem Stress

Because of the size and fast growth of these pumpkins, training vines and root pruning is important. This will prevent stem breakage and splitting. While the pumpkin is basketball size, curve the vine 80 to 90 degrees away from the fruit. About 3 feet out from the fruit, curve the vine back in the general direction it was headed. Clip roots 3 feet out on the vine. This will allow the vine to easily move upward as the pumpkin grows. Pumpkins long in shape tend to push the vine forward, resulting in a kink. If this happens, slide the pumpkin back about 4 to 5 inches - this is usually necessary when the pumpkin is about 300 pounds. Pumpkins round in shape are difficult to rotate without damaging the stem.

Shade

To protect the pumpkin from direct sunlight, construct a shade out of burlap or other lightweight material. This will prevent premature hardening of the outer skin and will allow the pumpkin to reach its full genetic potential in terms of physical size.

Cultivars

Be sure to select plant varieties that have the genetics to attain large size. Check seed catalogs and garden centers for possible giant pumpkin seed cultivars.

Harvest/Storing

Pumpkins should be harvested when they have a deep, solid color and the rind is hard. The vines are usually dying back at this time. Cover during a light frost and avoid leaving pumpkins out during a hard freeze to prevent softening.

Compost Feeding

Getting Started:

Assuming you are starting in September, you need to start right away so you will have plenty of partially decomposed compost for next year. That's right "partially decomposed." The reason being

if it was completely broken down its nutrients would be lost to leaching long before the next growing season was complete. You do not need anything elaborate to start your compost pile. A piece of fence wire made into a circle will do just fine. In your pile put every piece of organic matter you can find. Some good sources are: grass clippings, all plant matter from your garden, maple leaves and fallen fruit of all kinds. Care should be given to the type of leaves used. Some leaves contain a growth inhibitor that will actually reduce your pumpkin's growth. Others may be very acidic like oak leaves and take too long to break down. Maple leaves are a good choice if you have them in your area. If maple leaves are unavailable check with your local University Extension Service for another type of leaf that could be used. Layer your ingredients with grass clippings to supply a natural source of nitrogen to aid in decomposition. A layer of manure will also be a big boost but avoid any mixed with sawdust, if possible. Sawdust consumes much of the nitrogen as it breaks down. Another very important ingredient is red wiggler worms. They will eat plant matter as soon as it starts to cool, unlike earthworms that will only eat compost that is almost completely broken down. Red wigglers are a reddish brown small to medium sized worm. Many bait stores carry them in the summer when regular earthworms are scarce. You can also buy them from garden supply houses. Place them near the bottom in your new compost pile when it is cool enough to touch. You do not need to turn your compost because the worms will eat their way right up through it. Place bags of leaves all around your compost pile before the weather becomes too cold, to keep it active well into the winter season.

Preparing Your Planting Spot Next Season:

Prepare your garden soil as usual by adjusting the PH and over all nutrient levels. This is important because this soil will have to feed the pumpkin plant until the roots reach the compost. Prepare your garden soil then mark out a spot four feet by five feet. Your pumpkin mound will be located here. Along side each of the five foot sides, mark a spot three feet by five feet. Then remove the top soil in both areas to a depth of one foot, (if you have it), and pile it on the pumpkin mound area. If you do not have one foot of top soil remove what is available down to the sub-soil. Then remove and discard enough sub-soil until you have a one foot deep hole. Pile the soil up on the mound and let it slide down all four edges to form slanted sides. When all soil is piled up in the mound area flatten the top into a rectangle that's smaller than the base of the pile. Smooth out the sides so they have enough slope to stay together and absorb the warm sunlight. Then place a board on one of the slopes so you can kneel and reach the top of the mound without compacting the soil. In the top of the mound dig another rectangle four to six inches deep by mounding the soil removed around the edges of the hole. Compact the sides slightly to prevent them from falling apart. Later this hole is where you will plant your seeds about two inches from the edges. You are now ready to add your compost. Loosen the soil or sub-soil at the bottom of your three by five holes. Then start adding layers of your compost from last fall's pile. Cover each layer, (about six inches), with a layer of leaves, (about one inch), from one of the leaf bags you placed around your compost pile. On top of that add a one inch layer of manure. Continue until you have one and a half foot of compost overflowing the hole. This will settle down during the summer. Check for red wigglers in the compost as you go and add some more if needed. You will find that over time they will multiply like crazy and you will never have to buy any again. To aid in early season growth you can add some porous black plastic around the outside of the mound to help in absorbing sunlight. Make sure you do not go any farther down than the top of the compost to avoid blocking root growth. You are now ready to plant your seeds. Plant several, then thin to the best looking one

when they start to send out a runner. As the pumpkin plant develops the roots will search out the compost that is being broken down by the red wigglers. They turn compost into food that the plant can readily use. This will supply a steady flow of nutrients throughout the season. Watch for a nitrogen deficiency, a condition that is more prevalent in a rainy season. This can be monitored by checking the terminal growth on the vines. This should be done on a warm sunny day late in the afternoon. A cloudy or cold day (below 80 degrees) can give you a false reading. The leaves should be a rich green color. If they are not for several days in a row, a nitrogen fix should be considered. Put one of the following on the compost and in the mound hole "VERY SPARINGLY." Manure tea, or Urea (45-0-0) will work very well. If you use Urea, water it in and be careful not to get the granules on the plant or it will burn it. Check the leaves again in a couple of days to see if the color is back. Your efforts will help produce a strong steady growth that should persist throughout the growing season. At the end of the season check and see if the root system grew into your compost. Make note of the success and/or failures and make the appropriate changes for next season.

Closing Thoughts and Precautions:

With any new process or seed variety you try in garden never rely on that one new thing. Try compost feeding on one of your plants next year to see how it works for you and gain the experience with this new method. This also applies to your seed stock as well. Always use several different seed stocks of Atlantic Giant Pumpkin. If the seed does not have the genetics needed to produce a big one, all your hard work will not produce a monster.

Steps for profitable pumpkin production

1. Find a market.
2. Use well-drained soils.
3. Use raised beds.
4. Soil test for lime, fertilizer and nematicide needs.
5. Lime to pH 6.0 to 6.5.
6. Choose a variety that sells in your area.
7. Allow soil to warm to 60 F before planting.
8. Space plants for harvest purposes.
9. Plant for harvest time, not too early.
10. Provide bees.
11. Control cucumber beetles and other insects.
12. Control weeds.
13. Spray for mildew
14. Prune for large fruit if market demands.
15. Allow skin to harden before harvest.

Pumpkin and Winter Squash - Post Harvest Rots

Pumpkins, gourds and other cucurbit fruits with ‘hard skins’ and firm starchy rinds may rot while still on the vine, after harvest, and in storage. In North Carolina these rots are typically caused by fungi such as Fusarium, Alternia, Pythium and the anthracnose, Colletotrichum, and gummy stem blight, Mycosphaerella fungi. On occasion, other fungi and soft rot bacteria may cause rots, especially during hot, wet weather. Infection of fruit usually starts in injuries on young or mature fruit. In the fall, growers often inquire about methods to control these rots. The following suggestions and comments come to mind to minimize rots.

1. Maintain a good fungicide and insecticide spray program during the growing season to manage foliar diseases and insect problems.
2. Avoid blossom-end rot of fruit by fertilizing and liming fields according to recommendations from soil test reports.
3. Do not injure fruit while on the vine.
4. Harvest the fruit when it is mature and the rind is hard but before night temperatures are below 40 degrees F and well before frost or a hard freeze.
5. Harvest fruit when it is dry. Do not handle wet fruit.
6. Harvest fruit by cutting the peduncle, (leave 3-4 inches) with pruning shears or loppers.
7. Harvest, handle and store fruit carefully to avoid injuries.
8. Discard all fruit that is immature, injured or has rots or blemishes. These fruit should not be harvested or stored.
9. Do not pick up freshly harvested fruit by the stem since many will separate from the stem.
10. Do not stack fruit higher than 3 feet.
11. Do not permit harvested or stored fruit to get wet.
12. Usually these fruit are not washed, but if washing is necessary, be sure the water is chlorinated (at least 50 ppm).
13. For better keeping, some growers cure pumpkins for 10 to 20 days at 80-85 degrees F with good ventilation.
14. Harvested fruit should be stored with good ventilation at temperatures from 50 to 55 degrees and relative humidity between 50 to 75%. Refrigeration temperatures (35-40 F) may cause chilling injury and shorten shelf life. High temperature storage will result in excessive loss of weight, color and culinary qualities. High humidities may promote rots.
15. Storage life without significant loss in quality is typically two or three months.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- How-To-Grow World Class Giant Pumpkins by Don Langevin - List: $14.95 - Publication date: October 1993

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Growing Raspberries

Frequently Asked Questions Other Information Sources Return to Orchard/Fruit Crops

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Raspberries

Of all the small fruits, raspberries are gaining the most popularity. The berries are versatile and can be used as fresh fruit, in preserves, or in pies and pastries. Newer plant varieties are productive and easy to grow.

Raspberries may be grown successfully at an elevation as high as 7,000 feet. They do best in full sun on non-alkaline, fertile loam soil. However, they may be grown in partial shade or under other environmental constraints. Natural protection against strong winter winds are provided in some valleys, but in other areas it is necessary to provide artificial protection during winter months.

Varieties

Red raspberries are the most commonly grown, but there are varieties of purple, black, or yellow berries that are adapted to Massachusetts. Purchase certified, virus-free plants from a reliable nursery. They cost more, but the benefits of having more vigorous, productive plants outweigh the extra cost. To help prevent problems with troublesome viruses, do not transplant either wild plants or cultivated plants from another site.

Red Raspberries

Boyne is a mid-season berry that was developed in northern Minnesota. It is extra hardy and bears large fruit. It is a top commercial variety in some northern states. Fruit are borne on dwarf canes that are easy to pick. Boyne is an excellent plant maker and may bear a week or ten days before Latham. Berries are succulent with large, dark red fruit. Heavy cropper.

Canby is a moderately hardy, mid-season, vigorous producer. It is very productive but produces fewer canes per hill than most red varieties. Canes are nearly thornless which makes picking easier. Berries are light red, high-capped, firm and non-crumbling.

Gatineau is a very early raspberry from Ottawa, Canada, maybe two weeks earlier than Latham. The berries are larger than many early red types. Heavy cropper with irrigation. Very cold-hardy.

Hilton is a cross between the Newburgh and Walfred and is reported to be vigorous, productive and usually winter-hardy. The canes are semi-erect. Berries are medium red and very large. They ripen mid-season. Hilton is one of the largest of all red raspberries. Berries are difficult to pick unless fully ripe.

Killarney is another fine Canadian variety that is similar to Madawaska. It is a very hardy mid-season cropper. Berries are large and excellent quality.

Latham is one of the most popular and dependable mid-season raspberries. The canes are very vigorous, productive and cold-hardy. The large red berries darken as they mature. Latham is a late-season variety with a fairly long harvest season. Ripens mid to late season. Berries are extra large and are good quality for fresh use and/or freezing.

Madawaska is another very early red berry. It is one of the hardiest varieties. The berries ripen about one to two weeks earlier than Latham. Madawaska is a prolific producer throughout
the growing season.

Newburgh is a light red berry of good quality and flavor. Plants are very productive and resistant to root rot. This variety is a relatively hardy mid-season producer. Berries are firm. Fall bearing raspberries (plants that produce fruit on the current season's growth) are becoming more popular. Because they produce fruit on current growth, the gardener need not be so concerned about cane hardiness. The canes can be pruned to the ground in the fall, mulched, and left for the winter without additional protection. These fall bearing varieties, however, must be grown where there is a moderate to long growing season. Earlier fruiting varieties will no doubt be appearing on the market in the near future.

Red Everbearing Raspberries

Fall Red bears a small crop in early summer with a large crop in the fall. Berries are large and have excellent flavor. Good fresh, frozen or canned.

Heritage is an excellent fall-bearing red raspberry. It is very vigorous

and suckers prolifically. Canes usually do not require support. The fall-crop berries are medium-sized and very firm unless produced under rainy conditions.

Nordic is a variety from Minnesota ripening mid-season, with medium sized fruit of good quality.

Reveille plants are vigorous and high yielding. Fruits ripen early and are medium to large with good flavor, but due to softness, do not keep long.

September is one of the best fall-fruiting varieties. Berries are medium size and bright red. The spring crop ripens early and is fair in quality. Good for jellies and pies.

Trent has fruit that ripens early, is colored medium to dark red and may be crumbly or soft.

Black Raspberries

Blackhawk

Cumberland

Bristol

Jewel

Purple Raspberries

Clyde

Brandywine

Yellow Raspberries

Canby

Site Selection

A high sloping site will reduce cold injury by allowing the cold air to drain into low areas. However, do not plant raspberries on the crest of a hill because of the drying effect of wind. Winterkill is often caused by wind desiccation instead of low temperature. Raspberries grow well on a wide range of soil types. The character of the subsoil is more important than the type of surface soil. The subsoil should be deep and well drained. The root system will be restricted if the subsoil is underlaid by a shallow hardpan or a high water table. Plants with restricted root systems may be damaged during drought periods because raspberries need an abundant supply of moisture at all times.

Raspberry roots and crowns are also extremely sensitive to excessive

moisture in poorly drained soils. Flooding for 24 hours or longer may kill the roots by suffocation. Young plants may appear to grow well the first season on poorly drained soils but injury symptoms will occur during the following seasons.

Well-drained loamy soils are usually most productive. The lighter textured sandy soils are easiest to cultivate but must be frequently watered and fertilized. Select a site at least 300 feet from other bramble crops to minimize transfer of virus diseases. Additionally, eliminate any wild bramble plants found within several hundred feet of the planting. Tomatoes, potatoes, eggplants, peppers, and brambles are all susceptible to many common diseases. Do not plant raspberries after these crops.

If possible, set raspberries on sites that were planted to cultivated crops the previous year. When sod fields are used, turn under the sod the season before planting.

Soil Preparation

The best soil for raspberries is a deep, well-drained, medium loam that is rich in organic matter. Raspberries do best in soil that has a pH of 6.0 to 6.5. Organic matter such as peat moss, compost, or aged manure can be added to enrich less desirable soils. These materials also make the soil loose, allowing rain and roots to penetrate deeper.

Unfortunately, raspberries are poor competitors. After choosing the best soil and site, be sure to destroy all perennial weeds. Weeds may be destroyed with cultivation, herbicides, and/or plastic mulch (see "Weed Control" section). Before working small areas, cover the ground with a black plastic mulch and place soil, rocks or other weighty objects on the edges to hold it in place. A good time to lay the plastic film is in the fall or early spring (March). Leave it there for six to eight weeks to help control weeds before working the soil.

Lime and Fertilizer

Raspberries use large amounts of nitrogen, phosphorous and potash. They use lower amounts of calcium and sulfur and even lesser amounts of trace or minor elements such as iron, zinc, magnesium, boron, manganese and copper. It is wise to have your soil tested and to mix up a complete and well-balanced fertilizer. A general application of fertilizer containing equal amounts of the three primary foods of nitrogen, phosphorus and potassium is recommended when a soil test is not available. A mix containing approximately 20 percent of each primary element is usually available at commercial outlets. Weigh out about one pound for every 35 feet of linear row and spread it in a strip

extending 2 feet past the row and 2 feet on each side. For a 35-foot row of plants this is an area 39 feet by 4 feet or 156 square feet.

Weigh out only about two-thirds of a pound for the 35-foot row if the fertilizer analysis is higher. Conversely, weigh out about one and one-fourth pounds for a 35-foot row if the nitrogen content is low.

Many fertilizer mixes contain enough sulfur with the three primary plant foods to satisfy plant needs. Additionally, many fertilizer mixes contain adequate calcium.

Before planting. Where soil pH is too low, work in the required amount of lime before planting. In addition, aged manure at the rate of two to five bushels per 100 feet of row can be worked into the soil to increase available organic matter.

After planting. If necessary, two pounds of 10-10-10 fertilizer (or equivalent) per 100 feet of row can be applied after growth has started. Do not apply fertilizer after June 15. Late fall growth increases risks of winter injury.

Following years. Use 10 pounds of 10-10-10 fertilizer or equivalent per 100 feet of row in early spring.

Planting

Sites for raspberries should be free of perennial weeds, have good air, drainage (preferably a hillside), and have adequate moisture. To avoid problems with verticillium wilt, do not plant raspberries where potatoes, tomatoes, peppers (solanaceous crops), or strawberries have been grown. Plant raspberries in full sunlight for maximum yields. Raspberries should be planted as early in spring as possible. Prune the canes to within six inches of the ground at planting time for best results. Soil should be thoroughly worked before planting. The most common planting system for red raspberries is the narrow hedge row in which individual plants are set 24 to 30 inches apart in the row, with rows six to ten feet apart. Black raspberries are often grown in hills 30 inches apart with seven to nine feet between rows. If planted in partial shade, the hills should be set about three and one half feet apart.

Place plants in holes five to six inches deep and fill holes with soil and press firmly. Keep the soil moist. Generally, two complete growing seasons are required before the plants grow large enough to produce an apprciable amount of fruit.

Raspberry plantings should be cultivated thoroughly and frequently. If weeds and grasses get a start, they are difficult to control.

Obtain plants from a reputable nurseryman or from a patch that is free

of virus disease. Keep the plants cool and moist until they are planted. They may be stored for several days in cold storage at 35 degrees F. Plant raspberries as soon as the ground can be worked early in the spring. It is better to delay planting than attempt to work wet soil.

Watering

Raspberries use more soil moisture than most fruit plants. Irrigated plants are more vigorous and yield fruit over a longer season than do unirrigated plants. Begin irrigating raspberries at the same time other garden crops are normally irrigated. Most cultivars require about one inch of water per week during the growing season. Extreme warm and windy conditions make greater amounts of water necessary. Light sandy soils need more frequent irrigation than heavier clay soils.

The fruiting period is a critical irrigation time. Apply 1 to 1 1/2 inches of water once a week if drought occurs during fruiting.

Do not over-water in late summer or fall. Excessive water application during this time may delay maturity of cane wood and result in a freezing injury that will become evident the next spring.

Weed Control

Proper site preparation will help control troublesome perennial weeds. After plants become established, shallow cultivation, hand weeding, or hoeing may be necessary to control weeds. Weeds should be kept out of the planting, especially the first year, to allow the raspberry plants full use of available nutrients and water. Once plants are fully established, weeds are not as troublesome within the rows.

Weed control usually involves a combination of both mechanical and chemical means. Cultivate soon after setting out the plants. Do not cultivate deeper than three to four inches or the roots may be damaged. An annual cover crop may be seeded each year that will die in winter. However, cover crops may be a disadvantage if water is scarce.

Mulches of straw, chips, sawdust or leaves placed around the canes in fall will reduce cane and root freeze injury. As mentioned under disease prevention, freeze injury can predispose the raspberry to diseases. Mulches can also provide a deterrent to weed invasion and if left throughout the growing season, help to retain soil moisture and reduce muddiness among the plants.

Several herbicides are registered for use in raspberries. For established plantings, spray the rows with a herbicide before the weeds and new canes emerge in early spring. Do not use pre-emergence herbicides the

year the planting is made.

- Dichlobenil (Casoron or Norosac) may be used at two to four pounds of active ingredient per acre depending on the soil type. Read and follow the label carefully. Dichlobenil is effective against quackgrass and many annual weeds. Granular formulations are most effective on quackgrass. Do not exceed four pounds active ingredient per acre. Use lower rates on young plantings.
- Sethoxydim (Poast). Apply at up to three pounds actual ingredient per acre to actively growing grasses. Should be combined with a crop oil or other emulsifier. Products such as Ortho Grass-be-Gone contain the emulsifier. Do not use within 45 days of harvest.
- Oryzalin (Surflan). Apply in late fall or early spring to bare soil where vegetation has been removed. Irrigate with 1/2 inch water to activate chemical.
- Napropamide (Devrinol). Apply in late fall or early spring. Need 1 inch of irrigation or rainfall after application.

Mulching

Mulching in the fall of the planting year will help keep down weed growth, increase moisture content of the soil, and help protect the plants against winter injury. Materials that can be used as mulch are straw, hay, and leaves. Add new mulch, as necessary, each year.

Pruning

Raspberries need annual pruning, or "thinning out" to encourage new growth, fruit formation, and minimize disease problems.
Summer-bearing varieties grow canes the first year, produce fruit the second year, and die after fruiting. Following are pruning guidelines for each variety:

- **Summer**. Remove old canes after harvest.
- **Early Spring**. Remove weak canes. Narrow and thin the rows to about one-foot widths. Shorten canes to heights of about 4 1/2 feet.
- **Ever-bearing**. These varieties set fruit during the summer and again in the fall. There are two "systems" for pruning this type of berry. One is to mow the canes within two inches of the ground after the fall harvest. Plants must then be mulched for protection during the winter. This system, however, eliminates the summer crop but allows a more consistent crop level in the fall. The second system is to remove the canes that bore fruit in the fall

after the fall harvest and then follow the procedure for summer-bearing reds.

- **Black and Purple**. Remove the top two inches of canes in early June to encourage lateral branching. This process is called "topping" and should be practiced in addition to the steps for pruning early spring raspberries. Shorten side branches to six inches (black) or ten inches (purple). Leave only three to four canes per hill.

Pruning is one of the most important parts of raspberry culture and it is often neglected or improperly done. Proper pruning of raspberries makes fruit picking easier with the individual fruits growing larger. Also, the shortened canes are less likely to break under a load of fruit.

In the hedge row system, spring pruning should consist of thinning the canes to 6 inches apart of 8 to 10 canes per two feet of row. Keep in mind that row should be only 18 inches wide. The remaining canes should be tip pruned or headed back to 3 to 3 feet tall. This spring pruning should be done in early spring before any growth takes place.

In midsummer, after the raspberries have finished fruiting, all canes that bore fruit should be removed. These old canes will die the following winter since the canes of raspberries live only two years. The first year the canes grow from a shoot starting from the root. The second year these canes fruit and die. Canes that have fruited compete with the young canes for moisture and nutrients. They also harbor insects and diseases. Burn or bury all the refuse removed in pruning.

Red raspberries need to be pruned annually. Two main reasons for pruning are to remove dead canes and to thin out the clumps. New canes grow annually and produce fruit the following year, then die. Dead canes should be cut at ground level and removed.

A healthy stand of raspberries will produce numerous new canes annually. They may become so dense that some canes are weak and produce little or no fruit. It is better to remove the weaker ones and leave six to ten large canes per hill. This should be done in July or August when the new crop of canes are young and tender.

Other pruning may be necessary to remove suckers which come up out and away from the hill or row. Generally, cultivation and mowing will keep suckers under control. If a natural planting is desired, suckers, or side shoots, may be allowed to spread freely as in the wild. Do not mow, cut, cultivate or control the suckers if room is available for this type of planting. Dead tips of raspberry plants may be removed in the spring or early summer.

Supporting Brambles

Since fruit-bearing canes are top heavy, it is often a good idea to support fruiting canes. Usually, all that is necessary is a wire trellis which has two posts, one at either end of the planting. Each post should have a horizontal arm with wires running each side of the planting at a height of 40 inches.

Unless the raspberries are the trailing varieties, the plants will stand erect. They will often bend over if they are grown in shaded or windy areas. Partial support is often necessary to keep plants upright. In some cases it may be necessary to provide support between the hills. Tie a short piece of cord or wire across the row with both ends connected to two long strands for support.

Pests

Birds often can be troublesome in raspberry plantings, and netting may be necessary.

Major insect pests include tarnished plant bugs, fruitworms, sap beetles, Japanese beetles, and cane borers.

Harvesting

Raspberries should be picked when they develop deep color, lose their glossy color, and separate easily from the receptacle. Fruit is usually harvested every other day, or daily, at the peak of the ripening period. Raspberries have a short shelf-life and must be refrigerated as soon as they are picked.

Harvesting fruits as soon as they are ripe helps eliminate problems with Japanese beetles, sap beetles, and fruit rots.

Other Problems

Problem: Leaves on my raspberries are yellowish, blotchy, twisted, and/or the fruit is small or crumbly.

Cause: The cause of any of the above symptoms is probably a virus. Infected plants should be removed and destroyed.

Diseases

Brambles--red raspberries, black raspberries and blackberries--are susceptible to many diseases. Practicing the following management techniques helps prevent and control many bramble diseases:

1. Select disease resistant varieties and high quality (certified virus-free), healthy stock.
2. Plant at least 600 feet away from existing wild or cultivated brambles. Plant in fields not recently cultivated with tomatoes, potatoes, eggplants, peppers, or strawberries.
3. Keep plantings free from weeds and plant debris.
4. Control aphids and other insects to prevent spread of diseases.
5. Remove canes that have fruited after harvest, and destroy all diseased canes.
6. Thin out plantings to allow for increased air circulation.

Disease Symptoms

Anthracnose is a fungus which damages canes and leaves and sometimes causes fruit rot. Anthracnose first appears on young shoots as purple, raised spots. Canes show light, grayish spots 1/8 inch in diameter. These spots enlarge, develop purple edges, and eventually girdle the cane. Leaves exhibit oval spots with light gray, sunken centers and purple margins. During severe infestations leaf edges tend to curl inward. Fruit may become deformed. It is very important to have clean plants to control this disease. Remove and burn infected plants immediately and spray the remaining plants with a fungicide as for raspberry rust.

Raspberry mosaic is an easily transmittable virus disease. Leaves develop a mottled appearance with large green blisters surrounded by yellow tissue. Eventually, leaves become deformed. Canes become stunted, and berries become dry, seedy, and crumbly. There are a number of other virus diseases which often affect brambles, causing similar symptoms. The best control is to use disease-free plants. Remove and burn diseased canes. Control leaf-feeding aphids because they may spread the disease.

Rhizoctonia is a fungus disease which injures roots. Normal raspberry roots, when washed, appear white or nearly so. Brown roots may be indicative of the disease. The outer portion or epidermis is dead if the roots appear brown. Fruiting canes will wilt and die due to lack of feeder roots. It is very difficult to control but Metalaxyl (Ridomil) or fosetyl (Aliette) may provide control. Because it tends to invade frost-injured roots it may be reduced by controlling the extent of winter freezing. This is done by applying a mulch over the crowns and soil surface within two feet of the plants.

Another fungus disease, **Spur Blight**, produces brown or purple spots around bud scars by the middle of July. These spots enlarge and encircle the cane. Buds shrivel and fail to develop. Leaves fall prematurely, and canes dry and crack. During the summer, spores are

produced and spread the fungus to other plants. It is essential to have raspberries in a sunny location and keep canes thinned out to control this disease. Spraying the plants with Bordeaux 4-4-50, lime-sulfur (Orthorix, Polysul) or captan (Orthocide) will reduce the spread of this disease, but the thinning of the canes and admission of sunlight is the first control measure. Burn diseased canes.

Verticillium wilt is a soil-borne fungus that infects plants through the roots and may persist in the soil many years. Symptoms appear about midsummer; lower leaves become infected, and the cane turns blue and dies.

Orange rust is a fungus that is often found on wild brambles. Infected shoots are thornless, spindly, and bear light green leaves. Leaves develop yellow spore bodies which turn black and later produces orange spores, causing the undersides of the leaves to turn bright orange. However, this disease is more visually spectacular than harmful. Upon first appearance of this rust, dig the plant out and burn it. Spray the remaining plants with a fungicide such as maneb, diathane, captan (e.g. Orthocide) or dust them with sulfur or any other recommended fungicide on the market. **Do not eat fruit containing any of the fungicide**. Read and follow the directions and precautions on the container label carefully.

Remove and burn infected plants. Fruit rots are caused by various fungi and occur most frequently during hot, humid or rainy weather. Pick fruit frequently, and refrigerate harvested fruit immediately. Be sure plants are adequately thinned to allow for proper air circulation.

If the above diseases cannot be controlled with the cultural techniques mentioned, refer to the current pest control guide for chemical control measures.

Winter Protection

There are two main ways in which raspberries become damaged or killed during winter months. They are:

- **Winter Drought** -- This drying process during sub-zero weather is common in Montana. Water the plants in late fall before the ground freezes (usually October or November) to reduce or avoid this damage. Provide protection against wind whenever possible.
- **Break of Dormancy** -- Whenever the temperature of the atmosphere reaches 41 degrees F (5 degrees C) for three or four days, raspberries break dormancy and become active. When a winter warm spell is followed by a sudden hard freeze it kills the active tissue. The top portion of the canes break dormancy first. This is why many canes with dead tops are evident in the spring.

To avoid this, wrap the canes with burlap or similar material to reduce the intensity of winter sun and wind. When possible, build a temporary fence to cast shade on the plants. Additionally, cover the ground around the plant with straw or other insulating material to reduce the intensity of the freezing period. Mulching reduces root injury which results in less root rot. Do not leave the mulch, shade or wrapping on too late in the spring. Usually these materials should be removed around the first of April or sooner in the lower elevations of the state to avoid injury.

Related web pages:

- The Northwest Berry & Grape Information Net: http://osu.orst.edu/dept/infonet/

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Raspberries and Blackberries : Their Breeding, Diseases, and Growth (Applied Botany and Crop Science Series) - by D.L. Jennings - Publication Date: April 1988 - List: $69.00

- Bramble Production : The Management and Marketing of Raspberries and Blackberries - by Perry C. Crandall - Publication Date: March 1995 - List: $39.95
  Booknews, Inc. , 08/01/95:
  Covers classification of raspberries and blackberries; growth and development; climatic requirements; site and plant selection; soil preparation and management; planting, pruning, training, and propagation; fruit production; harvesting and marketing;

insects and diseases; and pest control. Emphasizes American bramble production but grower practices in other parts of the world are included as well. Includes b&w photographs. Annotation copyright Book News, Inc. Portland, Or.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

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Raspberries

Of all the small fruits, raspberries are gaining the most popularity. The berries are versatile and can be used as fresh fruit, in preserves, or in pies and pastries. Newer plant varieties are productive and easy to grow.

Raspberries may be grown successfully at an elevation as high as 7,000 feet. They do best in full sun on non-alkaline, fertile loam soil. However, they may be grown in partial shade or under other environmental constraints. Natural protection against strong winter winds are provided in some valleys, but in other areas it is necessary to provide artificial protection during winter months.

Varieties

Red raspberries are the most commonly grown, but there are varieties of purple, black, or yellow berries that are adapted to Massachusetts. Purchase certified, virus-free plants from a reliable nursery. They cost more, but the benefits of having more vigorous, productive plants outweigh the extra cost. To help prevent problems with troublesome viruses, do not transplant either wild plants or cultivated plants from another site.

Red Raspberries

Boyne is a mid-season berry that was developed in northern Minnesota. It is extra hardy and bears large fruit. It is a top commercial variety in some northern states. Fruit are borne on dwarf canes that are easy to pick. Boyne is an excellent plant maker and may bear a week or ten days before Latham. Berries are succulent with large, dark red fruit. Heavy cropper.

Canby is a moderately hardy, mid-season, vigorous producer. It is very productive but produces fewer canes per hill than most red varieties. Canes are nearly thornless which makes picking easier. Berries are light red, high-capped, firm and non-crumbling.

Gatineau is a very early raspberry from Ottawa, Canada, maybe two weeks earlier than Latham. The berries are larger than many early red types. Heavy cropper with irrigation. Very cold-hardy.

Hilton is a cross between the Newburgh and Walfred and is reported to be vigorous, productive and usually winter-hardy. The canes are semi-erect. Berries are medium red and very large. They ripen mid-season. Hilton is one of the largest of all red raspberries. Berries are difficult to pick unless fully ripe.

Killarney is another fine Canadian variety that is similar to Madawaska. It is a very hardy mid-season cropper. Berries are large and excellent quality.

Latham is one of the most popular and dependable mid-season raspberries. The canes are very vigorous, productive and cold-hardy. The large red berries darken as they mature. Latham is a late-season variety with a fairly long harvest season. Ripens mid to late season. Berries are extra large and are good quality for fresh use and/or freezing.

Madawaska is another very early red berry. It is one of the hardiest varieties. The berries ripen about one to two weeks earlier than Latham. Madawaska is a prolific producer throughout the growing season.

Newburgh is a light red berry of good quality and flavor. Plants are very productive and resistant to root rot. This variety is a relatively hardy mid-season producer. Berries are firm. Fall bearing raspberries (plants that produce fruit on the current season's growth) are becoming more popular. Because they produce fruit on current growth, the gardener need not be so concerned about cane hardiness. The canes can be pruned to the ground in the fall, mulched, and left for the winter without additional protection. These fall bearing varieties, however, must be grown where there is a moderate to long growing season. Earlier fruiting varieties will no doubt be appearing on the market in the near future.

Red Everbearing Raspberries

Fall Red bears a small crop in early summer with a large crop in the fall. Berries are large and have excellent flavor. Good fresh, frozen or canned.

Heritage is an excellent fall-bearing red raspberry. It is very vigorous and suckers prolifically. Canes usually do not require support. The fall-crop berries are medium-sized and very firm unless produced under rainy conditions.

Nordic is a variety from Minnesota ripening mid-season, with medium sized fruit of good quality.

Reveille plants are vigorous and high yielding. Fruits ripen early and are medium to large with good flavor, but due to softness, do not keep long.

September is one of the best fall-fruiting varieties. Berries are medium size and bright red. The spring crop ripens early and is fair in quality. Good for jellies and pies.

Trent has fruit that ripens early, is colored medium to dark red and may be crumbly or soft.

Black Raspberries

Blackhawk

Cumberland

Bristol

Jewel

Purple Raspberries

Clyde

Brandywine

Yellow Raspberries

Canby

Site Selection

A high sloping site will reduce cold injury by allowing the cold air to drain into low areas. However, do not plant raspberries on the crest of a hill because of the drying effect of wind. Winterkill is often caused by wind desiccation instead of low temperature. Raspberries grow well on a wide range of soil types. The character of the subsoil is more important than the type of surface soil. The subsoil should be deep and well drained. The root system will be restricted if the subsoil is underlaid by a shallow hardpan or a high water table. Plants with restricted root systems may be damaged during drought periods because raspberries need an abundant supply of moisture at all times.

Raspberry roots and crowns are also extremely sensitive to excessive moisture in poorly drained soils. Flooding for 24 hours or longer may kill the roots by suffocation. Young plants may appear to grow well the first season on poorly drained soils but injury symptoms will occur during the following seasons.

Well-drained loamy soils are usually most productive. The lighter textured sandy soils are easiest to cultivate but must be frequently watered and fertilized. Select a site at least 300 feet from other bramble crops to minimize transfer of virus diseases. Additionally, eliminate any wild bramble plants found within several hundred feet of the planting. Tomatoes, potatoes, eggplants, peppers, and brambles are all susceptible to many common diseases. Do not plant raspberries after these crops.

If possible, set raspberries on sites that were planted to cultivated crops the previous year. When sod fields are used, turn under the sod the season before planting.

Soil Preparation

The best soil for raspberries is a deep, well-drained, medium loam that is rich in organic matter. Raspberries do best in soil that has a pH of 6.0 to 6.5. Organic matter such as peat moss, compost, or aged manure can be added to enrich less desirable soils. These materials also make the soil loose, allowing rain and roots to penetrate deeper.

Unfortunately, raspberries are poor competitors. After choosing the best soil and site, be sure to destroy all perennial weeds. Weeds may be destroyed with cultivation, herbicides, and/or plastic mulch (see "Weed Control" section). Before working small areas, cover the ground with a black plastic mulch and place soil, rocks or other weighty objects on the edges to hold it in place. A good time to lay the plastic film is in the fall or early spring (March). Leave it there for six to eight weeks to help control weeds before working the soil.

Lime and Fertilizer

Raspberries use large amounts of nitrogen, phosphorous and potash. They use lower amounts of calcium and sulfur and even lesser amounts of trace or minor elements such as iron, zinc, magnesium, boron, manganese and copper. It is wise to have your soil tested and to mix up a complete and well-balanced fertilizer. A general application of fertilizer containing equal amounts of the three primary foods of nitrogen, phosphorus and potassium is recommended when a soil test is not available. A mix containing approximately 20 percent of each primary element is usually available at commercial outlets. Weigh out about one pound for every 35 feet of linear row and spread it in a strip extending 2 feet past the row and 2 feet on each side. For a 35-foot row of plants this is an area 39 feet by 4 feet or 156 square feet.

Weigh out only about two-thirds of a pound for the 35-foot row if the fertilizer analysis is higher. Conversely, weigh out about one and one-fourth pounds for a 35-foot row if the nitrogen content is low.

Many fertilizer mixes contain enough sulfur with the three primary plant foods to satisfy plant needs. Additionally, many fertilizer mixes contain adequate calcium.

Before planting. Where soil pH is too low, work in the required amount of lime before planting. In addition, aged manure at the rate of two to five bushels per 100 feet of row can be worked into the soil to increase available organic matter.

After planting. If necessary, two pounds of 10-10-10 fertilizer (or equivalent) per 100 feet of row can be applied after growth has started. Do not apply fertilizer after June 15. Late fall growth increases risks of winter injury.

Following years. Use 10 pounds of 10-10-10 fertilizer or equivalent per 100 feet of row in early spring.

Planting

Sites for raspberries should be free of perennial weeds, have good air, drainage (preferably a hillside), and have adequate moisture. To avoid problems with verticillium wilt, do not plant raspberries where potatoes, tomatoes, peppers (solanaceous crops), or strawberries have been grown. Plant raspberries in full sunlight for maximum yields. Raspberries should be planted as early in spring as possible. Prune the canes to within six inches of the ground at planting time for best results. Soil should be thoroughly worked before planting. The most common planting system for red raspberries is the narrow hedge row in which individual plants are set 24 to 30 inches apart in the row, with rows six to ten feet apart. Black raspberries are often grown in hills 30 inches apart with seven to nine feet between rows. If planted in partial shade, the hills should be set about three and one half feet apart.

Place plants in holes five to six inches deep and fill holes with soil and press firmly. Keep the soil moist. Generally, two complete growing seasons are required before the plants grow large enough to produce an apprciable amount of fruit.

Raspberry plantings should be cultivated thoroughly and frequently. If weeds and grasses get a start, they are difficult to control.

Obtain plants from a reputable nurseryman or from a patch that is free of virus disease. Keep the plants cool and moist until they are planted. They may be stored for several days in cold storage at 35 degrees F. Plant raspberries as soon as the ground can be worked early in the spring. It is better to delay planting than attempt to work wet soil.

Watering

Raspberries use more soil moisture than most fruit plants. Irrigated plants are more vigorous and yield fruit over a longer season than do unirrigated plants. Begin irrigating raspberries at the same time other garden crops are normally irrigated. Most cultivars require about one inch of water per week during the growing season. Extreme warm and windy conditions make greater amounts of water necessary. Light sandy soils need more frequent irrigation than heavier clay soils.

The fruiting period is a critical irrigation time. Apply 1 to 1 1/2 inches of water once a week if drought occurs during fruiting.

Do not over-water in late summer or fall. Excessive water application during this time may delay maturity of cane wood and result in a freezing injury that will become evident the next spring.

Weed Control

Proper site preparation will help control troublesome perennial weeds. After plants become established, shallow cultivation, hand weeding, or hoeing may be necessary to control weeds. Weeds should be kept out of the planting, especially the first year, to allow the raspberry plants full use of available nutrients and water. Once plants are fully established, weeds are not as troublesome within the rows.

Weed control usually involves a combination of both mechanical and chemical means. Cultivate soon after setting out the plants. Do not cultivate deeper than three to four inches or the roots may be damaged. An annual cover crop may be seeded each year that will die in winter. However, cover crops may be a disadvantage if water is scarce.

Mulches of straw, chips, sawdust or leaves placed around the canes in fall will reduce cane and root freeze injury. As mentioned under disease prevention, freeze injury can predispose the raspberry to diseases. Mulches can also provide a deterrent to weed invasion and if left throughout the growing season, help to retain soil moisture and reduce muddiness among the plants.

Several herbicides are registered for use in raspberries. For established plantings, spray the rows with a herbicide before the weeds and new canes emerge in early spring. Do not use pre-emergence herbicides the year the planting is made.

- Dichlobenil (Casoron or Norosac) may be used at two to four pounds of active ingredient per acre depending on the soil type. Read and follow the label carefully. Dichlobenil is effective against quackgrass and many annual weeds. Granular formulations are most effective on quackgrass. Do not exceed four pounds active ingredient per acre. Use lower rates on young plantings.

- Sethoxydim (Poast). Apply at up to three pounds actual ingredient per acre to actively growing grasses. Should be combined with a crop oil or other emulsifier. Products such as Ortho Grass-be-Gone contain the emulsifier. Do not use within 45 days of harvest.
- Oryzalin (Surflan). Apply in late fall or early spring to bare soil where vegetation has been removed. Irrigate with 1/2 inch water to activate chemical.
- Napropamide (Devrinol). Apply in late fall or early spring. Need 1 inch of irrigation or rainfall after application.

Mulching

Mulching in the fall of the planting year will help keep down weed growth, increase moisture content of the soil, and help protect the plants against winter injury. Materials that can be used as mulch are straw, hay, and leaves. Add new mulch, as necessary, each year.

Pruning

Raspberries need annual pruning, or "thinning out" to encourage new growth, fruit formation, and minimize disease problems. Summer-bearing varieties grow canes the first year, produce fruit the second year, and die after fruiting. Following are pruning guidelines for each variety:

- **Summer**. Remove old canes after harvest.
- **Early Spring**. Remove weak canes. Narrow and thin the rows to about one-foot widths. Shorten canes to heights of about 4 1/2 feet.
- **Ever-bearing**. These varieties set fruit during the summer and again in the fall. There are two "systems" for pruning this type of berry. One is to mow the canes within two inches of the ground after the fall harvest. Plants must then be mulched for protection during the winter. This system, however, eliminates the summer crop but allows a more consistent crop level in the fall. The second system is to remove the canes that bore fruit in the fall after the fall harvest and then follow the procedure for summer-bearing reds.
- **Black and Purple**. Remove the top two inches of canes in early June to encourage lateral branching. This process is called "topping" and should be practiced in addition to the steps for pruning early spring raspberries. Shorten side branches to six inches (black) or ten inches (purple). Leave only three to four canes per hill.

Pruning is one of the most important parts of raspberry culture and it is often neglected or improperly done. Proper pruning of raspberries makes fruit picking easier with the individual fruits growing larger. Also, the shortened canes are less likely to break under a load of fruit.

In the hedge row system, spring pruning should consist of thinning the canes to 6 inches apart of 8 to 10 canes per two feet of row. Keep in mind that row should be only 18 inches wide. The remaining canes should be tip pruned or headed back to 3 to 3 feet tall. This spring pruning should be done in early spring before any growth takes place.

In midsummer, after the raspberries have finished fruiting, all canes that bore fruit should be removed. These old canes will die the following winter since the canes of raspberries live only two

years. The first year the canes grow from a shoot starting from the root. The second year these canes fruit and die. Canes that have fruited compete with the young canes for moisture and nutrients. They also harbor insects and diseases. Burn or bury all the refuse removed in pruning.

Red raspberries need to be pruned annually. Two main reasons for pruning are to remove dead canes and to thin out the clumps. New canes grow annually and produce fruit the following year, then die. Dead canes should be cut at ground level and removed.

A healthy stand of raspberries will produce numerous new canes annually. They may become so dense that some canes are weak and produce little or no fruit. It is better to remove the weaker ones and leave six to ten large canes per hill. This should be done in July or August when the new crop of canes are young and tender.

Other pruning may be necessary to remove suckers which come up out and away from the hill or row. Generally, cultivation and mowing will keep suckers under control. If a natural planting is desired, suckers, or side shoots, may be allowed to spread freely as in the wild. Do not mow, cut, cultivate or control the suckers if room is available for this type of planting. Dead tips of raspberry plants may be removed in the spring or early summer.

Supporting Brambles

Since fruit-bearing canes are top heavy, it is often a good idea to support fruiting canes. Usually, all that is necessary is a wire trellis which has two posts, one at either end of the planting. Each post should have a horizontal arm with wires running each side of the planting at a height of 40 inches.

Unless the raspberries are the trailing varieties, the plants will stand erect. They will often bend over if they are grown in shaded or windy areas. Partial support is often necessary to keep plants upright. In some cases it may be necessary to provide support between the hills. Tie a short piece of cord or wire across the row with both ends connected to two long strands for support.

Pests

Birds often can be troublesome in raspberry plantings, and netting may be necessary.

Major insect pests include tarnished plant bugs, fruitworms, sap beetles, Japanese beetles, and cane borers.

Harvesting

Raspberries should be picked when they develop deep color, lose their glossy color, and separate easily from the receptacle. Fruit is usually harvested every other day, or daily, at the peak of the ripening period. Raspberries have a short shelf-life and must be refrigerated as soon as they are picked.

Harvesting fruits as soon as they are ripe helps eliminate problems with Japanese beetles, sap

beetles, and fruit rots.

Other Problems

Problem: Leaves on my raspberries are yellowish, blotchy, twisted, and/or the fruit is small or crumbly.

Cause: The cause of any of the above symptoms is probably a virus. Infected plants should be removed and destroyed.

Diseases

Brambles--red raspberries, black raspberries and blackberries--are susceptible to many diseases. Practicing the following management techniques helps prevent and control many bramble diseases:

1. Select disease resistant varieties and high quality (certified virus-free), healthy stock.
2. Plant at least 600 feet away from existing wild or cultivated brambles. Plant in fields not recently cultivated with tomatoes, potatoes, eggplants, peppers, or strawberries.
3. Keep plantings free from weeds and plant debris.
4. Control aphids and other insects to prevent spread of diseases.
5. Remove canes that have fruited after harvest, and destroy all diseased canes.
6. Thin out plantings to allow for increased air circulation.

Disease Symptoms

Anthracnose is a fungus which damages canes and leaves and sometimes causes fruit rot. Anthracnose first appears on young shoots as purple, raised spots. Canes show light, grayish spots 1/8 inch in diameter. These spots enlarge, develop purple edges, and eventually girdle the cane. Leaves exhibit oval spots with light gray, sunken centers and purple margins. During severe infestations leaf edges tend to curl inward. Fruit may become deformed. It is very important to have clean plants to control this disease. Remove and burn infected plants immediately and spray the remaining plants with a fungicide as for raspberry rust.

Raspberry mosaic is an easily transmittable virus disease. Leaves develop a mottled appearance with large green blisters surrounded by yellow tissue. Eventually, leaves become deformed. Canes become stunted, and berries become dry, seedy, and crumbly. There are a number of other virus diseases which often affect brambles, causing similar symptoms. The best control is to use disease-free plants. Remove and burn diseased canes. Control leaf-feeding aphids because they may spread the disease.

Rhizoctonia is a fungus disease which injures roots. Normal raspberry roots, when washed, appear white or nearly so. Brown roots may be indicative of the disease. The outer portion or epidermis is dead if the roots appear brown. Fruiting canes will wilt and die due to lack of feeder roots. It is very difficult to control but Metalaxyl (Ridomil) or fosetyl (Aliette) may provide control. Because it tends to invade frost-injured roots it may be reduced by controlling the extent of winter freezing.

This is done by applying a mulch over the crowns and soil surface within two feet of the plants.

Another fungus disease, **Spur Blight**, produces brown or purple spots around bud scars by the middle of July. These spots enlarge and encircle the cane. Buds shrivel and fail to develop. Leaves fall prematurely, and canes dry and crack. During the summer, spores are produced and spread the fungus to other plants. It is essential to have raspberries in a sunny location and keep canes thinned out to control this disease. Spraying the plants with Bordeaux 4-4-50, lime-sulfur (Orthorix, Polysul) or captan (Orthocide) will reduce the spread of this disease, but the thinning of the canes and admission of sunlight is the first control measure. Burn diseased canes.

Verticillium wilt is a soil-borne fungus that infects plants through the roots and may persist in the soil many years. Symptoms appear about midsummer; lower leaves become infected, and the cane turns blue and dies.

Orange rust is a fungus that is often found on wild brambles. Infected shoots are thornless, spindly, and bear light green leaves. Leaves develop yellow spore bodies which turn black and later produces orange spores, causing the undersides of the leaves to turn bright orange. However, this disease is more visually spectacular than harmful. Upon first appearance of this rust, dig the plant out and burn it. Spray the remaining plants with a fungicide such as maneb, diathane, captan (e.g. Orthocide) or dust them with sulfur or any other recommended fungicide on the market. **Do not eat fruit containing any of the fungicide**. Read and follow the directions and precautions on the container label carefully.

Remove and burn infected plants. Fruit rots are caused by various fungi and occur most frequently during hot, humid or rainy weather. Pick fruit frequently, and refrigerate harvested fruit immediately. Be sure plants are adequately thinned to allow for proper air circulation.

If the above diseases cannot be controlled with the cultural techniques mentioned, refer to the current pest control guide for chemical control measures.

Winter Protection

There are two main ways in which raspberries become damaged or killed during winter months. They are:

- **Winter Drought** -- This drying process during sub-zero weather is common in Montana. Water the plants in late fall before the ground freezes (usually October or November) to reduce or avoid this damage. Provide protection against wind whenever possible.
- **Break of Dormancy** -- Whenever the temperature of the atmosphere reaches 41 degrees F (5 degrees C) for three or four days, raspberries break dormancy and become active. When a winter warm spell is followed by a sudden hard freeze it kills the active tissue. The top portion of the canes break dormancy first. This is why many canes with dead tops are evident in the spring. To avoid this, wrap the canes with burlap or similar material to reduce the intensity of winter sun and wind. When possible, build a temporary fence to cast shade on the plants. Additionally, cover the ground around the plant with straw or other insulating material to reduce the intensity of the freezing period. Mulching reduces root injury which results in less root rot. Do not leave the mulch, shade or wrapping on too late in the spring.

Usually these materials should be removed around the first of April or sooner in the lower elevations of the state to avoid injury.

Related web pages:

- The Northwest Berry & Grape Information Net: http://osu.orst.edu/dept/infonet/

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Raspberries and Blackberries : Their Breeding, Diseases, and Growth (Applied Botany and Crop Science Series) - by D.L. Jennings - Publication Date: April 1988 - List: $69.00

- Bramble Production : The Management and Marketing of Raspberries and Blackberries - by Perry C. Crandall - Publication Date: March 1995 - List: $39.95
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  Covers classification of raspberries and blackberries; growth and development; climatic requirements; site and plant selection; soil preparation and management; planting, pruning, training, and propagation; fruit production; harvesting and marketing; insects and diseases; and pest control. Emphasizes American bramble production but grower practices in other parts of the world are included as well. Includes b&w photographs. Annotation copyright Book News, Inc. Portland, Or.

Periodicals:

- None identified.

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Other Crops

Return to the Small Farm Resource

- Bamboo
- Christmas Trees
- Cotton
- Sweet Corn
- Tomatoes
- Walnuts

If you have a question, we will post the question in the appropriate contents page to get suggestions from our site visitors.

Questions and suggestions can be sent to us via our Feedback form.

Visitor Questions:

Go to Forage Crops

Go to Orchard/Fruit Crops

General crops related links and mailing lists

Growing Bamboo

Frequently Asked Questions Other Information Sources Return to Other Crops

Frequently Asked Questions:

Other Information Sources:

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Selecting & Preparing Land for Grove

Most bamboos thrive in tropical to warm temperate climates, where the minimum Summer temperature does not fall below 15° C. Some shelter from strong winds is desirable. Running bamboo is easily blown over in high winds because of its relatively shallow roots and luxuriant growth. Clumping bamboo is less susceptible, but cold winds kill the tips of branches and leaves of all bamboos. This delays the emergence of shoots so a forest or hill as a windbreak facing the prevailing wind is desirable.

Land should be well drained. Soil moisture is important both for growth and to transport plant food. Excessive moisture is harmful and if the soil easily yields drops of water when squeezed in the hand, it is too wet for rhizome growth and will cause rot.

Very flat land, with impermeable soils which lead to water ponding, will need drainage, either mole drains or slotted polythene pipe in trenches back-filled with pea gravel and coarse sand. Level land is desirable but a hillside will serve if the slope is not more than about 7° or 8°; it should not be greater than 15°. The land should slope toward the northeast, north or northwest. The hillside provides natural drainage, the slope allows the sun to warm the soil, hastening the decomposition of mulches and organic fertiliser and promoting the growth of shoots in Spring.

Bamboo can be grown in most types of soil provided they are not rocky. The ideal soil is either marly soil or a loam. A sandy loam is fairly satisfactory for bamboo growth, but clayey loam produces the best quality shoots. Remove weeds and cultivate to a depth of about 45 cm. Although the rhizomes of running bamboos may go as deep as 1 to 1.25 metres, these rhizomes produce no harvestable shoots so it is a waste of labour and expense to cultivate deeper. Clumping bamboos send their roots to about 1 metre, but shoot much closer to the surface.

- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

Ground on which other crops have been grown previously needs no special pre-treatment except cultivation. Soil acidity must be corrected before planting is started. An application of 300 kg to 400 kg of lime per acre will neutralise acid soil, make otherwise insoluble nutritive elements available and hasten the decomposition of organic matter.

Establishing & Managing a Plantation

The best time to establish a new plantation is just prior to the rainy season or the growing period (which may not coincide), usually during Spring or early Summer. In Australia this falls between the months of August and November. A rotational system for planting new groves should be established to allow for eventual loss of vigour of older clumps. Some plantation areas will be going out of production as new areas are brought in. Rotating the planting of new plants with clear-felling of exhausted clumps also allows time for replenishment of the soil.

Spacing and Mulching

For most species a spacing of from 6m to 8m between clump centres is usual. A plot with poorer soils should be planted at 8 metre centres and richer soils at 6 metre intervals. This spacing allows an annual harvest of both shoots and timber.

Bamboo clumps used for shoot production need access to more sunlight than those destined to be cut for timber. Soil warmth is necessary for shoot development, (but exposure to light will ruin the mild taste of emerging new shoots). Production of sweet good quality shoots thus requires either an annual top dressing with rich soil or applications of suitable mulch mounded around the bases of the clumps where the new shoots will emerge. The aim of this practise is to allow soil warming but to exclude sunlight as much as possible from the young shoots until they are selected for cutting.

Propagation

Establishing a plantation using large plants or even big divisions is very expensive. Smaller plantlets are needed. Sadly there is no sure-fire method of rapid propagation applicable to all the clumping bamboos. Most plantations are established using divisions of mature clumps. Some research work is proceeding on tissue culturing bamboos, but results are a little inconclusive except from some laboratories in India. These institutions seem to have established a reliable method of producing bamboo plants from callous tissue derived from seeds or

immature plantlets, but the procedure has only recently been applied to bamboo in Australia. Micro-propagation techniques using emerging branchlets from mature culms might prove the most successful and cheapest method to establish a plantation, but this technique too needs more research.

Current methods of vegetative propagation:

There are several methods of obtaining vegetative propagules. They depend on access to mature plants of the desired species from which various kinds of cuttings may be taken. These develop into new plants using the food reserves conserved in the parent material. Not all bamboos respond to these propagation methods. They seem to work best with thick-walled Bambusa and Dendrocalamus species and require high humidity and soil warmth for greatest success.

Layering whole culms:

Bend outer culms of a clump downwards after undercutting at the base and bury the culm in the soil after cutting off all but the main branches. After a few weeks, if soil temperatures are sufficiently high and moisture levels maintained, roots and shoots develop at the buried nodes. Saw off the culm sections bearing new plants and transplant these directly into the desired plantation area.

Whole culm cuttings:

Whole 18 month old culms may be severed from adult clumps and planted in a shallow trench. Leave the top of the culm and a few branches intact and allow them to protrude above the ground. After some weeks, new roots and shoots develop at the nodes. Cut these from the parent culm and transplant them directly into the plantation site.

Double-node cuttings:

Make cuttings of culms with at least two internodes left intact. Trim branches from lower node. Plant prepared cuttings vertically in warm soil with the top of the culm and the branches left protruding. If using potting bags or pots, cover each with a clear or lightly frosted plastic bag tied in place after watering and leave in part shade until new roots protrude from drain holes. New roots and shoots are produced at the lower node. Single node cuttings planted on their side with the branch complement upwards will work with some species.

Branch cuttings:

Propagation using branch cuttings has proved successful in some cases. In Bangladesh, Melocanna bacciffera has been successfully propagated in this way. Cut the whole complement of side branches from a culm using a sharp hacksaw and plant in warm soil. Maintain atmospheric humidity using the system described for double node cuttings. New

roots appear at the base of side branches within a few months.

Obtaining new plants using these methods can take up to one year. A few more years of growth are necessary before young plants are strong enough to produce new shoots suitable for cutting as vegetables.

Growing Bamboo

Compared to the cost of growing other vegetables or fruit, bamboo growing is relatively inexpensive. During the first two or three years of growth while the plantation is maturing and culms and shoots are too small to sell, growers can raise other crops in the grove to recover the starting capital. In Japan, where establishment costs may be less than Australia, farmers are able to recover their initial monetary investment after 8 or 9 years. In contrast to timber crops, no clearfelling is required to realise a profit after this time and the plantation continues.

Unlike most other agricultural crops, bamboos have been developed with little artificial selection. This means that, like most other grasses, bamboos are fairly resistant to diseases, insects, and climatic injuries. Consequently, growing bamboo for either timber or shoots (or both) requires much less labour than growing vegetables or fruit. Although it is desirable to have a large grove, many small scale growers can be successful, and reasonable profits can be made by saving the expense of hired labour.

Planting:

It is important that:

1. roots do not dry out in transit; drying may be avoided by placing them in the shade or covering them with straw or mats;
2. shaking does not injure the attachment between rhizome and culm;
3. the rhizome buds are not injured; and
4. the ball of earth remains unbroken.

Spacing:

The proper number of plants is about 400 per hectare. If the plants are planted in a grid, the spacing between them is about 5 metres.

Depth:

Replant at the same ground line as before. The part formerly above ground is usually green while the underground part is yellow. Place new plants so that the rhizomes run at right angles to the slope and are horizontal. This is the normal way that rhizomes grow.

Fertilizer:

Fertilizer is important during transplanting to increase the vigour of the rhizomes. It can be placed in the hole near the rhizomes. A shovel-full of well rotted stable manure, a handful of chemical fertilizer will give new plants a good start. After this initial treatment, follow the fertilizing guide given for clumping species in the previous section.

Back Filling:

Back fill the planting hole with top soil using a stick to push soil into any spaces left around the rhizomes. Next, step lightly on the ground around the culms. Sometimes water is applied to settle the soil around the rhizomes, but this may not be necessary with a plant which has the original soil bound by its roots.

Bamboo that have been stored for a long time after digging, plants whose roots have begun to dry out, those which have a small root ball or that are transplanted in a dry season should be planted into very wet soil. Fill the bottom of the hole with water, add soil and stir to make mud. Place the bamboo plant in the hole and add more water until the hole is filled. Top up the soil leaving a shallow pan to accept water.

Mulching:

All transplanted bamboos should be mulched with 15 to 20 cm depth of hay or straw to a diameter of about 2 metres. Spread soil on top of the hay or straw, covering it. This protects the ground from drying, controls soil temperature and checks the growth of weeds.

Increasing the Grove Area by Extension of the Rhizomes:

Bamboo rhizomes spread into well-watered and fertile or loamy soil. This characteristic can be used to expand the grove into adjacent plots.

Excavate to 45 cm depth in a belt about 60 cm wide next to the side of the plot which is selected for expansion of the grove. Place compost or stable manure in the trench. Refill with soil and cover with a mulch of hay or straw about 20 cm deep. Instead of using mulch it is possible to grow cover crops of lupins or vetches. The rhizomes spread about 2 m a year. Whether or not shoots have emerged on a prepared area, keep on preparing successive adjacent belts each year immediately after the emergence of the shoots. Needless to say, only well nourished bamboos will extend their rhizomes rapidly, so it is quite important to properly fertilize the grove.

Grove Management:

After about 7 years an equilibrium is reached where the number of new culms left each year equals the number harvested. For example, suppose there are 120 culms in a grove, and culms are harvested when they are six years old. There will be 20 culms of each age from one to six years old. In Spring, 20 of the new shoots are allowed to grow into new culms. In Autumn the 20 six year old culms are harvested and the garden is back to its original 120 culms.

A highly fertilised grove produces large culms with many branches and leaves. Because of the widely spaced culms wind damage to the rhizomes at the base of the culms is likely. To avoid this damage the culms should be topped. Topping also allows more sunshine to reach the ground promoting early shoot emergence.

The best time to top is just after the lowest 2 or 3 branching nodes have extended their branches and the upper branches are still enclosed in the sheaths. Count 12 nodes up from the lowest branches, and cut off the culm above it. Always cut the culm cleanly. Breaking it will cause ragged splits and provide entry points for disease.

Cropping Culms to Thin:

As tropical bamboo species usually have a short rhizome neck structure they form clumps composed of close growing culms. Unless correctly managed by thinning regularly, clumps become so dense and congested that harvest of shoots and poles becomes almost impossible. Systematic and regular cutting can actually increase yields and leads to greater convenience in harvesting. Excessive cutting reduces yields and the clump is more susceptible to wind damage during storms.

When clumps mature and spread outwards, a modified 'keyhole' system for culling shoots and culms will allow greater access to the clump. Poles can be cut from the older and more mature inner part of the clump while shoots are harvested from the outer fringe. Rhizomes in the central portion of the clump contribute to the vigour of the whole clump. It is therefore inadvisable to completely remove this part for propagules without giving the plant an opportunity to establish new culms on the outer rim over a couple of growing seasons.

Shoot Production:

Culms emerge from the soil at their full mature diameter, shedding the cardboard-like sheaths as they elongate. Culm sheaths can be densely hairy,with two prominent "ears" and a distinctively shaped leaf at the apex. Culms are more or less cylindrical. The surface of the culm is smooth, usually green, and is often covered to some extent by either fine hairs or a waxy bloom. Generally, culms are stout with relatively

thick or even solid walls. Nodes are ring-like and support a distinct pattern of branches which is more or less consistent within a genus. Branching begins directly above each culm node and proceeds alternately on opposite sides of the culm. Branches in turn may support a number of smaller branchlets. Usually about ten or more lanceolate or narrow-lanceolate leaves emerge at the ends of the branchlets. Leaves vary greatly in size, some being quite large and useful as wrapping materials for small bundles of cooked rice or other foods.

Suitable Species:

Among the tropical bamboos grown for shoots are: Edible Bamboo, Bambusa edulis, grown in Taiwan and used for shoot production but also building and paper pulp. Beechy Bamboo, Bambusa beecheyana is eaten in southern China, but the shoots must be boiled in two changes of water. Burmese Bamboo, Bambusa burmanica, shoots are eaten in Thailand.

Spiny Bamboo, Bambusa spinosa is used in the Philippines. Research on the nutritive value of this bamboo revealed that it had the highest levels of calcium, protein and phosphorus of the group of bamboos tested. Common Bamboo, B. vulgaris, which is not actually so common in Australia and its ornamental relative B. vulgaris Vittata, [Syn B. striata], also produce edible shoots, but these are said by some to be inedible because of bitterness. Giant Hedge Bamboo, B. bambos, [Syn. B. arundinacea] is a large and thorny species which forms useful impenetrable hedges. It has edible shoots which are pickled in Thailand. Asper Bamboo, Dendrocalamus asper, is one of the most favoured bamboos grown for shoots (and export) in Thailand. Bambusa blumeana is a bamboo which dislikes its roots being disturbed when young, but in India and Indonesia it is used as a building material, in basketry and its shoots are processed for eating.

Many other species including: Bambusa longispiculata, B. nutans, Dendrocalamus asper, D. latiflorus, D. giganteus (sweet enough to be eaten raw), D. merrilliana, D. membranaceus, D. strictus, Gigantochloa albociliata G. atter, G. robusta, G. levis, and Thyrsostachys siamensis produce edible shoots.

Running Species Shoot Production:

Suitable Species:

There are many temperate running varieties which are suitable for shoot production. "Moso" as it is known in China and Japan, with several more or less synonymous Latin names (Phyllostachys heterocycla, P. pubescens and P. edulis) is the most commonly grown species for shoot production mainly because of the size of the shoots and consequent

savings in labour that this characteristic gives per kilogram weight of harvested shoot. Other species with edible shoots include P. congesta, P. dulcis, P. elegans, P. nidularia, P. platyglossa, P. praecox and P. viridis. Square Bamboo, Chimonobambusa tetragonocalamus and a number of Pleioblastus and Sasa species also produce edible shoots, although the shoots from some of these are very slender.

Selection of Stock Plants:

Establishing a large plantation using nursery-grown potted plants could prove expensive. Although seedlings of some species are available occasionally the supply is erratic. Most plantations are established using small stock plants or divisions.

Rhizome cuttings:

Sections of vigorous rhizome about 30 cm long, taken from just behind the growing area can be either planted in nursery beds or directly into the plantation area parallel to the contour and watered in. These will produce new shoots from the viable buds and new rhizome in the next season. The ideal stock plant has one leafy culm with an attached rhizome fully capable of producing shoots. Select plants between 18 months and 2 years old. Plants over four years old are hopeless as stock plants as the buds on the rhizome will not shoot. It is not the growth of new culms above ground but the spreading of rhizomes underground that is the important consideration in the development of a strong and luxuriant grove. The most convenient size are those whose culms are between 2 and 4 cm in diameter.

Short culms are better than tall ones because they are less likely to be damaged by wind and require no support stakes, which saves labour and expense. Use young sun-hardy and vigorous culms having many branches.

Those with cracks or other injury at the junction of the culm and rhizome are worthless. Stock rhizomes should have at least five buds, for without buds shoots cannot grow. It is impossible to determine the presence of buds without digging into the ground; however, it is safe to assume that culms in their third year have live buds on their rhizomes.

Weeds:

Bamboo shoot gardens receive more sun than timber yielding groves because of the relatively wide separation of the culms. Sunlight encourages the growth of weeds which consume nutrients intended for the bamboo, shade the ground, lower soil temperature and thus retard shoot emergence.Weed using a hoe to scrape the ground surface except during the time just before shoots emerge; weeds should then be pulled up by hand. Weeds may also be controlled by growing another crop between the bamboos when the garden is new, but this should be

discontinued once the garden is three years old.

Fertilizer:

Bamboo is a heavy feeder so even rich soil becomes depleted after a few years if no fertilizer is added. Although fertilizer may be applied at any time of year, it is usually done after shoot harvest and again in late Summer just before mulching. Since the rhizomes are continuously active except in the coldest part of the year, it is better to apply small amounts of fertilizer several times during the year rather than a large amount all at once.

Bamboo appreciates nitrogen and potassium which are found in compost, stable manure, green manure, and wood ashes as well as in the chemical regime suggested earlier. Lime is often used both as a fertiliser and as a neutraliser for acid soil. Hay, compost, green manure and straw can simply be spread on the ground. Stable manure, ash, calcium phosphate, potassium chloride, and similar materials should be buried in small pits to avoid being washed away by rain.

Mulching:

Mulching the shoot plantation with hay, straw or composted bagasse is most important. Depending on its composition, mulch furnishes various nutrients, checks weed growth and improves soil condition. Mulch protects the shallow growing rhizomes both from Winter cold and Summer drought. Mulch should be spread during September in cool climates or during October in warm ones.

E**arly Treatment of Plants**:

Plants showing poor growth and slow development should be removed. For the first 2 or 3 years most new shoots are allowed to grow into culms. Only those that grow poorly or are too close to others are removed. Sometimes bamboo rhizomes produce slender stems that grow from old rhizomes. These should be pruned off since they take up nutrition that would otherwise go to good shoots. After five years a young grove on rich soil should have about 2000 mother culms per hectare. In this year the increase by selection of new mother culms is complete. Remove about 500 of the weakest culms per hectare. The spacing of the mother culms is important. Sometimes healthy culms must be removed if they are too crowded. In year six the original, oldest culms are removed. The remaining culms are thinned to obtain uniform spacing and density of 2000 culms per hectare. The proper spacing of mother culms depends on the soil. A rich soil allows wider spacing than poor soil. Climate is also a factor. Between 1500 and 2000 mother plants per hectare is desirable, fewer for rich soil and more for poor soil.

This density is maintained for the life of the plantation. Higher density

produces too many overcrowded rhizomes which reduces shoot quality. Culms are cut after they reach 7 years so that only about 500 shoots per hectare are allowed to grow into new culms each year. It is best to select these shoots from those that sprout early in the mid season of shoot production. Each must be carefully marked with the year of its emergence so that there will be no uncertainty at cutting time.

Characteristics of Running Species:

Culms arise from long underground rhizomes. These spread in sinuous courses about 30 cm deep reaching maximum depths of 1 to 1.25 m. New shoots begin to emerge in September, with peak production normally in October. Culm sheaths are papery in texture and can be densely hairy and spotted. They bear bristles at the apex. Sheath blades are usually long and slender. The sheaths gradually fall as the culms grow. Culms are more or less cylindrical in their lower section but in the upper parts each internode has a broad groove on the side from which the branches emerge. The surface of the culm is smooth, green, yellowish green or yellow, and the internodes are relatively short. Nodes are ring-like. When young, culms are often covered with fine hairs and beneath each node is a band of white waxy powder. Generally, culms are stout with relatively thick walls. Usually two, but sometimes one or three, semi-cylindrical branches having prominent nodes occur directly above each upper culm node and grow alternately on opposite sides of the culm. Two to 8 lanceolate or narrow-lanceolate leaves emerge at the ends of the branchlets.

Shoot Yields:

The annual yield of a bamboo clump depends on the number of new culms produced each year. This in turn is related to the production of young leaves. Culms become mature after two or three years. Prior to this stage, young culms contribute greatly to the health of the clump through photosynthesis in their new leaves. The foods they synthesize are partly consumed by leaves but the greater proportion is transported to the rhizomes. Here it is stored as energy which is converted into next year's growth of new shoots. If all the potential young culms (shoots) are cut from a clump through several annual cycles, the clump loses vigour as the rootstock becomes depleted of nutrients. This is why to maximise shoot output some shoots must be left each year to develop into leafy young culms. Large yields are produced in alternate years and so it advantageous for the intending farmer to have plantations of varying ages if a consistent supply of fresh shoots is required. Clearly it is a marketing advantage to have a number of plantations producing in sequence.

Fallen bamboo leaves mulch the soil surface. This layer of litter, along

with the leaves still attached to the plant, protect soils from erosion during storms. Growers must realise that this covering can also prevent penetration of chemical fertilizers and water into the root area around the clump. Set up a regular schedule of checking the soil surface around each clump by raking away a portion of the leaf litter and mulch to ensure the correct levels of soil moisture are being maintained. Where water repellent and "waxy' soils occur it may be necessary to apply soluble fertilizers along with a wetting agent. This procedure will ensure that the root mass receives the benefit of watering and fertilizer application and that these nutrients do not simply run away from the clump.

Fertilizing:

Manuring or fertilizing should be undertaken regularly. Little and often is more productive than occasional heavy fertilization. Fertilizers are used to promote the artificial regeneration of the bamboo especially when clumps are used for shoot production. The main nutrients needed include nitrogen, potassium and phosphorous. These should be applied at least one month prior to the shoot production period.

Fertilizer regime which may be used as a guide when establishing a plantation is as follows:

- Preplanting Potato E 3kg/10m² Muriate of Potash 150g/10m² Urea 200g/10m² Maintenance Monthly applications of Urea at 100g/10m² during the active growth period.
- A slow release fertilizer consisting mainly of Potassium silicate has been claimed as beneficial to bamboos cropped for shoots. Trials to gauge effectiveness of this fertilizer have yet to be conducted in Australia. Similarly, Calcium silicate (cement) has been recommended as a suitable fertilizer to produce strong culms by increasing the cell-building silica the plants need, but this compound is expensive to use as a fertilizer.

Diseases of Emerging Clums:

Bamboos, a major non-timber woody resource, occupy about 10.3 million hectares of forest lands in India. Of the 128 species of bamboos occurring in the country, only a certain bamboo species such as Bambusa bambos, B. nutans, Dendrocalamus strictus, D. hamiltonii have been planted on a large-scale in many States. Improper management, unscientific harvesting and over-exploitation have resulted in depletion of the bamboo resources in many areas. Apart from biotic interference, various diseases affecting the culms have also dwindled the stand productivity.

In natural stands and plantations, bamboo culms are affected with various diseases at their different growth phases which result in partial to complete failure in culm production. Rot of emerging and growing culms respectively caused by Fusarium moniliforme var. intermedium and F. equiseti, culm blight by Sarocladium oryzae, witches' broom by Balansia linearis and little leaf by mycoplasma-like organisms are the potential culm diseases recorded on bamboos.

Rot of emerging culms caused by F. moniliforme is the most widespread and economically important disease which affects about 23 species of bamboos in Kerala State. Among these, B. bambos, D. strictus, D. longispathus are the severely affected species. Very high incidence and mortality were recorded in emerging culms of 15 to 30 cm height; disease incidence varied from 14.5 to 33.7% in natural stands, while it ranged from 5.5 to 25.5% in plantations during 1987-91.

Rust Fungus:

Green bamboo (Bambusa oldhami Munro) and Ma bamboo (Dendrocalamus latiflorus Munro), cultured over an area from low elevation to 500 m in Nan-Tou, Yun-Lin, Chiayi, Tainan, Kaohsiung, and Pingtong counties in Taiwan, are important economic bamboo species for producing good quality bamboo shoot and pulp materials. However, the rust fungus, Dasturella divina, has spread over bamboo plantations, and caused serious damage to bamboo leaves. In this study, rust distribution was surveyed. Its morphology was observed with scanning electron microscope. Energy-dispersive X-ray microanalysis was applied to detect the element distribution in tissues of bamboo leaves. The rate of photosynthesis was measured with portable photosynthesis system.

The results revealed that in summer and fall lots of uredinia appear on lower leaf surface, and subsequently produce plenty of urediniospores. The rust is distributed throughout the island. Results from X-ray microanalysis showed that content of silicon and potassium was respectively higher and lower in tissues of diseased leaves in comparison to healthy ones. In November and December 1994, the average photosynthesis rates of healthy leaves of green bamboo and Ma bamboo were 18.35 mmole CO_2 m-2 s-1, and 19.61 µmole CO_2 m-2 s-1 respectively. However, in November and December 1994, the average photosynthesis rates of diseased leaves of green bamboo and Ma bamboo were 2.60 µmole CO_2 m-2 s-1, and 1.94 µmole CO_2 m-2 s-1 respectively.

These results demonstrated that Dasturella divina destroyed tissues of bamboo leaves, changed the distribution of elements in leaf tissues, and thus seriously decreased the rates of photosynthesis.

Pests Affecting Bamboo:

Leaf-biting and sucking insects including aphis cause minor damage to ornamental bamboos and may be a problem in shoot plantations especially when bamboos are small. Adult plants do not seem overly bothered by such pests. Systemic insecticides and predatory species offer a measure of control. Scale insects can be troublesome to some plants. They usually haunt culms and branches sheltered by adhering culm or leaf sheaths.

Shoot Harvesting:

Shoots of clumping bamboos grow vigorously beneath the soil surface, finally breaking through into the light. At this stage they often pause in their growth. The reason for this is not known. However, exposure to sunlight causes the production of chemicals that are bitter and hastens shoot elongation by stimulating the development of a very woody base. Consequently, shoots should be dug when the tips are just emerging from the surface of the soil or very soon after that stage. A tell-tale bulge or cracks in the soil usually reveal the new shoot's location.

As new shoots arise from rhizomes which more-or-less radiate outwards from the clump they can be harvested without wholesale disturbance of the surrounding soil. Digging should proceed with care so that shoots are not bruised. Remove the soil from around the base of the emerging shoot, exposing the lower part of the rhizome neck. Carefully sever the last third of the shoot with a narrow hoe, machete or sharpened narrow-bladed spade. Slope the cut away from the narrow woody neck that connects the new culm with an older one. If the necks remaining in the soil have viable buds, some will produce a shoot in following seasons.

Preparing shoots for use as a Vegetable:

A shoot that is fairly stout, light yellow or light brown, purple on the root buds, and white at the basal cut will be tender, fragrant, and tasty. On the other hand, a slender shoot with purple black skin, reddish root buds, and a dark coloured cut base will be tough and have little fragrance. Shoots that have grown above ground are very poor in quality. Preparing shoots for the table Shoots of certain types of bamboo contain amounts of cyanogens and may be toxic to cattle, but cooking destroys these substances and renders the shoots edible and even tasty. Boil freshly cut shoots in one or two changes of plain or lightly salted water before peeling with a sharp knife. Boiling (or steaming) softens the culm leaves covering the shoots and makes them

easier to peel. This pre-processing step should not be undertaken if the shoots are to be marketed fresh, as their keeping capacity is lowered drastically after cooking. It is usual to remove all the sheaths, but leave the tender ones near the tip if they are not too hairy. Cut off the woody basal section of the shoot and remove any discoloured parts. These indicate aged and bitter portions. Slice the shoot lengthwise into thin slices four or five millimetres thick, and carve the upper tender parts into decorative shapes if desired.

Prepared bamboo shoots form a useful ingredient in many ordinary dishes either with or without meat. After boiling for about 20 minutes and being drained they can also be served alone with butter melted over them. Add salt near the end of cooking. Use only the most tender parts of non-acrid shoots as a fresh salad ingredient.

How do you prepare bamboo to eat?

Suggestion A: In the spring, depending of the region, but in Japan usually April, bamboos start pushing the ground. As soon as you see the tip break the surface of the ground, you need to dig bamboo out from the ground. The variety called "Moso" is the best but any variety which has a large trunk diameter is good. Peal the skins off and boil it in white water (which you obtain when you polish rice) to take off the bitterness. The powder produced when a rice producer grinds rice is best, but this may be difficult to find in the U.S. In Japan, you can buy that powder in any supermarket. Then cook it with tuna and soy sauce, or with seaweed and soy sauce. You can cook Chinese dishes, like sweet and sour pork, with it too. If it's very fresh, you can just dip it in soy sauce and eat it. The canned bamboo is edible, but there is no aroma. It's just not the same as fresh.

The skin can be used for many things. In Japan, it is used for wrapping the meat at the meat market, or to wrap rice for lunch. Also, it can be used as a sheet spread under fish, when cooking the fish with very small amount of sauce, so the fish would not stick to the bottom of the pan. The soft tip part can be used to wrap around a pickled plum, which is then sucked. This is mostly children's snack.

Related web pages:

- See our Plant Pests page for information on how to eliminate bamboo.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Bamboos - by Christine Recht, Max F. Wetterwald, David Crampton (Editor), Walters - Publication Date: December 1992 - List: $32.95
  The publisher, Timber Press (www.timber-press.com) , 09/19/96: A complete illustrated reference to bamboos
  This book provides all the information gardeners need to successfully plant and grow bamboos, as well as an encyclopedia of species particularly suited for the garden, including dwarf, frost-resistant, and non-invasive varieties. Other fascinating topics are also covered, including bamboo's cultural influence in Asia, morphology, species characteristics, cultivars, and uses of the plant and its products, including a handful of recipes.

- The Bamboos (Linnean Society Symposium Series, No 19) - by G. P. Chapman (Editor), Linnean Society of London, Royal Botanic Gardens - Publication Date: April 1998 - List: $110.00

- The Bamboos - by F. A. McClure - Publication Date: November 1993 - List: $17.95
- "A Compendium of Chinese Bamboos". The experts from China have crafted a classic volume based on clear descriptions and excellent photos of mature bamboo species. Altogether, 39 genera and more than 500 species are included in this book. The morphological characteristics, geographical distribution and usage of every species is described fully and accurately. The book is 242 pages, 8.5" x 11", glossy paper and hardbound, 1994. The cost of this book including UPS delivery is approximately $96.00 US.

Periodicals:

- None identified.

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Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Selecting & Preparing Land for Grove

Most bamboos thrive in tropical to warm temperate climates, where the minimum Summer temperature does not fall below 15° C. Some shelter from strong winds is desirable. Running bamboo is easily blown over in high winds because of its relatively shallow roots and luxuriant growth. Clumping bamboo is less susceptible, but cold winds kill the tips of branches and leaves of all bamboos. This delays the emergence of shoots so a forest or hill as a windbreak facing the prevailing wind is desirable.

Land should be well drained. Soil moisture is important both for growth and to transport plant food. Excessive moisture is harmful and if the soil easily yields drops of water when squeezed in the hand, it is too wet for rhizome growth and will cause rot.

Very flat land, with impermeable soils which lead to water ponding, will need drainage, either mole drains or slotted polythene pipe in trenches back-filled with pea gravel and coarse sand. Level land is desirable but a hillside will serve if the slope is not more than about 7° or 8°; it should not be greater than 15°. The land should slope toward the northeast, north or northwest. The hillside provides natural drainage, the slope allows the sun to warm the soil, hastening the decomposition of mulches and organic fertiliser and promoting the growth of shoots in Spring.

Bamboo can be grown in most types of soil provided they are not rocky. The ideal soil is either marly soil or a loam. A sandy loam is fairly satisfactory for bamboo growth, but clayey loam produces the best quality shoots. Remove weeds and cultivate to a depth of about 45 cm. Although the rhizomes of running bamboos may go as deep as 1 to 1.25 metres, these rhizomes produce no harvestable shoots so it is a waste of labour and expense to cultivate deeper. Clumping bamboos send their roots to about 1 metre, but shoot much closer to the surface. Ground on which other crops have been grown previously needs no special pre-treatment except cultivation. Soil acidity must be corrected before planting is started. An application of 300 kg to 400 kg of lime per acre will neutralise acid soil, make otherwise insoluble nutritive elements available and hasten the decomposition of organic matter.

Establishing & Managing a Plantation

The best time to establish a new plantation is just prior to the rainy season or the growing period (which may not coincide), usually during Spring or early Summer. In Australia this falls between the months of August and November. A rotational system for planting new groves should be established to allow for eventual loss of vigour of older clumps. Some plantation areas will be going out of production as new areas are brought in. Rotating the planting of new plants with clear-felling of exhausted clumps also allows time for replenishment of the soil.

Spacing and Mulching

For most species a spacing of from 6m to 8m between clump centres is usual. A plot with poorer soils should be planted at 8 metre centres and richer soils at 6 metre intervals. This spacing allows an annual harvest of both shoots and timber.

Bamboo clumps used for shoot production need access to more sunlight than those destined to be cut for timber. Soil warmth is necessary for shoot development, (but exposure to light will ruin the mild taste of emerging new shoots). Production of sweet good quality shoots thus requires either an annual top dressing with rich soil or applications of suitable mulch mounded around the bases of the clumps where the new shoots will emerge. The aim of this practise is to allow soil warming but to exclude sunlight as much as possible from the young shoots until they are selected for cutting.

Propagation

Establishing a plantation using large plants or even big divisions is very expensive. Smaller plantlets are needed. Sadly there is no sure-fire method of rapid propagation applicable to all the clumping bamboos. Most plantations are established using divisions of mature clumps. Some research work is proceeding on tissue culturing bamboos, but results are a little inconclusive except from some laboratories in India. These institutions seem to have established a reliable method of producing bamboo plants from callous tissue derived from seeds or immature plantlets, but the procedure has only recently been applied to bamboo in Australia. Micro-propagation techniques using emerging branchlets from mature culms might prove the most successful and cheapest method to establish a plantation, but this technique too needs more research.

Current methods of vegetative propagation:

There are several methods of obtaining vegetative propagules. They depend on access to mature plants of the desired species from which various kinds of cuttings may be taken. These develop into new plants using the food reserves conserved in the parent material. Not all bamboos respond to these propagation methods. They seem to work best with thick-walled Bambusa and Dendrocalamus species and require high humidity and soil warmth for greatest success.

Layering whole culms:

Bend outer culms of a clump downwards after undercutting at the base and bury the culm in the soil after cutting off all but the main branches. After a few weeks, if soil temperatures are sufficiently high and moisture levels maintained, roots and shoots develop at the buried nodes. Saw off the culm sections bearing new plants and transplant these directly into the desired plantation area.

Whole culm cuttings:

Whole 18 month old culms may be severed from adult clumps and planted in a shallow trench. Leave the top of the culm and a few branches intact and allow them to protrude above the ground.

After some weeks, new roots and shoots develop at the nodes. Cut these from the parent culm and transplant them directly into the plantation site.

Double-node cuttings:

Make cuttings of culms with at least two internodes left intact. Trim branches from lower node. Plant prepared cuttings vertically in warm soil with the top of the culm and the branches left protruding. If using potting bags or pots, cover each with a clear or lightly frosted plastic bag tied in place after watering and leave in part shade until new roots protrude from drain holes. New roots and shoots are produced at the lower node. Single node cuttings planted on their side with the branch complement upwards will work with some species.

Branch cuttings:

Propagation using branch cuttings has proved successful in some cases. In Bangladesh, Melocanna bacciffera has been successfully propagated in this way. Cut the whole complement of side branches from a culm using a sharp hacksaw and plant in warm soil. Maintain atmospheric humidity using the system described for double node cuttings. New roots appear at the base of side branches within a few months.

Obtaining new plants using these methods can take up to one year. A few more years of growth are necessary before young plants are strong enough to produce new shoots suitable for cutting as vegetables.

Growing Bamboo

Compared to the cost of growing other vegetables or fruit, bamboo growing is relatively inexpensive. During the first two or three years of growth while the plantation is maturing and culms and shoots are too small to sell, growers can raise other crops in the grove to recover the starting capital. In Japan, where establishment costs may be less than Australia, farmers are able to recover their initial monetary investment after 8 or 9 years. In contrast to timber crops, no clearfelling is required to realise a profit after this time and the plantation continues.

Unlike most other agricultural crops, bamboos have been developed with little artificial selection. This means that, like most other grasses, bamboos are fairly resistant to diseases, insects, and climatic injuries. Consequently, growing bamboo for either timber or shoots (or both) requires much less labour than growing vegetables or fruit. Although it is desirable to have a large grove, many small scale growers can be successful, and reasonable profits can be made by saving the expense of hired labour.

Planting:

It is important that:

1. roots do not dry out in transit; drying may be avoided by placing them in the shade or covering them with straw or mats;
2. shaking does not injure the attachment between rhizome and culm;

3. the rhizome buds are not injured; and
4. the ball of earth remains unbroken.

Spacing:

The proper number of plants is about 400 per hectare. If the plants are planted in a grid, the spacing between them is about 5 metres.

Depth:

Replant at the same ground line as before. The part formerly above ground is usually green while the underground part is yellow. Place new plants so that the rhizomes run at right angles to the slope and are horizontal. This is the normal way that rhizomes grow.

Fertilizer:

Fertilizer is important during transplanting to increase the vigour of the rhizomes. It can be placed in the hole near the rhizomes. A shovel-full of well rotted stable manure, a handful of chemical fertilizer will give new plants a good start. After this initial treatment, follow the fertilizing guide given for clumping species in the previous section.

Back Filling:

Back fill the planting hole with top soil using a stick to push soil into any spaces left around the rhizomes. Next, step lightly on the ground around the culms. Sometimes water is applied to settle the soil around the rhizomes, but this may not be necessary with a plant which has the original soil bound by its roots.

Bamboo that have been stored for a long time after digging, plants whose roots have begun to dry out, those which have a small root ball or that are transplanted in a dry season should be planted into very wet soil. Fill the bottom of the hole with water, add soil and stir to make mud. Place the bamboo plant in the hole and add more water until the hole is filled. Top up the soil leaving a shallow pan to accept water.

Mulching:

All transplanted bamboos should be mulched with 15 to 20 cm depth of hay or straw to a diameter of about 2 metres. Spread soil on top of the hay or straw, covering it. This protects the ground from drying, controls soil temperature and checks the growth of weeds.

Increasing the Grove Area by Extension of the Rhizomes:

Bamboo rhizomes spread into well-watered and fertile or loamy soil. This characteristic can be used to expand the grove into adjacent plots.

Excavate to 45 cm depth in a belt about 60 cm wide next to the side of the plot which is selected for expansion of the grove. Place compost or stable manure in the trench. Refill with soil and cover with a mulch of hay or straw about 20 cm deep. Instead of using mulch it is possible to grow cover crops of lupins or vetches. The rhizomes spread about 2 m a year. Whether or not shoots have

emerged on a prepared area, keep on preparing successive adjacent belts each year immediately after the emergence of the shoots. Needless to say, only well nourished bamboos will extend their rhizomes rapidly, so it is quite important to properly fertilize the grove.

Grove Management:

After about 7 years an equilibrium is reached where the number of new culms left each year equals the number harvested. For example, suppose there are 120 culms in a grove, and culms are harvested when they are six years old. There will be 20 culms of each age from one to six years old. In Spring, 20 of the new shoots are allowed to grow into new culms. In Autumn the 20 six year old culms are harvested and the garden is back to its original 120 culms.

A highly fertilised grove produces large culms with many branches and leaves. Because of the widely spaced culms wind damage to the rhizomes at the base of the culms is likely. To avoid this damage the culms should be topped. Topping also allows more sunshine to reach the ground promoting early shoot emergence.

The best time to top is just after the lowest 2 or 3 branching nodes have extended their branches and the upper branches are still enclosed in the sheaths. Count 12 nodes up from the lowest branches, and cut off the culm above it. Always cut the culm cleanly. Breaking it will cause ragged splits and provide entry points for disease.

Cropping Culms to Thin:

As tropical bamboo species usually have a short rhizome neck structure they form clumps composed of close growing culms. Unless correctly managed by thinning regularly, clumps become so dense and congested that harvest of shoots and poles becomes almost impossible. Systematic and regular cutting can actually increase yields and leads to greater convenience in harvesting. Excessive cutting reduces yields and the clump is more susceptible to wind damage during storms.

When clumps mature and spread outwards, a modified 'keyhole' system for culling shoots and culms will allow greater access to the clump. Poles can be cut from the older and more mature inner part of the clump while shoots are harvested from the outer fringe. Rhizomes in the central portion of the clump contribute to the vigour of the whole clump. It is therefore inadvisable to completely remove this part for propagules without giving the plant an opportunity to establish new culms on the outer rim over a couple of growing seasons.

Shoot Production:

Culms emerge from the soil at their full mature diameter, shedding the cardboard-like sheaths as they elongate. Culm sheaths can be densely hairy,with two prominent "ears" and a distinctively shaped leaf at the apex. Culms are more or less cylindrical. The surface of the culm is smooth, usually green, and is often covered to some extent by either fine hairs or a waxy bloom. Generally, culms are stout with relatively thick or even solid walls. Nodes are ring-like and support a distinct

pattern of branches which is more or less consistent within a genus. Branching begins directly above each culm node and proceeds alternately on opposite sides of the culm. Branches in turn may support a number of smaller branchlets. Usually about ten or more lanceolate or narrow-lanceolate leaves emerge at the ends of the branchlets. Leaves vary greatly in size, some being quite large and useful as wrapping materials for small bundles of cooked rice or other foods.

Suitable Species:

Among the tropical bamboos grown for shoots are: Edible Bamboo, Bambusa edulis, grown in Taiwan and used for shoot production but also building and paper pulp. Beechy Bamboo, Bambusa beecheyana is eaten in southern China, but the shoots must be boiled in two changes of water. Burmese Bamboo, Bambusa burmanica, shoots are eaten in Thailand.

Spiny Bamboo, Bambusa spinosa is used in the Philippines. Research on the nutritive value of this bamboo revealed that it had the highest levels of calcium, protein and phosphorus of the group of bamboos tested. Common Bamboo, B. vulgaris, which is not actually so common in Australia and its ornamental relative B. vulgaris Vittata, [Syn B. striata], also produce edible shoots, but these are said by some to be inedible because of bitterness. Giant Hedge Bamboo, B. bambos, [Syn. B. arundinacea] is a large and thorny species which forms useful impenetrable hedges. It has edible shoots which are pickled in Thailand. Asper Bamboo, Dendrocalamus asper, is one of the most favoured bamboos grown for shoots (and export) in Thailand. Bambusa blumeana is a bamboo which dislikes its roots being disturbed when young, but in India and Indonesia it is used as a building material, in basketry and its shoots are processed for eating.

Many other species including: Bambusa longispiculata, B. nutans, Dendrocalamus asper, D. latiflorus, D. giganteus (sweet enough to be eaten raw), D. merrilliana, D. membranaceus, D. strictus, Gigantochloa albociliata G. atter, G. robusta, G. levis, and Thyrsostachys siamensis produce edible shoots.

Running Species Shoot Production:

Suitable Species:

There are many temperate running varieties which are suitable for shoot production. "Moso" as it is known in China and Japan, with several more or less synonymous Latin names (Phyllostachys heterocycla, P. pubescens and P. edulis) is the most commonly grown species for shoot production mainly because of the size of the shoots and consequent savings in labour that this characteristic gives per kilogram weight of harvested shoot. Other species with edible shoots include P. congesta, P. dulcis, P. elegans, P. nidularia, P. platyglossa, P. praecox and P. viridis. Square Bamboo, Chimonobambusa tetragonocalamus and a number of Pleioblastus and Sasa species also produce edible shoots, although the shoots from some of these are very slender.

Selection of Stock Plants:

Establishing a large plantation using nursery-grown potted plants could prove expensive. Although seedlings of some species are available occasionally the supply is erratic. Most plantations are established using small stock plants or divisions.

Rhizome cuttings:

Sections of vigorous rhizome about 30 cm long, taken from just behind the growing area can be either planted in nursery beds or directly into the plantation area parallel to the contour and watered in. These will produce new shoots from the viable buds and new rhizome in the next season. The ideal stock plant has one leafy culm with an attached rhizome fully capable of producing shoots. Select plants between 18 months and 2 years old. Plants over four years old are hopeless as stock plants as the buds on the rhizome will not shoot. It is not the growth of new culms above ground but the spreading of rhizomes underground that is the important consideration in the development of a strong and luxuriant grove. The most convenient size are those whose culms are between 2 and 4 cm in diameter.

Short culms are better than tall ones because they are less likely to be damaged by wind and require no support stakes, which saves labour and expense. Use young sun-hardy and vigorous culms having many branches.

Those with cracks or other injury at the junction of the culm and rhizome are worthless. Stock rhizomes should have at least five buds, for without buds shoots cannot grow. It is impossible to determine the presence of buds without digging into the ground; however, it is safe to assume that culms in their third year have live buds on their rhizomes.

Weeds:

Bamboo shoot gardens receive more sun than timber yielding groves because of the relatively wide separation of the culms. Sunlight encourages the growth of weeds which consume nutrients intended for the bamboo, shade the ground, lower soil temperature and thus retard shoot emergence.Weed using a hoe to scrape the ground surface except during the time just before shoots emerge; weeds should then be pulled up by hand. Weeds may also be controlled by growing another crop between the bamboos when the garden is new, but this should be discontinued once the garden is three years old.

Fertilizer:

Bamboo is a heavy feeder so even rich soil becomes depleted after a few years if no fertilizer is added. Although fertilizer may be applied at any time of year, it is usually done after shoot harvest and again in late Summer just before mulching. Since the rhizomes are continuously active except in the coldest part of the year, it is better to apply small amounts of fertilizer several times during the year rather than a large amount all at once.

Bamboo appreciates nitrogen and potassium which are found in compost, stable manure, green manure, and wood ashes as well as in the chemical regime suggested earlier. Lime is often used both as a fertiliser and as a neutraliser for acid soil. Hay, compost, green manure and straw can simply be spread on the ground. Stable manure, ash, calcium phosphate, potassium chloride, and similar materials should be buried in small pits to avoid being washed away by rain.

Mulching:

Mulching the shoot plantation with hay, straw or composted bagasse is most important. Depending on its composition, mulch furnishes various nutrients, checks weed growth and improves soil

condition. Mulch protects the shallow growing rhizomes both from Winter cold and Summer drought. Mulch should be spread during September in cool climates or during October in warm ones.

E**arly Treatment of Plants**:

Plants showing poor growth and slow development should be removed. For the first 2 or 3 years most new shoots are allowed to grow into culms. Only those that grow poorly or are too close to others are removed. Sometimes bamboo rhizomes produce slender stems that grow from old rhizomes. These should be pruned off since they take up nutrition that would otherwise go to good shoots. After five years a young grove on rich soil should have about 2000 mother culms per hectare. In this year the increase by selection of new mother culms is complete. Remove about 500 of the weakest culms per hectare. The spacing of the mother culms is important. Sometimes healthy culms must be removed if they are too crowded. In year six the original, oldest culms are removed. The remaining culms are thinned to obtain uniform spacing and density of 2000 culms per hectare. The proper spacing of mother culms depends on the soil. A rich soil allows wider spacing than poor soil. Climate is also a factor. Between 1500 and 2000 mother plants per hectare is desirable, fewer for rich soil and more for poor soil.

This density is maintained for the life of the plantation. Higher density produces too many overcrowded rhizomes which reduces shoot quality. Culms are cut after they reach 7 years so that only about 500 shoots per hectare are allowed to grow into new culms each year. It is best to select these shoots from those that sprout early in the mid season of shoot production. Each must be carefully marked with the year of its emergence so that there will be no uncertainty at cutting time.

Characteristics of Running Species:

Culms arise from long underground rhizomes. These spread in sinuous courses about 30 cm deep reaching maximum depths of 1 to 1.25 m. New shoots begin to emerge in September, with peak production normally in October. Culm sheaths are papery in texture and can be densely hairy and spotted. They bear bristles at the apex. Sheath blades are usually long and slender. The sheaths gradually fall as the culms grow. Culms are more or less cylindrical in their lower section but in the upper parts each internode has a broad groove on the side from which the branches emerge. The surface of the culm is smooth, green, yellowish green or yellow, and the internodes are relatively short. Nodes are ring-like. When young, culms are often covered with fine hairs and beneath each node is a band of white waxy powder. Generally, culms are stout with relatively thick walls. Usually two, but sometimes one or three, semi-cylindrical branches having prominent nodes occur directly above each upper culm node and grow alternately on opposite sides of the culm. Two to 8 lanceolate or narrow-lanceolate leaves emerge at the ends of the branchlets.

Shoot Yields:

The annual yield of a bamboo clump depends on the number of new culms produced each year. This in turn is related to the production of young leaves. Culms become mature after two or three years. Prior to this stage, young culms contribute greatly to the health of the clump through photosynthesis in their new leaves. The foods they synthesize are partly consumed by leaves but the greater proportion is transported to the rhizomes. Here it is stored as energy which is converted

into next year's growth of new shoots. If all the potential young culms (shoots) are cut from a clump through several annual cycles, the clump loses vigour as the rootstock becomes depleted of nutrients. This is why to maximise shoot output some shoots must be left each year to develop into leafy young culms. Large yields are produced in alternate years and so it advantageous for the intending farmer to have plantations of varying ages if a consistent supply of fresh shoots is required. Clearly it is a marketing advantage to have a number of plantations producing in sequence.

Fallen bamboo leaves mulch the soil surface. This layer of litter, along with the leaves still attached to the plant, protect soils from erosion during storms. Growers must realise that this covering can also prevent penetration of chemical fertilizers and water into the root area around the clump. Set up a regular schedule of checking the soil surface around each clump by raking away a portion of the leaf litter and mulch to ensure the correct levels of soil moisture are being maintained. Where water repellent and "waxy' soils occur it may be necessary to apply soluble fertilizers along with a wetting agent. This procedure will ensure that the root mass receives the benefit of watering and fertilizer application and that these nutrients do not simply run away from the clump.

Fertilizing:

Manuring or fertilizing should be undertaken regularly. Little and often is more productive than occasional heavy fertilization. Fertilizers are used to promote the artificial regeneration of the bamboo especially when clumps are used for shoot production. The main nutrients needed include nitrogen, potassium and phosphorous. These should be applied at least one month prior to the shoot production period.

Fertilizer regime which may be used as a guide when establishing a plantation is as follows:

- Preplanting Potato E 3kg/10m² Muriate of Potash 150g/10m² Urea 200g/10m² Maintenance Monthly applications of Urea at 100g/10m² during the active growth period.
- A slow release fertilizer consisting mainly of Potassium silicate has been claimed as beneficial to bamboos cropped for shoots. Trials to gauge effectiveness of this fertilizer have yet to be conducted in Australia. Similarly, Calcium silicate (cement) has been recommended as a suitable fertilizer to produce strong culms by increasing the cell-building silica the plants need, but this compound is expensive to use as a fertilizer.

Diseases of Emerging Clums:

Bamboos, a major non-timber woody resource, occupy about 10.3 million hectares of forest lands in India. Of the 128 species of bamboos occurring in the country, only a certain bamboo species such as Bambusa bambos, B. nutans, Dendrocalamus strictus, D. hamiltonii have been planted on a large-scale in many States. Improper management, unscientific harvesting and over-exploitation have resulted in depletion of the bamboo resources in many areas. Apart from biotic interference, various diseases affecting the culms have also dwindled the stand productivity.

In natural stands and plantations, bamboo culms are affected with various diseases at their

different growth phases which result in partial to complete failure in culm production. Rot of emerging and growing culms respectively caused by Fusarium moniliforme var. intermedium and F. equiseti, culm blight by Sarocladium oryzae, witches' broom by Balansia linearis and little leaf by mycoplasma-like organisms are the potential culm diseases recorded on bamboos.

Rot of emerging culms caused by F. moniliforme is the most widespread and economically important disease which affects about 23 species of bamboos in Kerala State. Among these, B. bambos, D. strictus, D. longispathus are the severely affected species. Very high incidence and mortality were recorded in emerging culms of 15 to 30 cm height; disease incidence varied from 14.5 to 33.7% in natural stands, while it ranged from 5.5 to 25.5% in plantations during 1987-91.

Rust Fungus:

Green bamboo (Bambusa oldhami Munro) and Ma bamboo (Dendrocalamus latiflorus Munro), cultured over an area from low elevation to 500 m in Nan-Tou, Yun-Lin, Chiayi, Tainan, Kaohsiung, and Pingtong counties in Taiwan, are important economic bamboo species for producing good quality bamboo shoot and pulp materials. However, the rust fungus, Dasturella divina, has spread over bamboo plantations, and caused serious damage to bamboo leaves. In this study, rust distribution was surveyed. Its morphology was observed with scanning electron microscope. Energy-dispersive X-ray microanalysis was applied to detect the element distribution in tissues of bamboo leaves. The rate of photosynthesis was measured with portable photosynthesis system.

The results revealed that in summer and fall lots of uredinia appear on lower leaf surface, and subsequently produce plenty of urediniospores. The rust is distributed throughout the island. Results from X-ray microanalysis showed that content of silicon and potassium was respectively higher and lower in tissues of diseased leaves in comparison to healthy ones. In November and December 1994, the average photosynthesis rates of healthy leaves of green bamboo and Ma bamboo were 18.35 mmole CO2 m-2 s-1, and 19.61 µmole CO2 m-2 s-1 respectively. However, in November and December 1994, the average photosynthesis rates of diseased leaves of green bamboo and Ma bamboo were 2.60 µmole CO2 m-2 s-1, and 1.94 µmole CO2 m-2 s-1 respectively.

These results demonstrated that Dasturella divina destroyed tissues of bamboo leaves, changed the distribution of elements in leaf tissues, and thus seriously decreased the rates of photosynthesis.

Pests Affecting Bamboo:

Leaf-biting and sucking insects including aphis cause minor damage to ornamental bamboos and may be a problem in shoot plantations especially when bamboos are small. Adult plants do not seem overly bothered by such pests. Systemic insecticides and predatory species offer a measure of control. Scale insects can be troublesome to some plants. They usually haunt culms and branches sheltered by adhering culm or leaf sheaths.

Shoot Harvesting:

Shoots of clumping bamboos grow vigorously beneath the soil surface, finally breaking through into the light. At this stage they often pause in their growth. The reason for this is not known. However, exposure to sunlight causes the production of chemicals that are bitter and hastens shoot elongation by stimulating the development of a very woody base. Consequently, shoots should be dug when the tips are just emerging from the surface of the soil or very soon after that stage. A tell-tale bulge or cracks in the soil usually reveal the new shoot's location.

As new shoots arise from rhizomes which more-or-less radiate outwards from the clump they can be harvested without wholesale disturbance of the surrounding soil. Digging should proceed with care so that shoots are not bruised. Remove the soil from around the base of the emerging shoot, exposing the lower part of the rhizome neck. Carefully sever the last third of the shoot with a narrow hoe, machete or sharpened narrow-bladed spade. Slope the cut away from the narrow woody neck that connects the new culm with an older one. If the necks remaining in the soil have viable buds, some will produce a shoot in following seasons.

Preparing shoots for use as a Vegetable:

A shoot that is fairly stout, light yellow or light brown, purple on the root buds, and white at the basal cut will be tender, fragrant, and tasty. On the other hand, a slender shoot with purple black skin, reddish root buds, and a dark coloured cut base will be tough and have little fragrance. Shoots that have grown above ground are very poor in quality. Preparing shoots for the table Shoots of certain types of bamboo contain amounts of cyanogens and may be toxic to cattle, but cooking destroys these substances and renders the shoots edible and even tasty. Boil freshly cut shoots in one or two changes of plain or lightly salted water before peeling with a sharp knife. Boiling (or steaming) softens the culm leaves covering the shoots and makes them easier to peel. This pre-processing step should not be undertaken if the shoots are to be marketed fresh, as their keeping capacity is lowered drastically after cooking. It is usual to remove all the sheaths, but leave the tender ones near the tip if they are not too hairy. Cut off the woody basal section of the shoot and remove any discoloured parts. These indicate aged and bitter portions. Slice the shoot lengthwise into thin slices four or five millimetres thick, and carve the upper tender parts into decorative shapes if desired.

Prepared bamboo shoots form a useful ingredient in many ordinary dishes either with or without meat. After boiling for about 20 minutes and being drained they can also be served alone with butter melted over them. Add salt near the end of cooking. Use only the most tender parts of non-acrid shoots as a fresh salad ingredient.

How do you prepare bamboo to eat?

Suggestion A: In the spring, depending of the region, but in Japan usually April, bamboos start pushing the ground. As soon as you see the tip break the surface of the ground, you need to dig bamboo out from the ground. The variety called "Moso" is the best but any variety which has a large trunk diameter is good. Peal the skins off and boil it in white water (which you obtain when you polish rice) to take off the bitterness. The powder produced when a rice producer grinds rice is best, but this may be difficult to find in the U.S. In Japan, you can buy that powder in any supermarket. Then cook it with tuna and soy sauce, or with seaweed and soy sauce. You can cook

Chinese dishes, like sweet and sour pork, with it too. If it's very fresh, you can just dip it in soy sauce and eat it. The canned bamboo is edible, but there is no aroma. It's just not the same as fresh.

The skin can be used for many things. In Japan, it is used for wrapping the meat at the meat market, or to wrap rice for lunch. Also, it can be used as a sheet spread under fish, when cooking the fish with very small amount of sauce, so the fish would not stick to the bottom of the pan. The soft tip part can be used to wrap around a pickled plum, which is then sucked. This is mostly children's snack.

Related web pages:

- See our Plant Pests page for information on how to eliminate bamboo.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Bamboos - by Christine Recht, Max F. Wetterwald, David Crampton (Editor), Walters - Publication Date: December 1992 - List: $32.95
  The publisher, Timber Press (www.timber-press.com) , 09/19/96:
  A complete illustrated reference to bamboos
  This book provides all the information gardeners need to successfully plant and grow bamboos, as well as an encyclopedia of species particularly suited for the garden, including dwarf, frost-resistant, and non-invasive varieties. Other fascinating topics are also covered, including bamboo's cultural influence in Asia, morphology, species characteristics, cultivars, and uses of the plant and its products, including a handful of recipes.

- The Bamboos (Linnean Society Symposium Series, No 19) - by G. P. Chapman (Editor), Linnean Society of London, Royal Botanic Gardens - Publication Date: April 1998 - List: $110.00

- The Bamboos - by F. A. McClure - Publication Date: November 1993 - List: $17.95
- "A Compendium of Chinese Bamboos". The experts from China have crafted a classic volume based on clear descriptions and excellent photos of mature bamboo species. Altogether, 39 genera and more than 500 species are included in this book. The morphological characteristics, geographical distribution and usage of every species is described fully and accurately. The book is 242 pages, 8.5" x 11", glossy paper and hardbound, 1994. The cost of this book including UPS delivery is approximately $96.00 US.

Periodicals:

- None identified.

This page was last updated on August 02, 2002

Plant Pests

Frequently Asked Questions Other Information Sources Return to Pest Contents

Frequently Asked Questions:

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Warning:

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How can I get rid of bamboo?

- **Suggestion A:** I used Roundup, however using it in greater concentrations isn't the answer. Patience and persistence is. Roundup is absorbed by the leaves and is transported to the roots where it does its job. Anything you can do to facilitate this process will help. Apply the roundup during periods of intense growth such as the spring and make sure you reapply after a rainstorm. Remember to wear protective clothing and wear a face mask. I also added a spreader sticker to make it stick better but call Monsanto to find out the best treatment. Roundup will work but it will take all summer. Please don't use soil sterilizers as they can pollute your water table and prevent plant growth sometimes for years.
- **Suggestion B:** I have removed bamboo from my yard in Alabama by frequent (every two weeks) mowing. I cut the dead material back with a machete and mowed it with a rotary lawn mower. It did not come back.
- **Suggestion C:** Try using Roundup, but only in growth stage. Mix in a handful of ammonia nitrate, or any good plant food.

How can I get rid of blackberries?

- **Suggestion A:** Blackberries are extremely hard to get rid of. Mowing several times will help, however if your land is rather rough and since blackberries tend to love growing around large obstacles, this might be hard to do. In the past, I have run cattle. My land is becoming blackberry, scrub oak, and hickory infested and I don't care to use chemicals when I can avoid it. I have changed my operation over to goats. They will only eat grass when no woody foliage is available. They love blackberries and

all the other "trash" plants. As a side benefit, their manure and urine is excellent fertilizer. With the influx of ethnic groups into the U.S. there has been a very good market developing for meat goats and so you should have no trouble marketing them.

- **Suggestion B:** Run a bush-hog over them frequently. They will eventually die off.

How can I get rid of kudzu?

- **Suggestion A:** Kudzu does not tolerate grazing very well. Nip the apical meristem off early in the year and it will die quick enough. If you have not noticed, kudzu is not found in grazed pastures, but it is found in the relatively opened, ungrazed areas around humanity. Also, a number of herbicides, will kill kudzu.
- **Suggestion B:** If you want to use land for pasture, just let them eat Kudzu. Kudzu was introduced into this country in the 1930's as pasture fodder crop and soil stabilizer by either USDA or Soil Conservation Service. Twenty acres of kudzu will nicely feed 10-20 cows. Kudzu only becomes a problem when it is not grazed. Overgrazing will kill kudzu. Kudzu is high protein legume. It fixes nitrogen and actually improves soil. Roots can be dug and boiled and eaten like potatoes.

How can I get rid of poison ivy/oak/sumac?

- **Suggestion A:** Goats are the best thing for controlling poison oak or ivy. My tribe loves to eat it. I am very sensitive to poison oak and ivy, having more than once needed cortisone shots to control my reaction. I have found that drinking the milk of the goats browsing on poison oak and ivy seems to severely lessen and mostly eliminate any reaction from the plant. When we are not drinking the milk (the 2 months everyone is dry) I get the rashes (we are surrounded by the plant wherever the goats don't browse). Watch out for the garden and fruit trees, the goats will eat that first. The oils don't affect the goats at all. they really like to eat the leaves. They will also eat stinging nettles and the big thistle leaves I can't even grab with gloves on. Goat lips are amazing things

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Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- **NIPMN-L: National Integrated Pest Management Network**

  Subscription address: listproc@cornell.edu

  Topics:

  Subscribe to NIPMN-L. Type "subscribe NIPMN-L Your Name" in the message&127 body. (Not supported by all browsers.)
- **PANUPS: Pesticide Action Network; North American Update Service**

  Subscription address: majordomo@igc.apc.org

  Subscribe to PANUPS. Type "subscribe PANUPS Your Name" in the message body. (Not supported by all browsers.)

Suggested references:

- None identified.

Periodicals:

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introduced into this country in the 1930's as pasture fodder crop and soil stabilizer by either USDA or Soil Conservation Service. Twenty acres of kudzu will nicely feed 10-20 cows. Kudzu only becomes a problem when it is not grazed. Overgrazing will kill kudzu. Kudzu is high protein legume. It fixes nitrogen and actually improves soil. Roots can be dug and boiled and eaten like potatoes.

How can I get rid of poison ivy/oak/sumac?

- **Suggestion A:** Goats are the best thing for controlling poison oak or ivy. My tribe loves to eat it. I am very sensitive to poison oak and ivy, having more than once needed cortisone shots to control my reaction. I have found that drinking the milk of the goats browsing on poison oak and ivy seems to severely lessen and mostly eliminate any reaction from the plant. When we are not drinking the milk (the 2 months everyone is dry) I get the rashes (we are surrounded by the plant wherever the goats don't browse). Watch out for the garden and fruit trees, the goats will eat that first. The oils don't affect the goats at all. they really like to eat the leaves. They will also eat stinging nettles and the big thistle leaves I can't even grab with gloves on. Goat lips are amazing things

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Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- **NIPMN-L: National Integrated Pest Management Network**

  Subscription address: listproc@cornell.edu

  Topics:

  Subscribe to NIPMN-L. Type "subscribe NIPMN-L Your Name" in the message&127 body. (Not supported by all browsers.)
- **PANUPS: Pesticide Action Network; North American Update Service**

  Subscription address: majordomo@igc.apc.org

  Subscribe to PANUPS. Type "subscribe PANUPS Your Name" in the message body. (Not supported by all browsers.)

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on August 02, 2002

Pest Contents

Return to the Small Farm Resource

If you have a question, we will post the question in the appropriate contents page to get suggestions from our site visitors.

Questions and suggestions can be sent to us via our Feedback form.

Visitor Questions:

One of our web site visitors has 5 acres with over 100 gophers. The gophers are interferring with their flood irrigation. Does anyone have any suggestions on how to get rid of them?

Animal Pests

Frequently Asked Questions Other Information Sources Return to Pest Contents

Frequently Asked Questions:

Other Information Sources:

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How can I keep bears out of my garden?

- **Suggestion A:** Electric fences or wires are used through out the forests to keep bears from garbage bins. Zoos use them extensively also to keep bears and other animals from fighting. The pain will turn all but the most hungry bear away. Bear fences are a standard practice in some areas of Northern Alberta. I seem to remember 3 strands of smooth wire. It is usual to hang cans of sardines (punctured with a nail in several spots) on each side so the bear won't accidentally wander through it in the night and not notice it. Fur sometimes insulates. With the sardines, the bear touches the fence with his nose and is sure to want to leave. From then on he is 'fence trained'.

How can I get rid of beavers?

- **Suggestion A:** I would suggest trapping them using Conibear 330 traps. Check your local laws and be very careful with these traps. They can break arms. The pelts are almost worthless (maybe $2), but beaver itself is supposed to taste good, so eating them is an option. While butchering the beaver, be careful not to cut the castor gland, or you'll have to toss the whole animal away.
- **Suggestion B:** Live trap and relocate the beavers. The problem with this is that they often become someone else's problem. Again, check your local laws and game authority. You may find that there are places looking to add beavers for ecological restoration.

How can I keep birds from roosting in my barn?

- **Suggestion A:** Hang silver mylar streamers down from the

gutters. The noise or reflections seems to scare them off.

- **Suggestion B:** Try a product called "Hot Foot". Supposedly, it irritates their feet, and it's very sticky stuff so they don't like to land in it. It lasts for ages too. It's made in Australia. The active ingredient is Polybutene.

How can I keep deer away from my plants?

- **Suggestion A:** Down here in south Georgia, lots of people seem to have great success warding off deer with human hair. Get some from your barbershop and spread it around whatever you want the deer to avoid. Cheap, non-lethal, and a good source of nitrogen for next year's gardens.
- **Suggestion B:** I am an organic grower also and will be fencing 2-3 acres of my six. An electric fence is all you will need to keep them completely out of your garden. You will need to use the right equipment and install it properly.

  Specs:

  1. 8' galvanized, painted T-posts with plastic screw-on insulators.
  2. The hottest charger you can get - New Zealand types are best but pricey, may be overkill anyway - American-made brands will probably be adequate (International is a good brand).
  3. 1-3 8' copper-clad ground rods driven into ground under charger. Use heavy copper wire (10 gauge minimum) to connect charger to them Best not to install your charger near your electric service - lightning strikes are more likely to take your charger out in that situation (I've lost 2 that way). Connect hot lead to fence with 10 gauge copper wire using a brass clamp.
  4. 14-gauge galvanized steel wire - minimum; don't use aluminum (no matter what advice you get to the contrary) and don't use lighter than 14 gauge. Use 12 1/2 gauge hi-tensile 200 lb.-test wire for the lines they are likeliest to run into, 14 gauge is OK for the rest.
  5. Space the lines 16" to 28" apart from the ground up - the first 4 lines are critical, the remaining uppermost ones can be spaced further apart - you absolutely don't want them going between the wires.
  6. Turn the fence charger off as infrequently as possible.
  7. Initially, bait the fence with peanut butter and corn in aluminum foil boats hung from the middle wire (about 3'

from ground).

They quickly catch on and avoid the fence. Their feeding pattern gets disrupted and they move to other areas. They always know when the fence is on and will avoid it - they usually won't come closer than 30-40 '. This will absolutely keep them out of your garden. Nothing less will work and no more is necessary.

- **Suggestion C:** This is my first year managing a vineyard, and I have noticed there are several options:
    1. Shoot "bird bombs"--firecrackers that are both explosive and "whistling"
    2. High fences
    3. Propane cannons that sound as if a war is going on
    4. Use a product called 'Hinder'in conjunction with blood meal around vineyard
    5. Use bird netting over your vines...maybe that'll slow them down.
- **Suggestion D:** Another way to keep deer away from plants and trees is to cut up cheap deodorant soap into about 4 pieces and place one piece into a net or nylon bag (pantyhose work) and tie the bag to the tree or on a stake near the plant. This works for about a one yard radius around the tree or plant.
- **Suggestion E:** A deer repellent recipe:
  3 raw eggs
  3 tbls.of red hot sauce
  3 tbls. of garlic juice or minced
  add enough water to a blender to process and mix well.add this a gallon of water and spray on plants. You can make the spray last longer by adding Wilt-Proof to it.

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- **Suggestion A:** Well, my personal choice is "tank and blast". I have a 400 gallon water tank on a trailer which has a 2 1/2" hose out the bottom. I stick the hose down a reasonable hole and "fill 'em up". The little "orchard rats" have a choice of either drowning or running and they generally wind up running. For the runners I like to use shot shells in 38 revolvers. They are good for about 30 feet with very small risk to friends the neighbors. We wound up loading our own with #7 shot as the commercial shells are quite expensive, not reloadable and not as effective as the hand loads. I used to have a bounty on the "rats" but after I started tanking I have to limit the number of "helpers" I have on any given day. And for safety reasons I'm quite picky about who I take out with me and avoid those who suffer from "buck fever".

We've been doing this for over ten years now and the worst injury was a sprained ankle from tripping on a burrow while chasing down a rat.

How can I keep mice from getting in my house?

- **Suggestion A:** Put aquarium gravel in the spots where the mice are digging to get in the house. The hole collapses as the mice dig through the gravel, killing them. The depth of the gravel needs to be about 4 to 6 inches. If you have a large area to cover, you can try pea gravel from your local landscaping company. This is a much less expensive alternative.

How can I get rid of moles?

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- **Suggestion B:** Plant daffodil bulbs. There is something about daffodil bulbs that moles don't like.
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How can I get rid of the skunks or raccoons living under my (house, porch, barn)?

- **Suggestion A:** Put mothballs under the house. Supposedly, it irritates the heck out of their eyes. After the skunks/raccoons leave, seal up the sides to keep them from moving in again. [ed. *note: several replies have indicated success with this method*]
- **Suggestion B:** Get a small peanut can. Fill it 1/3 full of flowers of sulfur. Light it. Put it under the house. The skunks/raccoons will leave, and the sulfur smell will dissipate fairly quickly. Then seal up the sides to keep them from moving in again.

Related web pages:

- None identified.

Commercial suppliers:

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Electronic mailing lists:

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Suggested references:

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- None identified.

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Commercial suppliers:

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Electronic mailing lists:

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Suggested references:

- None identified.

Periodicals:

- None identified.

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Insect Pests

Frequently Asked Questions Other Information Sources Return to Pest Contents

Frequently Asked Questions:

Other Information Sources:

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How can I get rid of ants?

- **Suggestion A:** The safest pesticide I know is diatomaceous earth. You can put one tea spoon of it on an ant hill and eliminate the entire population in 30 minutes [ed. note: people have noted it can take up to a couple of weeks, depending on variety of ant]. It is harmless to humans and animals. Diatomaceous earth is comprised of tiny microscopic sea animals which are the sharpest smallest creatures known to man. They cut the outer membranes of the parasites body and cause them to bleed to death. It is not harmful to the stomach as I have used this for 6 years now on my goats for internal (worms) and external (lice and ticks) parasites with no ill effects. You can purchase this stuff in most health food stores or nurseries. Don't buy the pool filter variety as it has rounded off edges, plus it typically contains heavy metals. The food store variety is for human consumption. I buy it by the 50 pound bag for $15 per bag.
- **Suggestion B:** For getting rid of ants in your house, there is an insecticide called "Demon". It worked perfectly the first time on my carpenter ants and every other kind of bug for that matter. I strongly recommend it to anyone that asks and I've had nothing but thanks back. Just use it according to directions. I was able to get to the area where they were doing the most damage and sprayed directly on that wood. Any insect that crosses the powder is killed (not instantly) and it seems to send out a "signal" that keeps them away after a while.
- **Suggestion C:** I had a problem with some... I bought some of the various cans of ant poison/bait and placed them where the little buggers could haul it all back to momma - the queen ant. Took about a month before all of the existing workers died out. Three years later, they have not been back.
- **Suggestion D:** They are attracted to 'moist wood'... get rid of that

and they tend to go somewhere else. A good 'homemade' poison is a mixture of confectionery (powdered) sugar and borax (or boric acid?) in equal parts, with enough water to make a paste. Leave it in their trail and they will take it back to the nest. The nest will die off. This system worked for me, I haven't seen any since (three years). I did leave the 'poison' mixture out in the various spots the ants would frequent. (BTW this works for common 'kitchen' type ants too, although keeping the crumbs cleaned up works and is probably more ecologically fair.)

- **Suggestion E:** I sprayed with some harsh chemicals and used diazanon granules around the exterior. I know, it ain't politically correct, but it is even less correct for my house to fall down. So. It worked, although the diazanon has to be reapplied occasionally.
- **Suggestion F:** I would recommend spending the time to follow the buggers and locate the nest. This will take several hours over a couple, three days. Once you find the nest hit it with Durban (called OrthoChlor by Ortho Inc. {I have no connection with Ortho}) at the highest concentration allowed on the label. This stuff will kill for 30 days minimum and much longer when soaked into a stump or fence post. Then I would spray the trail and around the outside of the house with Diazanon. Diazanon will kill for 7 days minimum and does not last as long in the environment.
- **Suggestion G:** Plant mint around your house. The ants don't like it. The only problem with this is that mint grows like a weed. It will quickly take over where you plant it.

How can I get rid of Bumblebees?

Bumble bees usually nest in the ground in a deserted mouse nest or bird nest. Occasionally they nest in cavities within a wall or even in the clothes drier vent**.**

- **Suggestion A:** If the vicinity of a bumble bee nest can be avoided, then leaving them alone and waiting for them to die in the fall would be the preferred "management" option. Trapping bumble bees is not practical and exclusion techniques may not solve the problem. When controlling bumble bees is necessary, using insecticides to poison bee colonies is the control method of choice. Bumble bees, honey bees and yellowjackets are all controlled the same way. After determining the nest location and nest entrance during the day, wait until night to treat if possible. Wear long-sleeved shirt and trousers and tie sleeves and pants legs shut or pull your socks out over your pant cuffs. Apply insecticide through the entrance hole. Dust formulations of insecticides are preferred (e.g., Sevin dust). Use a duster or

"fling" insecticide into the hole off an old plastic spoon. Sprays and ready-to-use "wasp and hornet" aerosol sprays can also be used, but often with less satisfactory results. Do not plug the entrance hole until all activity has stopped. Be prepared to repeat the treatment if necessary. Finally, seal shut, caulk and paint all openings in the vicinity of the old entrance.

How can I get rid of flies?

- **Suggestion A:** Suspend clear bags, filled with water, with a strip of aluminum foil suspended inside. Apparently, the flies are startled by the reflection and leave.
- **Suggestion B:** Providing (1) that you've lost your beneficial predator insects; or (2) that the fly population is more intense than expected, get out the Food Grade Diatomaceous Earth!!! Mix it as a 1 percent wettable powder and hose out the area, spraying walls, ceilings, roofs, the nearby trees... well, at least get carried away in the area that the flies are bothering you. (Wear eye protection and the proper respirator when spraying wettable powders). The DE will act to repulse the flies and the residue will be as if you had applied a fine dusting by hand. (DE strips an insects' protective layer of surface oil from the exoskeleton, which is why it is so effective on Ants, discussed elsewhere in this page. With the oil gone, the insect quickly dehydrates and dies). Retreat in 5 days only if your beneficial/predator insects and birds have not been able to take control of the fly population. Several treatments may be needed if there was adequate food sources for the last season of flies to get crazy while mating and laying eggs. Move livestock and domestic animals out of the area during spraying or dusting with DE.
- **Suggestion C:** "Attic" flies are the large, black, pesky flies that show up in bed rooms and on window sills from late fall through early spring. These flies are known as cluster flies, a name that describes their habit of clustering in large numbers inside attics. Cluster flies do not reproduce indoors, and home owners bothered by these pests do not need to fear the flies are 'hatching' from a dead animal or other unpleasant material within the attic or walls. Cluster flies develop as parasites inside the bodies of earthworms. There are three generations of flies produced each summer, and the final generation of the season migrates to houses and other buildings during mid to late September. Houses located on an exposed hill top or high ground are most attractive to these migrating flies. The flies cluster on the warm sides of buildings in late summer during the day. When the sun goes down and the temperatures cool, these flies crawl into the building through cracks under the eaves and around windows or through gaps in

the siding. Once inside and secured in a protected location, they remain in hibernation until warmed by heat from the furnace or the sun. As the flies warm throughout the winter, and especially in the early spring, they come out of their cold temperature dormancy and begin sluggishly moving around. Their random crawling brings them into the house by way of electrical outlets, window pulley holes, and small openings around windows, moldings and base boards. Cluster flies are difficult to control in homes because they hibernate within inaccessible places. Because they hide inside walls or under insulation, they are usually not vulnerable to treatment until they appear within the living space of the house. Preventing attic flies is a job for the summer and fall. As much as possible, seal cracks and openings around the outside of the house, especially under the eaves, as you would for energy conservation. Insecticides can be used on the outside of the house in mid-September if you have a persistent problem with attic flies. The problem varies greatly from year to year and is worse after a wet summer. The outdoor treatment with residual insecticides such as garden sprays labeled for exterior house treatment, or cattle barn fly sprays is difficult and potentially messy. There is little that can be done for flies already inside the attic and walls. Space sprays and fogs into the attic have little if any affect, as the flies are usually under insulation or deep in cracks and crevices. They do not fly around much in attics. Therefore, fly paper, fly strips and bug zappers are of no value. Flies buzzing within a room can be dispatched with a fly swatter, a short burst from a household insecticide aerosol sprayer or the hand vacuum or shop-vac.

How can I get rid of ground hornets?

- **Suggestion A:** In the evening, when it's cool, place a clear glass bowl over the nest entrance for a few days. The ground hornets will keep flying against the bowl to go get food. When they can't, they will eventually starve to death.

How can I repel or eliminate mosquitoes?

- **Suggestion A:** Eliminate places where they can breed. They don't need a whole pond to breed. Even the tiniest amount of still water makes them happy, such as water collected in an old tire, or the top of a hollow stump.
- **Suggestion B:** Citronella supposedly repels them, but the "mosquito plants" sold for big bucks (citronella-scented geraniums or other plants) seem to be a rip-off. Citronella candles

may help, too.

- **Suggestion C:** How about frogs, and toads, and other little amphibious people. Or, how about dragon flies? Dragonflies are huge mosquito eaters. The object I think is not to subtract from the web, because it only perturbs the balance to try and eliminate factors from the system rather than balance the system more by integrating other life forms that have more beneficial affects. It is philosophically hard to try and argue for a reduction or addition as far as integrated pest management, but in general, balance through predator/prey relationships is better than eliminating the resources of the pest, or merely deterring the pest with sustainable methods.

What can be done about Whiteflies?

- **Suggestion A:** Whiteflies cause more than $200 million worth of damage each year to U.S. crops including greenhouse ornamentals, such as poinsettias, and most melons and vegetables. Other plants -- such as the Nicotiana family (which includes the commercial tobacco plant), and wild tomato and potato species -- have a natural protection against whiteflies and other pests. Their defense is based on a group of chemicals known as sugar esters. Unfortunately, the amount of these sugars available in plants is very small, so plants aren't practical sources of commercial quantities of insecticides, according to Dr. Orestes Chortyk, acting research leader in the Natural Products Utilization Research Unit at the U.S. Department of Agriculture in Athens, Ga. So he and his colleagues turned to the lab to make a series of environmentally friendly synthetic sugar esters similar in structure to the natural pesticides. They proved to be highly toxic to whiteflies and also may be useful in the battle against other soft-bodied arthropods. A patent application has been filed for these uses, three companies have committed funding for further research, and field testing by more than a dozen cooperators is underway.

How can I repel or eliminate yellow jackets?

Yellow jackets (Vespula spp. - colonial wasps), can pose a severe problem for people when these wasps aggressively seek food. (Remember, though, yellow jackets do pollinate plants, such as squash, and dispose of waste matter and thus are not all bad). Early in the season meat is preferred; later they focus more on sweets. Normally, they are an annual species, with colonies started in the spring of each year by a single mated and over-wintered queen. As the season progresses, nest sizes grow and can contain thousands of individuals by

late summer or fall. In mild climates colonies can even over-winter.

Effective control measures vary according to the circumstances:

- At eating areas in a backyard, wasps can be kept under control by diligent use of traps (next section). Public picnic areas, however, have wasps already locked into the readily available food supply (messy previous picnickers). Bring along a fly swatter and eliminate the early arrivals - other wasps are then not recruited. Fortunately, individuals of many yellow jacket species are not aggressive when not near their nest. Wasps do not hesitate to go into soft drink cans or bottles, posing a problem for anyone not paying sufficient attention to their activities before taking another swallow. Neither do they hesitate to ride along on a meat sandwich as it is put into one's mouth. Watch out, also, for wasps attracted to meat covered hands, fingers, or utensils. If one places an effective trap (next section) 20-30 feet upwind from the picnic table, the foraging wasps, when shooed away by picnickers, continue to go upwind past the picnic table and end up in the trap.
- Traps: Remote treatment yellow jacket bait traps have been used for more than a century, with one basic characteristic in design: Wasps will fly into a funnel (sometimes quite small) to get at the bait provided and then cannot get out of the transparent or translucent enclosure that incorporates the funnel. One can buy any variety of ready-made traps with a wide range of effectiveness. The following two companies (among others) have produced successful traps: Seabright Laboratories, 4026 Harlan Street, Emeryville,CA 94608, (800) 284-7363 or (415) 655-3126; Sterling International, Inc., P.O. Box 220, Liberty Lake, WA 99019, (800) 666-6766 [FAX: (509)928-7313]. These commercial traps can become clogged with yellow jackets in a relatively short time during severe infestations, and then one must remove them. The problem then arises that live wasps may still be inside and pose a threat. In that case, one can place the trap in a freezer or an ice chest, wait until the cold immobilizes them, and then empty the trap. Alternatively, the trap can be placed in a paper or plastic bag just large enough to contain it. One can then spray a very small amount of electronic parts cleaner (e.g., Electric Parts Cleaner, CRC, Warminster, PA 18974;(215) 674-4300; Electric Motor Cleaner, Berryman, Arlington, TX 76011),one that contains 1-1-1 Trichloroethane, into the bag and close tightly for a few minutes.
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more than halfway up the sides. Bend the point so formed inward. Fashion part of a wire coat hanger into a hook at the bottom and thread it through a small hole punctured into the cap so that the hook will be down about halfway to the bottom of the bottle when inserted. Bend the top of the coat hanger piece so that it can be suspended from the lid. Fill the bottle about one-third full of soapy water. Then pierce a small piece of turkey ham, salami, or ham (small enough to go through the bottle opening) with the hook and put the lid, hook, and meat in place in the bottle's neck. Hang the bottle in a tree or bush upwind from the area where wasps are not wanted. You might also dig a hole and place the bottle in the ground so the down wind opening is at ground level (wasps often search along the ground for food). If no gallon bottles are available, a one-liter transparent soft drink bottle should suffice.

- Nest location known (perhaps with more than one entrance). If one knows the location of a ground nesting colony, the entire colony can be exterminated quite easily by using nothing more than soapy water. Take care, though, because these wasps are highly defensive of their nest, usually allowing one to get no closer than about 10 feet before attacking. Some people prefer to treat the colony at dawn or late evening, when activity at the entrance is less than in mid-day. Fill an adjustable nozzle spray bottle with water, add one level tablespoon of liquid detergent, and shake. Set the spray nozzle on stream, approach from downwind (also from down slope or protected by bushes, if possible), and spray wasps (guards as well as departing and returning individuals) at the nest entrance as fast as possible from a distance of 10-15 feet (practice at a target first to improve aim). Wear full protection, including a beekeeper hat and veil, if possible. Once all activity at the entrance has ceased, pour a bucket of soapy water into the ground through one of the entrances and block all entrances with a shovel-full or two of dirt.
- A take home poison when wasp infestations become severe, you may wish to use stronger measures. To reduce their numbers, one can lace a desired food with poison after yellow jackets become committed to that source of food. With this method, timing and procedure are somewhat critical. Expose marauding wasps to canned cat food, such as a shrimp and tuna mixture. Allow the number of foragers to build up into a "feeding frenzy." Then provide a second dish alongside the first, but one laced with a take home poison. Orthene (20 drops per small can of cat food) or KNOX OUT (trade name for a micro-encapsulated diazanon product; one-half teaspoon per can). Don't attempt to use straight diazanon, or the laced food will be rejected).

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Periodicals:

- None identified.

This page was last updated on August 02, 2002

Frequently Asked Questions:

- How can I get rid of ants?
- How can I get rid of Bumblebees?
- How can I get rid of flies?
- How can I get rid of ground hornets?
- How can I repel or eliminate mosquitoes?
- What can be done about Whiteflies?
- How can I repel or eliminate yellow jackets?

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

Warning:

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How can I get rid of ants?

- **Suggestion A:** The safest pesticide I know is diatomaceous earth. You can put one tea spoon of it on an ant hill and eliminate the entire population in 30 minutes [ed. note: people have noted it can take up to a couple of weeks, depending on variety of ant]. It is harmless to humans and animals. Diatomaceous earth is comprised of tiny microscopic sea animals which are the sharpest smallest creatures known to man. They cut the outer membranes of the parasites body and cause them to bleed to death. It is not harmful to the stomach as I have used this for 6 years now on my goats for internal (worms) and external (lice and ticks) parasites with no ill effects. You can purchase this stuff in most health food stores or nurseries. Don't buy the pool filter variety as it has rounded off edges, plus it typically contains heavy metals. The food store variety is for human consumption. I buy it by the 50 pound bag for $15 per bag.
- **Suggestion B:** For getting rid of ants in your house, there is an insecticide called "Demon". It worked perfectly the first time on my carpenter ants and every other kind of bug for that matter. I strongly recommend it to anyone that asks and I've had nothing but thanks back. Just use it according to directions. I was able to get to the area where they were doing the most damage and sprayed directly on that wood. Any insect that crosses the powder is killed (not instantly) and it seems to send out a "signal" that keeps them away after a while.
- **Suggestion C:** I had a problem with some... I bought some of the various cans of ant poison/bait and placed them where the little buggers could haul it all back to momma - the queen ant. Took about a month before all of the existing workers died out. Three years later, they have not been back.
- **Suggestion D:** They are attracted to 'moist wood'... get rid of that and they tend to go somewhere else. A good 'homemade' poison is a mixture of confectionery (powdered) sugar and borax (or boric acid?) in equal parts, with enough water to make a paste. Leave it in their trail and they will take it back to the nest. The nest will die off. This system worked for me, I haven't seen any since (three years). I did leave the 'poison' mixture out in the various spots the ants would frequent. (BTW this works for common 'kitchen' type ants too, although keeping the crumbs cleaned up works and is probably more ecologically fair.)
- **Suggestion E:** I sprayed with some harsh chemicals and used diazanon granules around the exterior. I know, it ain't politically correct, but it is even less correct for my house to fall down. So. It worked, although the diazanon has to be reapplied occasionally.
- **Suggestion F:** I would recommend spending the time to follow the buggers and locate the nest. This will take several hours over a couple, three days. Once you find the nest hit it with Durban (called OrthoChlor by Ortho Inc. {I have no connection with Ortho}) at the highest concentration allowed on the label. This stuff will kill for 30 days minimum and much

longer when soaked into a stump or fence post. Then I would spray the trail and around the outside of the house with Diazanon. Diazanon will kill for 7 days minimum and does not last as long in the environment.

- **Suggestion G:** Plant mint around your house. The ants don't like it. The only problem with this is that mint grows like a weed. It will quickly take over where you plant it.

How can I get rid of Bumblebees?

Bumble bees usually nest in the ground in a deserted mouse nest or bird nest. Occasionally they nest in cavities within a wall or even in the clothes drier vent**.**

- **Suggestion A:** If the vicinity of a bumble bee nest can be avoided, then leaving them alone and waiting for them to die in the fall would be the preferred "management" option. Trapping bumble bees is not practical and exclusion techniques may not solve the problem. When controlling bumble bees is necessary, using insecticides to poison bee colonies is the control method of choice. Bumble bees, honey bees and yellowjackets are all controlled the same way. After determining the nest location and nest entrance during the day, wait until night to treat if possible. Wear long-sleeved shirt and trousers and tie sleeves and pants legs shut or pull your socks out over your pant cuffs. Apply insecticide through the entrance hole. Dust formulations of insecticides are preferred (e.g., Sevin dust). Use a duster or "fling" insecticide into the hole off an old plastic spoon. Sprays and ready-to-use "wasp and hornet" aerosol sprays can also be used, but often with less satisfactory results. Do not plug the entrance hole until all activity has stopped. Be prepared to repeat the treatment if necessary. Finally, seal shut, caulk and paint all openings in the vicinity of the old entrance.

How can I get rid of flies?

- **Suggestion A:** Suspend clear bags, filled with water, with a strip of aluminum foil suspended inside. Apparently, the flies are startled by the reflection and leave.
- **Suggestion B:** Providing (1) that you've lost your beneficial predator insects; or (2) that the fly population is more intense than expected, get out the Food Grade Diatomaceous Earth!!! Mix it as a 1 percent wettable powder and hose out the area, spraying walls, ceilings, roofs, the nearby trees... well, at least get carried away in the area that the flies are bothering you. (Wear eye protection and the proper respirator when spraying wettable powders). The DE will act to repulse the flies and the residue will be as if you had applied a fine dusting by hand. (DE strips an insects' protective layer of surface oil from the exoskeleton, which is why it is so effective on Ants, discussed elsewhere in this page. With the oil gone, the insect quickly dehydrates and dies). Retreat in 5 days only if your beneficial/predator insects and birds have not been able to take control of the fly population. Several treatments may be needed if there was adequate food sources for the last season of flies to get crazy while mating and laying eggs. Move livestock and domestic animals out of the area during spraying or dusting with DE.
- **Suggestion C:** "Attic" flies are the large, black, pesky flies that show up in bed rooms and on window sills from late fall through early spring. These flies are known as cluster flies, a name that describes their habit of clustering in large numbers inside attics. Cluster flies do

not reproduce indoors, and home owners bothered by these pests do not need to fear the flies are 'hatching' from a dead animal or other unpleasant material within the attic or walls. Cluster flies develop as parasites inside the bodies of earthworms. There are three generations of flies produced each summer, and the final generation of the season migrates to houses and other buildings during mid to late September. Houses located on an exposed hill top or high ground are most attractive to these migrating flies. The flies cluster on the warm sides of buildings in late summer during the day. When the sun goes down and the temperatures cool, these flies crawl into the building through cracks under the eaves and around windows or through gaps in the siding. Once inside and secured in a protected location, they remain in hibernation until warmed by heat from the furnace or the sun. As the flies warm throughout the winter, and especially in the early spring, they come out of their cold temperature dormancy and begin sluggishly moving around. Their random crawling brings them into the house by way of electrical outlets, window pulley holes, and small openings around windows, moldings and base boards. Cluster flies are difficult to control in homes because they hibernate within inaccessible places. Because they hide inside walls or under insulation, they are usually not vulnerable to treatment until they appear within the living space of the house. Preventing attic flies is a job for the summer and fall. As much as possible, seal cracks and openings around the outside of the house, especially under the eaves, as you would for energy conservation. Insecticides can be used on the outside of the house in mid-September if you have a persistent problem with attic flies. The problem varies greatly from year to year and is worse after a wet summer. The outdoor treatment with residual insecticides such as garden sprays labeled for exterior house treatment, or cattle barn fly sprays is difficult and potentially messy. There is little that can be done for flies already inside the attic and walls. Space sprays and fogs into the attic have little if any affect, as the flies are usually under insulation or deep in cracks and crevices. They do not fly around much in attics. Therefore, fly paper, fly strips and bug zappers are of no value. Flies buzzing within a room can be dispatched with a fly swatter, a short burst from a household insecticide aerosol sprayer or the hand vacuum or shop-vac.

How can I get rid of ground hornets?

- **Suggestion A:** In the evening, when it's cool, place a clear glass bowl over the nest entrance for a few days. The ground hornets will keep flying against the bowl to go get food. When they can't, they will eventually starve to death.

How can I repel or eliminate mosquitoes?

- **Suggestion A:** Eliminate places where they can breed. They don't need a whole pond to breed. Even the tiniest amount of still water makes them happy, such as water collected in an old tire, or the top of a hollow stump.
- **Suggestion B:** Citronella supposedly repels them, but the "mosquito plants" sold for big bucks (citronella-scented geraniums or other plants) seem to be a rip-off. Citronella candles may help, too.
- **Suggestion C:** How about frogs, and toads, and other little amphibious people. Or, how

about dragon flies? Dragonflies are huge mosquito eaters. The object I think is not to subtract from the web, because it only perturbs the balance to try and eliminate factors from the system rather than balance the system more by integrating other life forms that have more beneficial affects. It is philosophically hard to try and argue for a reduction or addition as far as integrated pest management, but in general, balance through predator/prey relationships is better than eliminating the resources of the pest, or merely deterring the pest with sustainable methods.

What can be done about Whiteflies?

- **Suggestion A:** Whiteflies cause more than $200 million worth of damage each year to U.S. crops including greenhouse ornamentals, such as poinsettias, and most melons and vegetables. Other plants -- such as the Nicotiana family (which includes the commercial tobacco plant), and wild tomato and potato species -- have a natural protection against whiteflies and other pests. Their defense is based on a group of chemicals known as sugar esters. Unfortunately, the amount of these sugars available in plants is very small, so plants aren't practical sources of commercial quantities of insecticides, according to Dr. Orestes Chortyk, acting research leader in the Natural Products Utilization Research Unit at the U.S. Department of Agriculture in Athens, Ga. So he and his colleagues turned to the lab to make a series of environmentally friendly synthetic sugar esters similar in structure to the natural pesticides. They proved to be highly toxic to whiteflies and also may be useful in the battle against other soft-bodied arthropods. A patent application has been filed for these uses, three companies have committed funding for further research, and field testing by more than a dozen cooperators is underway.

How can I repel or eliminate yellow jackets?

Yellow jackets (Vespula spp. - colonial wasps), can pose a severe problem for people when these wasps aggressively seek food. (Remember, though, yellow jackets do pollinate plants, such as squash, and dispose of waste matter and thus are not all bad). Early in the season meat is preferred; later they focus more on sweets. Normally, they are an annual species, with colonies started in the spring of each year by a single mated and over-wintered queen. As the season progresses, nest sizes grow and can contain thousands of individuals by late summer or fall. In mild climates colonies can even over-winter.

Effective control measures vary according to the circumstances:

- At eating areas in a backyard, wasps can be kept under control by diligent use of traps (next section). Public picnic areas, however, have wasps already locked into the readily available food supply (messy previous picnickers). Bring along a fly swatter and eliminate the early arrivals - other wasps are then not recruited. Fortunately, individuals of many yellow jacket species are not aggressive when not near their nest. Wasps do not hesitate to go into soft drink cans or bottles, posing a problem for anyone not paying sufficient attention to their activities before taking another swallow. Neither do they hesitate to ride along on a meat sandwich as it is put into one's mouth. Watch out, also, for wasps attracted to meat covered hands, fingers, or utensils. If one places an effective trap (next section) 20-30 feet upwind

from the picnic table, the foraging wasps, when shooed away by picnickers, continue to go upwind past the picnic table and end up in the trap.

- Traps: Remote treatment yellow jacket bait traps have been used for more than a century, with one basic characteristic in design: Wasps will fly into a funnel (sometimes quite small) to get at the bait provided and then cannot get out of the transparent or translucent enclosure that incorporates the funnel. One can buy any variety of ready-made traps with a wide range of effectiveness. The following two companies (among others) have produced successful traps: Seabright Laboratories, 4026 Harlan Street, Emeryville,CA 94608, (800) 284-7363 or (415) 655-3126; Sterling International, Inc., P.O. Box 220, Liberty Lake, WA 99019, (800) 666-6766 [FAX: (509)928-7313]. These commercial traps can become clogged with yellow jackets in a relatively short time during severe infestations, and then one must remove them. The problem then arises that live wasps may still be inside and pose a threat. In that case, one can place the trap in a freezer or an ice chest, wait until the cold immobilizes them, and then empty the trap. Alternatively, the trap can be placed in a paper or plastic bag just large enough to contain it. One can then spray a very small amount of electronic parts cleaner (e.g., Electric Parts Cleaner, CRC, Warminster, PA 18974;(215) 674-4300; Electric Motor Cleaner, Berryman, Arlington, TX 76011),one that contains 1-1-1 Trichloroethane, into the bag and close tightly for a few minutes.
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- Nest location known (perhaps with more than one entrance). If one knows the location of a ground nesting colony, the entire colony can be exterminated quite easily by using nothing more than soapy water. Take care, though, because these wasps are highly defensive of their nest, usually allowing one to get no closer than about 10 feet before attacking. Some people prefer to treat the colony at dawn or late evening, when activity at the entrance is less than in mid-day. Fill an adjustable nozzle spray bottle with water, add one level tablespoon of liquid detergent, and shake. Set the spray nozzle on stream, approach from downwind (also from down slope or protected by bushes, if possible), and spray wasps (guards as well as departing and returning individuals) at the nest entrance as fast as possible from a distance of 10-15 feet (practice at a target first to improve aim). Wear full protection, including a beekeeper hat and veil, if possible. Once all activity at the entrance has ceased, pour a bucket of soapy water into the ground through one of the entrances and block all entrances with a shovel-full or two of dirt.
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Periodicals:

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This page was last updated on August 02, 2002

Growing Christmas Trees

Frequently Asked Questions Other Information Sources Return to Other Crops

Frequently Asked Questions:

- What are good ways to start a Christmas Tree farm?

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

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What are good ways to start a Christmas Tree farm?

- **Suggestion A:** In order to get the right species of tree(s) for your soil and climate you should first seek the advice of your County Extension Service and/or Forestry Service/Dept. of Environmental Management (or whatever they call it in your state). A soil test, which the Extension Service can also help with, is a MUST. Otherwise you can end up spending much time and money getting the wrong tree(s) started and having them not survive.
- **Suggestion B:** There are a number of Christmas tree farms near me. The one on 40 acres is beautifully maintained, and the owner's harvest was impressively orchestrated (and was all over by Thanksgiving). He complains about the marginal nature of the business, though, even though he and his wife provide all the labor, which keeps their expenses down. The much larger tree farm near me used helicopters to carry bundles of trees out to the road. Since the land's not too hilly, they must have figured that the trees could be planted where the roads would normally have gone would pay for the expense of hiring the helicopter. Christmas tree farms are a lot more labor-intensive than they look, and the short harvest season and the need to have transportation lined up in advance make organization incredibly important. But it can be done.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Christmas Trees : Growing and Selling Trees, Wreaths, and Greens - by Lewis Hill - Publication Date: December 1989 - List: $12.95

- Christmas Trees for Pleasure and Profit - by Arthur G. Chapman - Publication Date: August 1985 - List: $18.95

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Growing Cotton

Frequently Asked Questions Other Information Sources Return to Other Crops

Frequently Asked Questions:

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What is colored cotton?

Colored cotton is natural cotton which has been bred to produce light green, light brown and rusty red bolls. The colored fluff is processed into cloth that is gaining popularity with environmentally conscious consumers and people who are allergic to the dyes in regular cotton. Scientists are trying to breed new varieties with longer, stronger fibers and higher yields. An improved green variety should be available in two years and a genetically engineered blue version is on the way. Colored cotton sells for $1.30 to $1.40 per pound, compared with 65 cents to 70 cents for white cotton. But yields on colored cotton are lower, so farmers may not see much difference in profits. Colored cotton may yield only one 500-pound bale to an acre, compared with up to 2 1/2 for regular cotton. Colored cotton has been grown for years in Russia, India and South and Central America, and Israel has become a major supplier. White cotton still dominates. Mills like white cotton because it can be dyed to keep pace with changes in fashions.

Where can I get cotton seed?

- **Suggestion A:** There are only two major seed companies left in that business: Delta & Pine Land Company, Scott, Mississippi, and Stoneville Pedigreed Seed Company, Stoneville, Mississippi. I don't know any addresses, but both are small towns and their telephone numbers should be easily obtainable. If it's ginned cottonseed for marketing you want, you might contact the National Cottonseed Products Association, 1255 Lynnfield Rd, Memphis, Tennessee. 901-682-0800.
- **Suggestion B:** You must not forget Hyperformer Seed Company, a subsidiary of Helena Chemical Co. They can be reached in Memphis, TN at the Agricenter International at phone: 901-756-1771.

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- None identified.

Commercial suppliers:

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- Agricultural Price Policy and Its Impact on Production, Income, Employment and the Adoption of Innovations : A Farming Systems Based Analysis of cotton - by Michael Bruntrup - Publication Date: June 1997 - List: $95.95

- Bale O' Cotton : The Mechanical Art of Cotton Ginning (Centennial Series of the Association of Former Students, Texas A&m University, No 43) - by Karen Gerhardt Britton - Publication Date: January 1993 - List: $28.50

- Ginning Cotton : An Entrepreneur's Story - by A. L. Vandergriff - Publication Date: March 1997 - List: $34.95
  Midwest Book Review :
  A. L. Vandergriff went to work in a cotton gin at the age of nine. Now an octogenarian, there's nothing he doesn't know about an industry and a technology that has been a part of his long and productive life. Ginning Cotton: An Entrepreneur's Story is an opportunit y to follow the technological advancements in the ginning and processing industry made by a cotton legend. "Vandy" developed many of the most revolutionary engineering innovations of this century (he holds 28 U. S. patents recording his contributions), and in Ginning Cotton he ex plains the technology and the historical context of its development.

Vandergriff's story is, quite literally, the story of the development of modern cotton ginning. Ginning Cotton is a unique blend of technological history and personal biography that will entertain as much as it informs.

- Integrated Pest Management Systems and Cotton Production (Environmental Science and Technology) - by Raymond E. Frisbie, Kamal M. El-Zik, L. Ted Wilson (Editor) - Publication Date: May 1989 - List: $89.95
  The publisher, John Wiley & Sons :
  Presents a comprehensive integration of IPM techiques into cotton production methodology. Practical approach addresses economic, agronomic, and biological factors of pest management, focussing on the plant's resistance to pests and the genetic rationale for improving plant health. Discusses methods of quantifying plant damage and pest abundance, surveys the latest research developments, and suggests various approaches to an overall management strategy for each of the major pest groups. Also evaluates the latest approaches to economic analysis of cotton IPM systems.

- Like a Family : The Making of a Southern Cotton Mill World - by Jacquelyn Dowd Hall - Publication Date: November 1989 - List: $13.95

Periodicals:

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Frequently Asked Questions:

- What is colored cotton?
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What is colored cotton?

Colored cotton is natural cotton which has been bred to produce light green, light brown and rusty red bolls. The colored fluff is processed into cloth that is gaining popularity with environmentally conscious consumers and people who are allergic to the dyes in regular cotton. Scientists are trying to breed new varieties with longer, stronger fibers and higher yields. An improved green variety should be available in two years and a genetically engineered blue version is on the way. Colored cotton sells for $1.30 to $1.40 per pound, compared with 65 cents to 70 cents for white cotton. But yields on colored cotton are lower, so farmers may not see much difference in profits. Colored cotton may yield only one 500-pound bale to an acre, compared with up to 2 1/2 for regular cotton. Colored cotton has been grown for years in Russia, India and South and Central America, and Israel has become a major supplier. White cotton still dominates. Mills like white cotton because it can be dyed to keep pace with changes in fashions.

Where can I get cotton seed?

- **Suggestion A:** There are only two major seed companies left in that business: Delta & Pine Land Company, Scott, Mississippi, and Stoneville Pedigreed Seed Company, Stoneville, Mississippi. I don't know any addresses, but both are small towns and their telephone numbers should be easily obtainable. If it's ginned cottonseed for marketing you want, you might contact the National Cottonseed Products Association, 1255 Lynnfield Rd, Memphis, Tennessee. 901-682-0800.
- **Suggestion B:** You must not forget Hyperformer Seed Company, a subsidiary of Helena Chemical Co. They can be reached in Memphis, TN at the Agricenter International at phone: 901-756-1771.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Agricultural Price Policy and Its Impact on Production, Income, Employment and the Adoption of Innovations : A Farming Systems Based Analysis of cotton - by Michael Bruntrup - Publication Date: June 1997 - List: $95.95

- Bale O' Cotton : The Mechanical Art of Cotton Ginning (Centennial Series of the Association of Former Students, Texas A&m University, No 43) - by Karen Gerhardt Britton - Publication Date: January 1993 - List: $28.50

- Ginning Cotton : An Entrepreneur's Story - by A. L. Vandergriff - Publication Date: March 1997 - List: $34.95
  Midwest Book Review :
  A. L. Vandergriff went to work in a cotton gin at the age of nine. Now an octogenarian, there's nothing he doesn't know about an industry and a technology that has been a part of his long and productive life. Ginning Cotton: An Entrepreneur's Story is an opportunit y to follow the technological advancements in the ginning and processing industry made by a cotton legend. "Vandy" developed many of the most revolutionary engineering innovations of this century (he holds 28 U. S. patents recording his contributions), and in Ginning Cotton he ex plains the technology and the historical context of its development. Vandergriff's story is, quite literally, the story of the development of modern cotton ginning. Ginning Cotton is a unique blend of technological history and personal biography that will entertain as much as it informs.

- Integrated Pest Management Systems and Cotton Production (Environmental Science and Technology) - by Raymond E. Frisbie, Kamal M. El-Zik, L. Ted Wilson (Editor) - Publication Date: May 1989 - List: $89.95
  The publisher, John Wiley & Sons :
  Presents a comprehensive integration of IPM techiques into cotton production methodology. Practical approach addresses economic, agronomic, and biological factors of pest management, focussing on the plant's resistance to pests and the genetic rationale for improving plant health. Discusses methods of quantifying plant damage and pest abundance, surveys the latest research developments, and suggests various approaches to an overall management strategy for each of the major pest groups. Also evaluates the latest approaches to economic analysis of cotton IPM systems.

- Like a Family : The Making of a Southern Cotton Mill World - by Jacquelyn Dowd Hall - Publication Date: November 1989 - List: $13.95

Periodicals:

- None identified.

This page was last updated on August 02, 2002

Growing Walnuts

Frequently Asked Questions Other Information Sources Return to Other Crops

Frequently Asked Questions:

- Black Walnut toxicity to Plants, Humans and Horses

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

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Black Walnut Toxicity to Plants, Humans and Horses

Roots of Black Walnut (Juglans nigra L.) and Butternut (Juglans cinerea L.) produce a substance known as juglone (5-hydroxy-alphanapthaquinone). Persian (English or Carpathian) walnut trees are sometimes grafted onto black walnut rootstocks. Many plants such as tomato, potato, blackberry, blueberry, azalea, mountain laurel, rhododendron, red pine and apple may be injured or killed within one to two months of growth within the root zone of these trees. The toxic zone from a mature tree occurs on average in a 50 to 60 foot radius from the trunk, but can be up to 80 feet. The area affected extends outward each year as a tree enlarges. Young trees two to eight feet high can have a root diameter twice the height of the top of the tree, with susceptible plants dead within the root zone and dying at the margins.

Not all plants are sensitive to juglone. Many trees, vines, shrubs, groundcovers, annuals and perennials will grow in close proximity to a walnut tree. Certain cultivars of "resistant" species are reported to do poorly. Black walnut has been recommended for pastures on hillsides in the Ohio Valley and Appalachian mountain regions. Trees hold the soil, prevent erosion and provide shade for cattle. The beneficial effect of black walnut on pastures in encouraging the growth of Kentucky bluegrass (Poa pratensis L.) and other grasses appears to be valid as long as there is sufficient sunlight and water.

Gardeners should carefully consider the planting site for black walnut, butternut, or persian walnut seedlings grafted to black walnut rootstock, if other garden or landscape plants are to be grown within the root zone of mature trees. Persian walnut seedlings or trees grafted onto Persian walnut rootstocks do not appear to have a toxic effect on other plants.

Horses may be affected by black walnut chips or sawdust when they are used for bedding material. Close association with walnut trees while

pollen is being shed (typically in May) also produce allergic symptoms in both horses and humans. The juglone toxin occurs in the leaves, bark and wood of walnut, but these contain lower concentrations than in the roots. Juglone is poorly soluble in water and does not move very far in the soil.

Walnut leaves can be composted because the toxin breaks down when exposed to air, water and bacteria. The toxic effect can be degraded in two to four weeks. In soil, breakdown may take up to two months. Black walnut leaves may be composted separately, and the finished compost tested for toxicity by planting tomato seedlings in it. Sawdust mulch, fresh sawdust or chips from street tree prunings from black walnut are not suggested for plants sensitive to juglone, such as blueberry or other plants that are sensitive to juglone. However, composting of bark for a minimum of six months provides a safe mulch even for plants sensitive to juglone.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Integrated Pest Management for Walnuts - by Mary Louise Flint - Publication Date: December 1987 - List: $22.00
- Black Walnut for Profit, Bruce Thompson, Timber Press, Forest Grove, OR 97116-1976.

Periodicals:

- None identified.

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Frequently Asked Questions:

- Black Walnut toxicity to Plants, Humans and Horses

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Crops related links and mailing lists

Related Web Sites:

Related Mailing Lists:

CASHCROP: Specialty Crop Discussion Group

Subscription address: cashcrop-request@stat.mlnet.com

Aimed at promoting the exchange of ideas and information about specialty crops, their markets, prices, and their production around the world.

STAT Publishing, who maintains the list, will post a couple of standard pieces of information in this mailing list:

- Daily grower bid summaries for western Canadian specialty crops
- A weekly review of specialty crop markets
- Occasional observations and messages.

Subscribe to CASHCROP. Type "subscribe" in the message body. (Not supported by all browsers.)

NEWCROPS: New Crops Discussion List

Subscription address: listserv@vm.cc.purdue.edu

Topics: New crops

Subscribe to NEWCROPS. Type "subscribe NEWCROPS Your Name" in the message body. (Not supported by all browsers.)

Return to The Small Farm Resource

This page was last updated on August 02, 2002

Equipment

Return to the Small Farm Resource

- Chainsaws
- Tractors

If you have a question, we will post the question in the appropriate contents page to get suggestions from our site visitors.

Questions and suggestions can be sent to us via our Feedback form.

Visitor Questions:

Chainsaws

Frequently Asked Questions Other Information Sources Return to Equipment Contents

Frequently Asked Questions:

- Chain Saw Safety
- Maintenance

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

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Chain Saw Safety

Chain saws can be great labor-saving tools. But if not operated properly and with respect, they can quickly cause severe injury and death. At least two people died from injuries related to chain saws during the first week of cleanup after Hurricane Hugo. This leaflet cannot address every potential hazard you may encounter while using a chain saw. If you are not familiar with techniques of sawing, saw operation, or maintenance, read your owner's manual, consult a more detailed publication, or ask a dealer for more information.

Do You Need to Use a Chain Saw?

If you have only small branches (four inches or less), use a hand saw or axe. Chain saws are not suited for cutting such small branches.

Owner's Manual

Read the owner's manual before operating a chain saw for the first time. Note the safety practices. Note how to check and adjust the chain tension. It's important for safe operation.

Personal Protective Equipment

One of the best safeguards against injury is wearing the proper protective equipment. This includes: safety glasses or goggles, heavy-duty, non-slip gloves, sturdy non-slip shoes hearing protection, trim fitting clothes (not loose or ragged), long-sleeve shirt and pants (chaps if you have them), hardhat,

Transporting the Saw

Put the chain guard on the saw when not in use. Always carry the saw at your side with the cutting bar and chain to the rear and to the outside. Never carry a chain saw in the passenger area of a vehicle.

Fueling a Chain Saw

Use the fuel mix recommended by the manufacturer. Never fuel a hot chain saw; let it cool first. Always fuel in a clear area away from debris. If your fuel can has no spout, use a funnel. Wipe the saw clean of any spilled fuel after fueling. Never smoke while fueling.

Starting the Chain Saw

There is only one safe way to start a chain saw:

1. Move 10 feet or more away from the fueling area.
2. Place the saw in a clear, debris-free area.
3. Hold the saw firmly on the ground by putting your foot through the rear handle (if possible) and by holding it down with one hand on the top handle. Pull the starter cord with the other hand. The chain should not be moving while the saw is idling.
4. Never start the saw while holding it off the ground, or by "drop starting" it.

Preparing to Cut

Clear away anything that has a chance of interfering with the operation. Remove debris that could cause you to slip or lose your balance or accidentally contact the chain. Keep both hands firmly on the saw when cutting.

Avoiding Kickback

Kickback occurs when the saw rotates back, or "kicks back" at the operator, due to the nose of the saw contacting an object or obstruction. To prevent kickback:

1. Use a saw equipped with chain brake or kickback guard.
2. Hold the saw firmly with both hands. Grip the top handle by putting the thumb around it.
3. Watch for twigs that can snag the chain.
4. Don't pinch the chain while cutting the log.
5. Saw with the lower part of the bar close to the bumper, not on the top near the nose.
6. Maintain high saw speed when entering or leaving a cut.
7. Keep the chain sharp.
8. Do not reach above your shoulder to cut. The chain is too close to your face in this position.
9. Fatigue Many injuries occur because the operator got tired or withstood long periods of saw vibration. Take frequent breaks.
10. Felling, Limbing, and Bucking

11. Cutting down large trees is not simple and should be left to experienced operators who have felled trees before. Limbing requires proper position and consideration of kickback potential, the springing back of branches, and the chance the log will roll. Bucking (cutting a log into lengths) requires knowing how to block the log to prevent binding, kickback, and rolling. If you are not familiar with these operations, get more information from your owner's manual, a saw dealer, a book or video, or from an experienced operator.

Maintenance

Perform maintenance BEFORE using the chainsaw, NOT afterwards.

- Remove the sprocket cover, bar and chain.
- Remove, check and wash the air filter in straight petrol.
- Clean the spark plug and check the gap. Check the manufacturer's specification for the gap width.
- Clean the grill on the fan housing.
- Clean the sprocket cover.
- Check the brake mechanism.
- Check the chain for wear and uneven use.
- Remove any grit from the bar groove, working from the tip backwards.
- Clear all the oil holes and check the tension on all nuts and bolts.
- Replace the chain and bar.
- The chain should be replaced with the cutters pointing forward and the depth gauge leading.
- The bar should be replaced upside down, rotating each time the chainsaw is used to allow even wear and tear on the bar.
- Replace and tighten the sprocket cover nuts finger tight.
- Holding the bar up, tension the chain so that the bottom of the chain JUST touches the bar. The chain should move freely. Do not touch the chain with unprotected hands.
- Tighten the nuts holding the sprocket cover.

After usage, clean the chain saw before storing.

Sharpening the Chain

Sharpen the cutting edges at (normally) 30-35° using three good strokes (do not sharpen on the return or inward movement). Reduce the height of the depth gauge as needed. Round off the leading edge retaining the original shape.

If you accidentally allow the chainsaw to touch the ground while it is still running, stop what you are doing and resharpen the chain. It will be instantly blunt.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

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- Handy Farm Devices and How to Make Them - by Rolfe Cobleigh - Publication Date: March, 1996 - List: $12.95
- Rotary Tiller Service Manual - Publication Date: February, 1990 - List: $26.95
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  Synopsis:
  This definitive guide on collecting authenic rural items covers every aspect of farm life from the turn of the century onward, including needlework, cooking and canning utensils. It offers descriptions and prices for thousands of items with over 175 photos. Each chapter describes an aspect of farming in detail, including the tools and activities involved and how the task has evolved.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

- Chain Saw Safety
- Maintenance

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Periodicals:

- None identified.

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Frequently Asked Questions:

- Safety
- Will a tractor with a front-end loader clear snow?
- Which is better, a brush hog or a mower deck?
- Which is better, lugged tires or turf tires?
- How much horsepower do I need?

Other Information Sources:

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Safety

Tractors are one of the most important pieces of equipment on a farm, yet they are also among the most dangerous. More deaths are caused by tractors than by any other type of farm accident. It is therefore imperative that farmers routinely check their tractors and keep in mind the following safety guidelines:

- Make sure your tractor has a Rollover Protective Structure (ROPS). Other than using safe operating procedures, having a ROPS is the most important thing you can do to ensure you don't become a farm fatality statistic.
- Make sure the Power-Take-Off equipment is shielded. They are installed for your safety. Always shut off engine and be sure that implement motion has ceased before making any adjustments or repair.
- Make sure your tractor has rear-wheel and front-end weights that you can mount when needed. Use rear-wheel weights to add stability for front- end loaders, and always lower the loader before transporting.
- Make sure the steps and platform of your tractor are free of loose tools, snow, ice, mud, and other debris that might cause you to slip and fall.
- An ABC fire-extinguisher and a first-aid kit should always be readily available. Inspect fire extinguishers every six months to ensure your safety.
- Be sure to have a slow moving vehicle emblem mounted on the rear of each tractor and each implement. This emblem should be centered between two and six feet above the ground.
- Review safety procedures in your manual regularly. Your operator's manual is the best safety guide you have, so make good use of it.
- Make sure the wheels of our tractor are set as wide as possible for a particular job. The broader the wheel base, the less likely it will be that the tractor will turn over.
- Make sure that your tractor is matched to its load. Many fatalities

have been caused by the loss of control of a tractor that was going down hill with a heavy load. Even on level ground, the load should be no more than two times as heavy as the tractor.

- Make sure that your tractor's steering and braking mechanisms, gauges, and lights are working properly.
- Make sure you check all fluid levels, fan belts, tire pressures, and hydraulic lines, and check for fluid leaks before every use.
- Be sure to have a slow moving vehicle emblem in good condition mounted on the rear of the tractor. The tractor and towed implements should also be outfitted with the appropriate reflectors and lights. These things are a must, and will help protect your from a rear end collision.
- Review safety procedures in your manual regularly. Your operator's manual is the best safety guide you have, so make good use of it. Give yourself a few days to get used to new equipment, and study the manual carefully.
- Finally, no matter how much they beg, never let your small children ride with you on the tractor. One recent 20-year study of tractor fatalities found that in accidents involving an extra rider, 73 percent of the deaths were children under the age of 10. Don't let your child become a farm fatality statistic. Say no to tractor rides.

Operation safety

A rear rollover generally happens too fast for the operator to react; it takes only 3/4 of a second to reach the point of no return. Most rear rollovers are the result of changing the tractor's center of gravity. Normally, a tractor's center of gravity is located about two feet in front of and ten inches above the rear axle. Hitching above the drawbar or in a location not designated by the manufacturer increases the risk of a rear turnover.

Excessive throttle use or applying too much power to a restrained rear axle can cause the front-end of the tractor to lift off the ground. As the front end lifts it gains momentum and the tractor flips over. Without a ROPS and a seat belt the operator will likely be crushed.

If a load must be pulled up a hill, keep the operation of the clutch and throttle smooth. Do not stop or shift gears while driving up a hill.

Back out of ditches, holes or places where the tractor is mired or wedged. Extra time may be spent unhitching and moving machinery out of the way, but it will be a fraction of the time that may be spent healing from injuries suffered from a turnover, if you survive. If backing out a tractor is not possible, use another tractor to pull the stuck tractor free. Always make sure the chain is hitched to the drawbar of the pulling

tractor. Never place boards in front of the tractor wheels or attempt to move the tractor forward by its own power.

Operating on unlevel ground can change the tractor's center of gravity, making it easier to turnover. Mounted equipment, especially if the equipment is not mounted as directed by the tractor manufacturer, will also shift the center of gravity.

Always keep front-end loader equipment in the lowest position possible when in transport. A front-end loader in the raised position alters the tractor's center of gravity, reducing its stability.

Turning too quickly or too sharply may increase the centrifugal force against the tractor and cause it to overturn sideways. Always slow down when turning.

Tractor speeds should match surface conditions. Rough or uneven surfaces require reduced speeds. Be alert for rocks, holes, embankments or other hazards that can change the tractor's center of gravity.

When working on a sloped surface, use a tractor with a wide front-end and space the rear wheels as far apart as possible. Cross slopes slowly and keep side-mounted equipment on the uphill side of the tractor.

Lock brake pedals together when driving at transport speeds to ensure even braking. Shift to a lower gear before traveling downhill to let the engine and transmission reduce speeds. Be sure that any loads are not going to try and outrun the tractor on the way down a hill. To avoid having a load outrun the tractor, never pull a load heavier than the tractor can safely handle under any conditions that may be encountered. Remember, two trips may take longer, but it is better than never completing the job.

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Safety

Tractors are one of the most important pieces of equipment on a farm, yet they are also among the most dangerous. More deaths are caused by tractors than by any other type of farm accident. It is therefore imperative that farmers routinely check their tractors and keep in mind the following safety guidelines:

- Make sure your tractor has a Rollover Protective Structure (ROPS). Other than using safe operating procedures, having a ROPS is the most important thing you can do to ensure you don't become a farm fatality statistic.
- Make sure the Power-Take-Off equipment is shielded. They are installed for your safety. Always shut off engine and be sure that implement motion has ceased before making any adjustments or repair.
- Make sure your tractor has rear-wheel and front-end weights that you can mount when needed. Use rear-wheel weights to add stability for front- end loaders, and always lower the loader before transporting.
- Make sure the steps and platform of your tractor are free of loose tools, snow, ice, mud, and other debris that might cause you to slip and fall.
- An ABC fire-extinguisher and a first-aid kit should always be readily available. Inspect fire extinguishers every six months to ensure your safety.
- Be sure to have a slow moving vehicle emblem mounted on the rear of each tractor and each implement. This emblem should be centered between two and six feet above the ground.
- Review safety procedures in your manual regularly. Your operator's manual is the best safety guide you have, so make good use of it.
- Make sure the wheels of our tractor are set as wide as possible for a particular job. The broader the wheel base, the less likely it will be that the tractor will turn over.
- Make sure that your tractor is matched to its load. Many fatalities have been caused by the loss of control of a tractor that was going down hill with a heavy load. Even on level ground, the load should be no more than two times as heavy as the tractor.
- Make sure that your tractor's steering and braking mechanisms, gauges, and lights are working properly.
- Make sure you check all fluid levels, fan belts, tire pressures, and hydraulic lines, and check for fluid leaks before every use.
- Be sure to have a slow moving vehicle emblem in good condition mounted on the rear of the tractor. The tractor and towed implements should also be outfitted with the appropriate reflectors and lights. These things are a must, and will help protect your from a rear end

collision.

- Review safety procedures in your manual regularly. Your operator's manual is the best safety guide you have, so make good use of it. Give yourself a few days to get used to new equipment, and study the manual carefully.
- Finally, no matter how much they beg, never let your small children ride with you on the tractor. One recent 20-year study of tractor fatalities found that in accidents involving an extra rider, 73 percent of the deaths were children under the age of 10. Don't let your child become a farm fatality statistic. Say no to tractor rides.

Operation safety

A rear rollover generally happens too fast for the operator to react; it takes only 3/4 of a second to reach the point of no return. Most rear rollovers are the result of changing the tractor's center of gravity. Normally, a tractor's center of gravity is located about two feet in front of and ten inches above the rear axle. Hitching above the drawbar or in a location not designated by the manufacturer increases the risk of a rear turnover.

Excessive throttle use or applying too much power to a restrained rear axle can cause the front-end of the tractor to lift off the ground. As the front end lifts it gains momentum and the tractor flips over. Without a ROPS and a seat belt the operator will likely be crushed.

If a load must be pulled up a hill, keep the operation of the clutch and throttle smooth. Do not stop or shift gears while driving up a hill.

Back out of ditches, holes or places where the tractor is mired or wedged. Extra time may be spent unhitching and moving machinery out of the way, but it will be a fraction of the time that may be spent healing from injuries suffered from a turnover, if you survive. If backing out a tractor is not possible, use another tractor to pull the stuck tractor free. Always make sure the chain is hitched to the drawbar of the pulling tractor. Never place boards in front of the tractor wheels or attempt to move the tractor forward by its own power.

Operating on unlevel ground can change the tractor's center of gravity, making it easier to turnover. Mounted equipment, especially if the equipment is not mounted as directed by the tractor manufacturer, will also shift the center of gravity.

Always keep front-end loader equipment in the lowest position possible when in transport. A front-end loader in the raised position alters the tractor's center of gravity, reducing its stability.

Turning too quickly or too sharply may increase the centrifugal force against the tractor and cause it to overturn sideways. Always slow down when turning.

Tractor speeds should match surface conditions. Rough or uneven surfaces require reduced speeds. Be alert for rocks, holes, embankments or other hazards that can change the tractor's center of gravity.

When working on a sloped surface, use a tractor with a wide front-end and space the rear wheels as far apart as possible. Cross slopes slowly and keep side-mounted equipment on the uphill side of the tractor.

Lock brake pedals together when driving at transport speeds to ensure even braking. Shift to a lower gear before traveling downhill to let the engine and transmission reduce speeds. Be sure that any loads are not going to try and outrun the tractor on the way down a hill. To avoid having a load outrun the tractor, never pull a load heavier than the tractor can safely handle under any conditions that may be encountered. Remember, two trips may take longer, but it is better than never completing the job.

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Extension Service

Frequently Asked Questions Other Information Sources Return to the Small Farm Resource

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What is the Extension Service?

Each state has a Land-Grant University, so every state has an Extension system. The Land-Grant University system was created through an Act of Congress, the Morrill Act of 1862. The universities were created as a partnership in agricultural education between the Federal Government (USDA) and the states.

However, it was soon recognized that because Land-Grant Universities had a central location (Columbus in Ohio, West Lafayette in Indiana, Lexington in Kentucky, etc.), they were unable to effectively reach out and provide consistent educational support to individuals throughout the states. For example, people in Franklin County, Ohio benefitted greatly, while people in Hamilton County, Ohio gained little.

So, in 1914 Congress passed the Smith-Lever Act. The act created the Cooperative Extension Service. It was call "Cooperative" because the new entity was a partnership between the federal government (the USDA), the states (the Land-Grant Universities), and the individual counties within the states. It was called "Extension" because the Service was an extension of the Land-Grant University system.

The Act specified teaching methods to be used and people to be served. The educational programs were to be provided "…to persons not attending or resident in said colleges [the Land-Grant Universities]…" Although Extension agents in Ohio are faculty members of The Ohio State University, this statement explains why agents do not teach at the University. Teaching methods specified by the Act included "...demonstrations, publications and otherwise..." OSU Extension has over 600 fact sheets and bulletins and demonstrations remain the mainstay of Extension teaching in Ohio.

The Smith-Lever Act also specified subject matter to be taught:

"…subjects relating to agriculture and home economics…" In effect, the Act specified two "doors" (agriculture and home economics) opened to clientele seeking Extension-based answers to their questions. Although not specified by the enabling Act, two additional doors were added in later years: 4-H and Community and Natural Resource Development (CNRD) program areas.

Extension Service Map/State Links.

Click below to get to a map of the states and various state Extension links.

http://www.reeusda.gov/statepartners/usa.htm

Ohio County Extension Offices

Adams
Courthouse, 110 West Main St.,
West Union 45693
(513) 544-2339

Allen
219 W. Northern Ave., Lima 45801
(419) 222-9946

Ashland
804 US 250 East, Ashland 44805
(419) 281 -8242

Ashtabula
39 Wall St., Jefferson 44047
(216) 576-9008

Athens
280 W. Union St., Athens 45701
(614) 593-8555

Auglaize
208 S. Blackhoof St.
Wapakoneta 45895
(419) 738-2219

Lorain
42110 Russia Rd., Elyria 44035-6813
(216) 322-0127

Lucas
Room 550, One Government Ctr., Toledo 43604
(419) 245-4254

Madison
217 Elm St., P.O. Box 230, London 43140
(614) 852-0975

Mahoning
490 S. Broad St., Canfield 44406
(216) 533-5538

Marion
1100 E. Center St., Marion 43302
(614) 387-2260

Medina
120 W. Washington St., Medina 44256
(216) 725-4911

Belmont
410 Fox Shannon Pl., St. Clairsville 43950
(614) 695-1455

Brown
740 Mt.Orab Pike, Georgetown 45121
(513) 378-6716

Butler
1810 Princeton Rd.
Hamilton 45011
(513) 887-3722

Carroll
Courthouse, 119 Public Square, Carrollton 44615
(216) 627-4310

Champaign
647 Bodey Circle, Urbana 43078
(513) 652-2204

Clark
Prime Ohio Corp. Park, Suite #104, 4400 Gateway Blvd., Springfield 45502
(513) 328-4607

Clermont
1000 Locust St., P.O. Box 670
Owensville 45103
(513) 732-7195

Clinton
111 S. Nelson Ave., Suite #2
Wilmington 45177
(513) 382-0901

Columbiana
3301/2 S. Lincoln Ave., Lisbon 44432
(216) 424-7291

Meigs
Mulberry Heights, P.O. Box 32, Pomeroy 45769
(614) 992-6696

Mercer
220 W. Livingston St., suite 2, Celine 45822
(419) 586-2179

Miami
Courthouse, 201 W. Main St., Troy 45373
(513) 332-6829

Monroe
Room 17,101 N. Main St., Woodsfield 43793
(614) 472-0810

Montgomery
1001 S. Main St., Dayton 45409
(513) 224-9654

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(614) 962-4854

Morrow
871 Marion Rd., Mt. Gilead 43338
(419) 947-1070

Muskingum
Room 6, 225 Underwood St. Zanesville 43701
(614) 454-0144

Noble
150 Courthouse, Caldwell 43724
(614) 732-5681

Coshocton
724 S. 7th St., Coshocton 43812
(614) 622-2265

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(419) 562-8731

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Cleveland 44102-5588
(216) 631 -1890

Darke
700 Wayne St., Greenville 45331
(513) 548-5215

Defiance
197-A Island Park Ave., Defiance 43512
(419) 782-4771

Delaware
560 Sunbury Rd., Suite 5, Delaware 43015
(614) 368-1925

Erie
2900 S. Columbus Ave., Sandusky 44870
(419) 627-7631

Fairfield
Suite D, 831 College Ave., Lancaster 43130
(614) 653-5419

Fayette
1225 US Rt. 22 SW, Washington CH 43160
(614) 335-1150

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(419) 898-1618

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(419) 399-8225

Perry
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Somerset 43783
(614) 743-1602

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Circleville 43113
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(614) 947-2121

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Burton 44021
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(513) 372-9971

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Cambridgc 43725
(614) 432-9300

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(513) 825-6000

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7708 C.R.140, Findlay 45840
(419) 422-3851

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(419) 674-2297

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(419) 668-8219

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372 Portsmouth St., P.O. Box 110,
Jackson 45640
(614) 286-5044

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Stambaugh Plaza, Suite A, 135 Main St.,
Wintersville 43952
(614) 264-2212

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1025 Harcourt Rd., P.O. Box 1268,
Mt. Vernon 43050-8268
(614) 397-0401

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(419) 238-1214

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McArthur 45651
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Suite 4, 777 Columbus Ave.,
Lebanon 45036
(513) 932-1891

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Marietta 45750
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Upper Sandusky 43351 -1423
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(419) 422-6106

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(614) 286-2177

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Linn County PO Box 765 Albany, OR 97321 phone 541-967-3871 fax 541-967-9169

Related web pages:

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- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

- What is the Extension Service?
- Extension Service Map/State Links.
- Ohio County Extension Offices
- Oregon Extension Services

Other Information Sources:

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- Electronic mailing lists
- Suggested references
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What is the Extension Service?

Each state has a Land-Grant University, so every state has an Extension system. The Land-Grant University system was created through an Act of Congress, the Morrill Act of 1862. The universities were created as a partnership in agricultural education between the Federal Government (USDA) and the states.

However, it was soon recognized that because Land-Grant Universities had a central location (Columbus in Ohio, West Lafayette in Indiana, Lexington in Kentucky, etc.), they were unable to effectively reach out and provide consistent educational support to individuals throughout the states. For example, people in Franklin County, Ohio benefitted greatly, while people in Hamilton County, Ohio gained little.

So, in 1914 Congress passed the Smith-Lever Act. The act created the Cooperative Extension Service. It was call "Cooperative" because the new entity was a partnership between the federal government (the USDA), the states (the Land-Grant Universities), and the individual counties within the states. It was called "Extension" because the Service was an extension of the Land-Grant University system.

The Act specified teaching methods to be used and people to be served. The educational programs were to be provided "…to persons not attending or resident in said colleges [the Land-Grant Universities]…" Although Extension agents in Ohio are faculty members of The Ohio State University, this statement explains why agents do not teach at the University. Teaching methods specified by the Act included "...demonstrations, publications and otherwise..." OSU Extension has over 600 fact sheets and bulletins and demonstrations remain the mainstay of Extension teaching in Ohio.

The Smith-Lever Act also specified subject matter to be taught: "…subjects relating to agriculture and home economics…" In effect, the Act specified two "doors" (agriculture and home economics) opened to clientele seeking Extension-based answers to their questions. Although not specified by the enabling Act, two additional doors were added in later years: 4-H and Community and Natural Resource Development (CNRD) program areas.

Extension Service Map/State Links.

Click below to get to a map of the states and various state Extension links.

http://www.reeusda.gov/statepartners/usa.htm

Ohio County Extension Offices

Adams
Courthouse, 110 West Main St.,
West Union 45693
(513) 544-2339

Allen
219 W. Northern Ave., Lima 45801
(419) 222-9946

Ashland
804 US 250 East, Ashland 44805
(419) 281 -8242

Ashtabula
39 Wall St., Jefferson 44047
(216) 576-9008

Athens
280 W. Union St., Athens 45701
(614) 593-8555

Auglaize
208 S. Blackhoof St. Wapakoneta 45895
(419) 738-2219

Belmont
410 Fox Shannon Pl., St. Clairsville 43950
(614) 695-1455

Brown
740 Mt.Orab Pike, Georgetown 45121
(513) 378-6716

Butler
1810 Princeton Rd.
Hamilton 45011
(513) 887-3722

Carroll
Courthouse, 119 Public Square,
Carrollton 44615
(216) 627-4310

Lorain
42110 Russia Rd., Elyria 44035-6813
(216) 322-0127

Lucas
Room 550, One Government Ctr.,
Toledo 43604
(419) 245-4254

Madison
217 Elm St., P.O. Box 230, London 43140
(614) 852-0975

Mahoning
490 S. Broad St., Canfield 44406
(216) 533-5538

Marion
1100 E. Center St., Marion 43302
(614) 387-2260

Medina
120 W. Washington St., Medina 44256
(216) 725-4911

Meigs
Mulberry Heights, P.O. Box 32,
Pomeroy 45769
(614) 992-6696

Mercer
220 W. Livingston St., suite 2, Celine 45822
(419) 586-2179

Miami
Courthouse, 201 W. Main St., Troy 45373
(513) 332-6829

Monroe
Room 17,101 N. Main St., Woodsfield 43793
(614) 472-0810

Champaign
647 Bodey Circle, Urbana 43078
(513) 652-2204

Clark
Prime Ohio Corp. Park, Suite #104, 4400 Gateway Blvd., Springfield 45502
(513) 328-4607

Clermont
1000 Locust St., P.O. Box 670
Owensville 45103
(513) 732-7195

Clinton
111 S. Nelson Ave., Suite #2
Wilmington 45177
(513) 382-0901

Columbiana
3301/2 S. Lincoln Ave., Lisbon 44432
(216) 424-7291

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Southwest District
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Garden Contents

Return to the Small Farm Resource

If you have a question, we will post the question in the appropriate contents page to get suggestions from our site visitors.

Questions and suggestions can be sent to us via our Feedback form.

Visitor Questions:

Growing Asparagus

Frequently Asked Questions Other Information Sources Return to Garden Contents

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Other Information Sources:

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Growing Asparagus

Asparagus is one of the most wholesome and appetizing products of the garden. Early appearance of asparagus in the spring makes it of special importance. The young, tender shoots of asparagus usually reach cutting size about the second week in May. These shoots may be cut every other day if temperature and moisture conditions are favorable.

Asparagus is a long-lived perennial vegetable crop that is enjoyed by many gardeners. It can be productive for 15 or more years if given proper care.

Varieties

Mary Washington is the most widely grown and generally available variety. It is tolerant to rust and when properly grown, produces good, high quality yields. **Viking** and **Jersey Giant** are also tolerant to rust and are becoming more available.

Select the new all-male hybrid asparagus varieties such as **Jersey Giant**, **Jersey Prince**, and **Jersey Knight**. These varieties produce spears only on male plants. Seeds produced on female plants fall to the ground and become a seedling weed problem in the garden. Female plants also have to expend more energy to produce the seeds that decreases the yields of asparagus spears on female plants. The all-male hybrids out-yield the old Mary Washington varieties by 3 to 1.

Soil Requirements

Asparagus grows in most any soil as long as it has good internal drainage. Asparagus roots do not like waterlogged soils that will lead to

root rot. It prefers a soil pH of 6.5-7.5., and will not do well if the pH is less than 6.0. Have the soil tested to determine phosphorus and potassium needs; or add 20 lbs of a 10-20-10 or similar analysis fertilizer per 1,000 square feet, tilled to a 6 inch depth before planting.

Planting

Buy one-year-old, healthy, disease-free crowns from a reputable crown grower. A crown is the root system of a one-year-old asparagus plant that is grown from seed. Each crown can produce 1/2 lb. of spears per year when fully established.

Asparagus can be planted from seed. However, caring for the small seedlings until they become established can be time consuming. Also, because the seeds are spaced a few inches apart, the crowns will have to be dug and transplanted to their permanent, wider-spaced location in the garden after one year. Thus, one year of potential spear production is lost due to transplanting.

Asparagus can be planted throughout Ohio from mid-April to late May after the soil has warmed up to about 50 degrees F. There is no advantage to planting the crowns in cold, wet soils. They will not grow until the soil warms and there is danger of the plants being more susceptible to Fusarium crown rot if crowns are exposed to cold, wet soils over a prolonged period. Plant the asparagus at either the west or north side of the garden so that it will not shade the other vegetables and will not be injured when the rest of the garden is tilled.

Dig a furrow no deeper than 5 to 6 inches. Research has shown that the deeper asparagus crowns are planted, the more the total yield is reduced. Apply about 1 lb. of 0-46-0 (triple superphosphate) or 2 lbs. of 0-20-0 (superphosphate) fertilizer per 50 feet of row in the bottom of the furrow before planting. This will make phosphorus immediately available to the crowns. Omitting this procedure will result in decreased yields and the spear production will not be as vigorous.

Toss the crowns into the furrow on top of the fertilizer. The fertilizer will not burn the crowns, and the plants will grow regardless of how they land so don't bother to spread the roots. Space the crowns 1-1/2 feet apart in the row. If more than one row is planted, space the rows five feet apart from center to center. Wide between-row spacing is necessary because the vigorously growing fern will fill in the space quickly. Wide spacing also promotes rapid drying of the fern to help prevent the onset of fungus diseases.

After planting, back fill the furrow to its original soil level. It isn't necessary to gradually cover the crowns with a few inches of soil until the furrow is filled in. However, do not compact the soil over the newly

filled furrow or the emergence of the asparagus will be severely reduced. Spears should emerge within one week in moist soils.

Do not harvest the asparagus during the planting year. Spears will be produced from expanded buds on the crown. As the spears elongate and reach a height of about 8 to 9 inches, the tips will open. The spear will become woody to support the small branchlets that become ferns. The ferns produce food for the plant and then move it down to the crown for next year's spear production.

Asparagus is very drought tolerant and can usually grow without supplemental watering because it seeks moisture deep in the soil. However, if rainfall is insufficient when planting or afterwards, it is beneficial to irrigate the crowns. Otherwise the plants will become stressed and vigorous growth will be impeded.

Insects and Diseases

Inspect the ferns throughout the season for insect feeding and fern dieback. Asparagus beetles chew on the fern, causing the stem to turn brown and reducing the yield the next year. Spray the ferns with an approved insecticide when beetles are seen. For disease prevention, spray with an approved fungicide on a 7 to 14 day schedule beginning when the ferns reach a 3 to 4 foot height and continuing until mid September.

Do not cut down the fern growth at the end of the growing season. The all-male hybrids stay green until frost, enabling photosynthesis to occur longer throughout the season. Leave the dead fern growth intact over the winter. This catches snow for additional soil moisture and keeps the soil temperature about 5 degrees F cooler than bare soil with no covering of dead fern. The cooler soil temperature is helpful in delaying the early emergence of asparagus in the spring, when air temperatures might rise prematurely and then fall again, predisposing the spears to frost damage. Frost-damaged spears should be snapped and discarded.

Remove the old fern growth by cutting or mowing as low as possible during the first week of April in central Ohio. Dead stalks are very sharp and can easily skin knuckles when harvesting new spears.

Weed Control

Weed control can be accomplished by hand hoeing and cultivating during the planting year since there are no herbicides labeled for use in asparagus during the first year. Labeled pre-emergence herbicides may be used during the second spring, by applying it over the shredded fern, about three weeks before spear emergence (April 1st in central Ohio).

Do not use salt as a weed killer. It will not harm the asparagus, but it inhibits water penetration in the soil. Also, rains can leach the salt out of the asparagus bed and into the rest of the garden, injuring other vegetables that are less salt tolerant than asparagus.

Harvesting

Do not harvest asparagus regularly until the plants are well established in the permanent location. A light harvest may be taken the first season, with full harvests in subsequent years, as long as the plants are vigorous. Cease harvesting shoots in late June. If the shoots become spindly, stop cutting so that good growth may be made for the following year. Remember, the tops have the job of storing the food in the roots, which will produce next year's crop.

Harvest asparagus by **snapping** 7 to 9 inch spears with tight tips (when bent, the spear will snap naturally just above the tough part). There is no need to cut asparagus below the soil with a knife. This may injure other buds on the crown that will send up new spears. The small stub that is left in the soil after snapping, dries up and disintegrates. A new spear does not come up at the same spot, but comes up from another bud that enlarges on another part of the crown. White asparagus is produced by burying the plants in soil and harvesting the spears before they are exposed to sunlight.

As the tips of the spears start to loosen (known as "ferning out"), fiber begins to develop at the base of the spears, causing them to become tough. The diameter of the spear has no bearing on its toughness. However, thin and thick asparagus spears have the same number of what is called vascular bundles and thinner spears may be less tender, more fibrous; 3/8 to 3/4 inch in diameter is recommended. When harvesting, the asparagus patch should be picked clean, never allowing any spears to fern out, as this gives asparagus beetles an excellent site to lay their eggs.

The year after planting, asparagus can be harvested several times throughout a three-week period, depending on air temperatures. Research shows there is no need to wait two years after planting before harvesting. In fact, harvesting the year after planting will stimulate more bud production on the crown and provide greater yields in future years, as compared with waiting two years before harvesting.

Asparagus spears will start to emerge when the soil temperature reaches 50 degrees F. After this, growth of asparagus is dependent on air temperature. Early in the season, 7 to 9 inch spears might be harvested every 2 to 4 days. As air temperatures increase, harvesting frequencies will increase to once or twice per day, harvesting 5 to 7 inch spears before the tips start to fern out and lose quality. The second year after

planting, the length of harvest can increase to about 4 to 6 weeks. The third year after planting and thereafter, harvesting can continue for 6 to 8 weeks. Since the length of harvest season will vary from year-to-year depending on air temperature, stop the harvest when the diameter of 3/4 of the spears becomes small (less then 3/8 inch). Experience gained by growing the crop will make it easier for the gardener to know when to discontinue the harvest.

When harvest is finished, snap all the spears off at ground level. Apply 1/2 lb. of ammonium nitrate fertilizer per 50 feet of row . At this time, a home garden formulation of glyphosate non-selective herbicide (such as Roundup) can be sprayed on the asparagus patch. This will kill any existing weeds. New spears will then emerge, fern out, and provide a large canopy to cover the space between the rows. Once a dense fern canopy is formed, weed growth will be shaded out.

Storage

Asparagus is very perishable and should be harvested in the morning when air temperatures are cool. After picking, immerse the spears in ice-cold water to remove the heat; then drain the water and place the spears in plastic bags. Store in the refrigerator at 38 to 40 degrees F. Asparagus will keep for 1 to 2 weeks with little loss of quality.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 04, 1997

Frequently Asked Questions:

Other Information Sources:

Warning:

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Growing Asparagus

Asparagus is one of the most wholesome and appetizing products of the garden. Early appearance of asparagus in the spring makes it of special importance. The young, tender shoots of asparagus usually reach cutting size about the second week in May. These shoots may be cut every other day if temperature and moisture conditions are favorable.

Asparagus is a long-lived perennial vegetable crop that is enjoyed by many gardeners. It can be productive for 15 or more years if given proper care.

Varieties

Mary Washington is the most widely grown and generally available variety. It is tolerant to rust and when properly grown, produces good, high quality yields. **Viking** and **Jersey Giant** are also tolerant to rust and are becoming more available.

Select the new all-male hybrid asparagus varieties such as **Jersey Giant**, **Jersey Prince**, and **Jersey Knight**. These varieties produce spears only on male plants. Seeds produced on female plants fall to the ground and become a seedling weed problem in the garden. Female plants also have to expend more energy to produce the seeds that decreases the yields of asparagus spears on female plants. The all-male hybrids out-yield the old Mary Washington varieties by 3 to 1.

Soil Requirements

Asparagus grows in most any soil as long as it has good internal drainage. Asparagus roots do not like waterlogged soils that will lead to root rot. It prefers a soil pH of 6.5-7.5., and will not do well if the pH is less than 6.0. Have the soil tested to determine phosphorus and potassium needs; or add 20 lbs of a 10-20-10 or similar analysis fertilizer per 1,000 square feet, tilled to a 6 inch depth before planting.

Planting

Buy one-year-old, healthy, disease-free crowns from a reputable crown grower. A crown is the root system of a one-year-old asparagus plant that is grown from seed. Each crown can produce 1/2 lb. of spears per year when fully established.

Asparagus can be planted from seed. However, caring for the small seedlings until they become

established can be time consuming. Also, because the seeds are spaced a few inches apart, the crowns will have to be dug and transplanted to their permanent, wider-spaced location in the garden after one year. Thus, one year of potential spear production is lost due to transplanting.

Asparagus can be planted throughout Ohio from mid-April to late May after the soil has warmed up to about 50 degrees F. There is no advantage to planting the crowns in cold, wet soils. They will not grow until the soil warms and there is danger of the plants being more susceptible to Fusarium crown rot if crowns are exposed to cold, wet soils over a prolonged period. Plant the asparagus at either the west or north side of the garden so that it will not shade the other vegetables and will not be injured when the rest of the garden is tilled.

Dig a furrow no deeper than 5 to 6 inches. Research has shown that the deeper asparagus crowns are planted, the more the total yield is reduced. Apply about 1 lb. of 0-46-0 (triple superphosphate) or 2 lbs. of 0-20-0 (superphosphate) fertilizer per 50 feet of row in the bottom of the furrow before planting. This will make phosphorus immediately available to the crowns. Omitting this procedure will result in decreased yields and the spear production will not be as vigorous.

Toss the crowns into the furrow on top of the fertilizer. The fertilizer will not burn the crowns, and the plants will grow regardless of how they land so don't bother to spread the roots. Space the crowns 1-1/2 feet apart in the row. If more than one row is planted, space the rows five feet apart from center to center. Wide between-row spacing is necessary because the vigorously growing fern will fill in the space quickly. Wide spacing also promotes rapid drying of the fern to help prevent the onset of fungus diseases.

After planting, back fill the furrow to its original soil level. It isn't necessary to gradually cover the crowns with a few inches of soil until the furrow is filled in. However, do not compact the soil over the newly filled furrow or the emergence of the asparagus will be severely reduced. Spears should emerge within one week in moist soils.

Do not harvest the asparagus during the planting year. Spears will be produced from expanded buds on the crown. As the spears elongate and reach a height of about 8 to 9 inches, the tips will open. The spear will become woody to support the small branchlets that become ferns. The ferns produce food for the plant and then move it down to the crown for next year's spear production.

Asparagus is very drought tolerant and can usually grow without supplemental watering because it seeks moisture deep in the soil. However, if rainfall is insufficient when planting or afterwards, it is beneficial to irrigate the crowns. Otherwise the plants will become stressed and vigorous growth will be impeded.

Insects and Diseases

Inspect the ferns throughout the season for insect feeding and fern dieback. Asparagus beetles chew on the fern, causing the stem to turn brown and reducing the yield the next year. Spray the ferns with an approved insecticide when beetles are seen. For disease prevention, spray with an approved fungicide on a 7 to 14 day schedule beginning when the ferns reach a 3 to 4 foot height and continuing until mid September.

Do not cut down the fern growth at the end of the growing season. The all-male hybrids stay green

until frost, enabling photosynthesis to occur longer throughout the season. Leave the dead fern growth intact over the winter. This catches snow for additional soil moisture and keeps the soil temperature about 5 degrees F cooler than bare soil with no covering of dead fern. The cooler soil temperature is helpful in delaying the early emergence of asparagus in the spring, when air temperatures might rise prematurely and then fall again, predisposing the spears to frost damage. Frost-damaged spears should be snapped and discarded.

Remove the old fern growth by cutting or mowing as low as possible during the first week of April in central Ohio. Dead stalks are very sharp and can easily skin knuckles when harvesting new spears.

Weed Control

Weed control can be accomplished by hand hoeing and cultivating during the planting year since there are no herbicides labeled for use in asparagus during the first year. Labeled pre-emergence herbicides may be used during the second spring, by applying it over the shredded fern, about three weeks before spear emergence (April 1st in central Ohio). Do not use salt as a weed killer. It will not harm the asparagus, but it inhibits water penetration in the soil. Also, rains can leach the salt out of the asparagus bed and into the rest of the garden, injuring other vegetables that are less salt tolerant than asparagus.

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When harvest is finished, snap all the spears off at ground level. Apply 1/2 lb. of ammonium nitrate fertilizer per 50 feet of row . At this time, a home garden formulation of glyphosate non-selective herbicide (such as Roundup) can be sprayed on the asparagus patch. This will kill any existing weeds. New spears will then emerge, fern out, and provide a large canopy to cover the space between the rows. Once a dense fern canopy is formed, weed growth will be shaded out.

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Commercial suppliers:

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Electronic mailing lists:

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Suggested references:

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Periodicals:

- None identified.

This page was last updated on November 04, 1997

Growing Beets

Frequently Asked Questions Other Information Sources Return to Garden Contents

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Growing Beets

Beets are popular in the home garden because they are relatively easy to grow and practically the whole plant can be eaten. Beets can be grown for their root qualities which include different shapes and sizes as well as red, yellow or white colors. The tops or greens, when young, are excellent in salads and when the plant is older, can be cooked. The greens are even more nutritious than the roots.

Varieties

Choice of cultivar depends on your tastes. Excellent varieties for Ohio home gardens include Early Wonder, Detroit Dark Red and Little Ball for red beets. More recent introductions include Pacemaker III, Red Ace Hybrid, Warrior and Avenger. Burpee Golden and Albino White are alternatives for a different color of beets. Below are some varieties and their characteristics.

- Burpee Golden - Round type with a unique yellow-orange color.
- Pacemaker III - Uniform, smooth a tender round beet, cercospera leaf spot tolerant, high quality tops.
- Red Ace hybrid - Exceptional weather tolerance, cercospera leaf spot tolerant, early maturity.
- Little Mini Ball - Sliver-dollar sized round roots.
- Detroit Dark Red - Excellent canning, pickling quality, tender & sweet, good boiling greens.

Climatic Requirements

Beets prefer a cooler climate although they are tolerant of heat.

Temperatures of 60 to 65 F and bright sunny days are ideal for beet plant growth and development. They can withstand cold weather short of severe freezing, making them a good long-season crop.

Soils

Beets prefer loose, well-drained soils but will tolerate a wide range. Remove stones and debris since this will hinder growth. In high clay soils, add organic matter to improve soil structure and to help avoid crusting after rainfall. Beets also make an excellent raised bed crop since soils are generally less compacted and there is less foot traffic. Beets are also sensitive to soil acidity. A low soil pH results in stunted growth. They prefer a pH of 6.2 to 6.8 and will tolerate 6.0 to 7.5.

Fertilizers

Fertilizers and lime are best applied using soil test results as a guide. Arrangements for soil testing can be made through your local Extension office. A fertilizer with the analysis of 5-10-10 can be applied at the time of seeding and again when the plants are about three inches high.

Planting

Plant the seeds in a well-prepared seedbed as soon as the soil can be worked in the spring. Sow the seeds 1/2-inch deep and in rows 12 to 18 inches or more apart depending on the method of cultivation.

Space the seeds, which are actually fruits containing several seeds, one inch apart in the rows. When the seedlings are one to two inches tall, thin to about one plant per inch. As they grow, thin to about three to four inches between plants.

Succession planting can be done at three week intervals throughout the season. Avoid seeding during daytime temperatures of 80 degrees F, wait until it is cooler. Most varieties will mature within 55 to 70 days and can be planted until late summer.

Culture

After plants are well established, the application of a mulch will conserve soil moisture, prevent soil compaction and help suppress weed growth. Any mechanical cultivation should be very shallow in order to avoid damage to the beet roots.

In order to obtain the highest quality, beets must make continuous

growth. Soil moisture and plant nutrient element supply must be adequately maintained to prevent checking of the growth. Supplemental watering may be necessary during dry spells.

Weeds, insects and diseases must be controlled in the planting. Principal insect and disease problems of beets are flea beetles, leaf miners, aphids and Cercospora leaf spot. Regular inspection of the crop can help deter a major pest infestation. Check with your local Extension office for current control recommendations when you notice a problem.

Harvesting and Storage

Beets can be harvested at any time in their growth cycle. Greens are best when four to six inches tall. Beet roots are generally most tender after growing for 40 to 50 days. The best size is between 1-1/2 to 2 inches in diameter. As beets get larger, they tend to become more fibrous. When harvested, leave at least one inch of foliage on the root to avoid bleeding during cooking.

Beets are suited to long-term storage if kept at temperatures near freezing and with high humidity to prevent wilting.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan -

Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed. Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable information. Original.*

- Collecting Processing and Germinating Seeds of Wildland Plants - by Cheryl Young, James A. Young - Publication Date: October 1, 1986 - List: $24.95
- Enduring Seeds : Native American Agriculture and Wild Plant Conservation - by Gary Paul Nabhan - Publication Date: April 1, 1991 - List: $14.00
- From Seed to Plant - by Gail Gibbons - Publication Date: March 1, 1991 - List: $15.95 *Explores the intricate relationship between seeds and the plants which they produce.*
- Kid's Gardening : A Kid's Guide to Messing Around in the Dirt/With Seeds - by Kevin Raftery, Kim Gilbert Raftery, Jim M'Guinness - Publication Date: May 1, 1989 - List: $13.95
  Now young readers will know from whence those carrots came. This full-color extravaganza contains nearly a hundred pages of wipe-clean cardstock, hundreds of illustrations, dozens of growing activities, plus 15 varieties of vegetable, flower, and herb seeds.
- Principles of Seed Science and Technology - by Larry O. Copeland, Miller B. McDonald, Lawrence O. Copeland - Publication Date: March 1, 1995 - List: $74.95
- Saving Seeds : The Gardener's Guide to Growing and Storing Vegetable and Flower Seeds - by Marc Rogers, Polly Alexander (Illustrator) - Publication Date: March 1991 - List: $12.95
- Seed to Seed - by Suzanne Ashworth - Publication Date: January 1, 1995 - List: $20.00
- Seeds : The Definitive Guide to Growing, History, and Lore - by H. Peter Loewer, Peter Loewer - Publication Date: April 1, 1996 - List: $25.00
  Loewer examines the vast and often surprisingly complex world of seeds in an unparalleled thoroughness. In addition to the how-to of growing all kinds of plants and vegetables from seed, the book also considers the role of seeds in history, literature, and business. 100 line drawings.
- Seeds and Propagation (Smith & Hawken--The Hands-On Gardener) - by Susan McClure, Jim Anderson (Illustrator) - Publication Date: June 1, 1997 - List: $10.95
- The New Seed Starter's Handbook - by Nancy Bubel -

Publication Date: April 1, 1988 - List: $15.95

- Gardening In Deer Country - by Vincent Drzewucki - Publication Date: January, 1998 - List: $9.95

- 200 Tips for Growing Vegetables in the Northeast - by Miranda Smith - Publication Date: February 1996 - List: $7.95

- 200 Tips for Growing Vegetables in the Pacific Northwest - by Maggie Stuckey - Publication Date: February 1996 - List: $7.95

- Building Your Own Greenhouse (Greenhouse Basics) - by Mark Freeman, Heather Bellanca (Illustrator) - Publication Date: April 1997 - List: $18.95

- Burpee : The Complete Vegetable & Herb Gardener : A Guide to Growing Your Garden
  Organically - by Karan Davis Cutler, Cavagnarok David (Photographer), Barbara W. Ellis - Publication Date: November 1997 - List: $29.95
  Synopsis:
  A companion to Burpee Complete Gardener, this book focuses on all aspects of growing organic vegetables and edible herbs in the home garden. Planting techniques and tools, garden design, and more than 90 individual plant portraits are included. 300 full-color photos.

- Culinary Gardens : From Garden to Palate - by Susan McClure - Publication Date: September 1997 - List: $37.95
- Five Acres and Independence: A Handbook for Small Farm Management - by Maurice Grenville Kains, Maurice G. Kain - Publication Date: March 1978 - List: $7.95

- Four-Season Harvest : How to Harvest Fresh Organic Vegetables from Your Home Garden All Year Long - by Eliot Coleman, Kathy Bary (Illustrator) - Publication Date: October 1992 - List: $19.95
  Booknews, Inc. , 01/01/93:
  Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.

- Gardening Under Cover : A Northwest Guide to Solar Greenhouses, Cold Frames, and Cloches - by William Head -

Publication Date: November 1989 - List: $10.95
This is a complete guide to gardening with protective shelters that encourages both beginning and experienced gardeners to add months of gardening pleasure at small expense. With a little under-cover gardening know-how, Pacific Northwest gardeners can take advantage of our mild climate to produce flowers, herbs, and vegetables throughout the year.

- Grow It : The Beginner's Complete In-Harmony-With-Nature Small Farm Guide-From Vegetable and Grain Growing to Livestock Care - by Richard W. Langer, Susan McNeill (Illustrator) - Publication Date: January 1994 - List: $12.00
Synopsis:
An indispensable guide to small-scale organic farming that features advice on everything from building and stocking a pond to planting an orchard or making cheese. This extremely practical and easy-to-use guide, first published in 1972, is for full-time or part-time country dwellers/gardeners.

- Growing Great Garlic : The Definitive Guide for Organic Gardeners and Small Farmers - by Ron L. Engeland - Publication Date: July 1995 - List: $14.95

- Heirloom Vegetable Gardening : A Master Gardener's Guide to Planting, Growing, Seed Saving, and Cultural History - by William Woys Weaver - Publication Date: June 1997 - List: $45.00
Synopsis:
Weaver focuses on 280 varieties of 37 vegetables in this encyclopedic guide to the history and cultivation of some of America's most treasured heirloom vegetables. 100+ color photos. 240 line drawings.

- A Dyer's Garden : From Plant to Pot Growing Dyes for Natural Fibers - by Rita Buchanan - Publication Date: August 1995 - List: $9.95

- A Produce Reference Guide to Fruits and Vegetables from Around the World : Nature's Harvest - by Donald D. Heaton - Publication Date: April 1997 - List: $29.95

- Growing Plants from Seed : A Comprehensive Beginners Handbook for Vegetables, Flowers, Herbs and More - by George Abraham, Katy Abraham, Doc Abraham - Publication Date: January 1992 - List: $13.95

Synopsis:
A guide for first-time seed growers addresses soil mixtures, lighting, types of seed, seed-starting kits, and more to help any gardener experience the rewarding feeling of growing flowers and vegetables from seed. Original.

- Peppers : The Domesticated Capsicums - by Jean Andrews - Publication Date: October 1995 - List: $65.00
Booknews, Inc. , 04/01/96:
An updated edition (first, 1984) of an elegantly produced, scholarly reference on peppers--their history and dispersion, biology, taxonomy, cultivation, and medicinal, economic, and gastronomic uses. Illustrated with the author's botanically accurate, aesthetically pleasing paintings that show the blossoms, buds, young peppers, and mature specimens of 34 cultivars. A review of the literature, a photo glossary, and an extensive bibliography add to the volume's reference value. 9x12" Annotation c. by Book News, Inc., Portland, Or.

- Peppers of the World : An Identification Guide - by Dave Dewitt, Paul W. Bosland - Publication Date: January 1997 - List: $19.95

- Plant Propagation : Principles and Practices - by Hudson Thomas Hartmann (Editor), Dale E. Kester, Fred T., Jr. Davies - Publication Date: January 1997 - List: $86.00
The publisher, Prentice-Hall Career & Technology :
Hallmarked as the most successful text of its kind, this remarkably thorough text covers all aspects of the propagation of plants - both sexual and asexual - with considerable attention given to human (vs natural) efforts to increase plant numbers.

- Forest Gardening : Cultivating an Edible Landscape - by Robert A. De J. Hart - Publication Date: September 1996 - List: $17.95

- Handbook of Organic Food Processing and Production - by Simon Wright (Editor) - Publication Date: October 1994 - List: $119.00

- Introduction to Permaculture - by Bill Mollison, Reny Mia Slay - Publication Date: November 1997 - List: $16.95

- Profitable Organic Farming - by Jon Newton - Publication Date: June 1995 - List: $36.95

- The New Organic Grower : A Master's Manual of Tools and Techniques for the Home and Market Gardener - by Eliot Coleman, Sheri Amsel (Illustrator), Molly Cook Field (Illustrator) - Publication Date: October 1995 - List: $24.95
  Booknews, Inc. , 05/01/96:
  This expansion of a now-classic guide originally published in 1989 is intended for the serious gardener or small-scale market farmer. It describes practical and sustainable ways of growing superb organic vegetables, with detailed coverage of scale and capital, marketing, livestock, the winter garden, soil fertility, weeds, and many other topics. Annotation c. by Book News, Inc., Portland, Or.

- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95

Periodicals:

- None identified.

This page was last updated on November 16, 2002

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Growing Broccoli

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Planting

All of these crops may be started from seed sown indoors about six weeks before the plants can be set in the garden. They all grow best during cool, moist weather. Well hardened cabbage and broccoli transplants can be set out between May 1-10. Cauliflower is more tender and should not be planted until May 15-20. Space plants of these crops 18-24 inches apart in the rows with 36 inches between rows. Weed control is necessary.

Pest Control

If you expect to grow good quality broccoli, cauliflower and cabbage over a long season, insect pests must be controlled. A safe dust or spray of thuracide Bt or Dipel will not harm people, honey bees or birds, but will kill the caterpillar pests of these vegetables if the directions on the package label are followed. Repeat applications are necessary for effective control. Do not forget to pull out all plants and compost them after you have completed the harvest.

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Growing Carrots

Because they are easy to grow and a wonderful source of Vitamin A, carrots are an excellent crop in the home garden. The new varieties are easy to grow and make a great addition to children's gardens.

Varieties

Choosing a variety depends upon your preference and your soil type. Shorter types such as Red-Cored Chantenay and Short and Sweet are better suited for heavy soils. Other varieties include Nantes Half-long, Danvers Half-long, Pioneer and Spartan Bonus. Gourmet varieties such as Little Finger are also excellent in container gardens. Below are some varieties and their characteristics.

- Red-Cored Chantenany - 6 inch roots, grow well in heavy clay soils, crisp and tender, red-orange color to the core.
- Danvers Half Long - Tapered roots average 6-1/2 to 7-inches long, heavy yields and good storage capabilities.
- Little Finger - 3 to 5 inches long and 1/2 inch across, exceptionally high sugar content, performs well in heavy soils.
- Thumberline - 2-inch golf ball sized round carrot, excellent for heavy clay soils.

Climatic Requirements

The carrot is a hardy, cool season crop that can be planted in the garden as soon as the soil can be prepared in the spring. Carrots require relatively large amounts of moisture and are not tolerant of drought. Prolonged hot weather in the later stages of development may not only retard growth but result in an undesirable strong flavor and coarseness

in the roots. At the other extreme, prolonged temperatures below 55 degrees F tend to make the roots longer, more slender and paler in color than expected. The best temperature for highest quality roots is between 60 and 70 degrees F.

Soils

Carrot plants thrive in deep, loose, well-drained soil. Avoid stony, cloddy or trash-laden soils as they increase the incidence of root defects. Because raised-beds usually have loose soil and receive little compaction from foot traffic, they are an ideal location to grow carrots. Carrots grown on heavy soils may produce considerable leaf growth and forked roots. Carrot plants do not grow well in strongly acid soils; therefore, a pH range of 6.0 to 6.8 should be maintained for best results.

Fertilizers

Fertilizers and lime are best applied to soils for carrot production using soil test results as a guide. Arrangements for soil testing can be made through your local Extension office. Carrots require large amounts of plant nutrient elements, particularly potassium, for good production. A fertilizer with the ratio of 1-2-2 such as a 5-10-10 analysis would be appropriate at the time of seeding and again when tops are three to four inches tall and six to eight inches tall. Too much manure and fertilizer applied just before seeding can result in forked roots.

Planting

Direct seed carrots into a well-prepared soil early in the spring. Suggested planting depth is 1/4 inch deep in rows spaced 12 to 18 inches or more apart depending on the method of cultivation used. It is important to avoid crusting of the soil around the seed-bed. Covering the seed with vermiculite or fine compost and keeping the soil evenly moist until the seedlings have emerged will help prevent this problem.

After the seedlings have emerged, thin them to one inch apart. When the tops of the carrots grow thicker, thin them to about two to three inches apart. Some seed companies are now offering pelletized seed, making the seeds easier to plant and thin.

Culture

After plants are established, applied mulches will help conserve moisture and suppress weed growth. Cultivation, if necessary, should be shallow in order to avoid root injury. Carrots require an

evenly-distributed and plentiful soil moisture supply throughout the growing season. However, avoid too much moisture towards the end of the season as this will cause roots to crack.

Watch for the appearance of orange crowns at the soil level as the plants mature. If this occurs, mulch with soil or compost as the sunlight will turn them green. Potential pest problems include leafhoppers, wireworms, carrot rust worm larvae, aster yellow, leaf spot and soft rot. Contact your local Extension office for current control recommendations.

Harvesting and Storage

Harvest can begin when carrots are finger size. In general, the smaller carrots are juicier and more tender. You do not have to harvest the entire crop at once. They can remain in the soil until you are ready to use them. Carrots will last until winter in the soil if mulched well. Carrots are best stored at temperatures near freezing in a moist environment.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

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Frequently Asked Questions:

Other Information Sources:

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Growing Carrots

Because they are easy to grow and a wonderful source of Vitamin A, carrots are an excellent crop in the home garden. The new varieties are easy to grow and make a great addition to children's gardens.

Varieties

Choosing a variety depends upon your preference and your soil type. Shorter types such as Red-Cored Chantenay and Short and Sweet are better suited for heavy soils. Other varieties include Nantes Half-long, Danvers Half-long, Pioneer and Spartan Bonus. Gourmet varieties such as Little Finger are also excellent in container gardens. Below are some varieties and their characteristics.

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Periodicals:

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Growing Chard

Frequently Asked Questions Other Information Sources Return to Garden Contents

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Chard - Beta vulgaris cicla

Chard (also known as Swiss chard) is a member of the beet family that can be successfully grown as a vegetable green. It is planted early because the seedlings are tolerant to moderate frost.

Chard will produce fresh greens throughout the summer. The large, fleshy leafstalks may be white or red with broad, crisp, green leaf blades. The leaf blades are prepared like spinach, and the midribs (or stalks) may be cooked in the same manner as asparagus. Chard is an attractive ornamental that adds to the beauty of a garden. Many gardeners like to grow chard because it is usually not available in food markets, and it yields well with few production problems.

Varieties

- **Fordhook Giant, White Mid-Rib** - 60 days to maturity, large leaf ribs or stalks.

- **Lucullus, White Mid-Rib** - 60 days to maturity, heat tolerant.

When to Plant

Chard does well on any soil where lettuce and spinach will grow. Plants may be started inside and transplanted in the garden after the danger of frost is past, but most gardeners plant seed directly into the garden in April and early May.

Spacing of Plants and Depth of Planting

For seeding outdoors, plant seed 1/2 to 3/4 inch deep (8 to 10 seed per

foot of row) in rows far enough apart to cultivate. Thin the seedlings to 4 to 6 inches apart. An alternative method is to thin the seedlings to 2 to 3 inches apart, then harvest the excess plants when they are sufficiently large for greens (6 to 8 inches high), leaving a final spacing of 9 to 12 inches between plants. Transplants should be set in the garden 9 to 12 inches apart.

Harvesting

The most common method of harvesting chard is to cut off the outer leaves 1 1/2 inches above the ground while they are young and tender (about 8 to 12 inches long). Be careful not to damage the terminal bud.

Swiss Chard

Since Swiss chard is a close relative of beets, plant it the same time you do beets. Seeds should be planted 2 to 3 weeks before the average last killing spring frost. Swiss chard is unusual in that quite often a single planting can be harvested for nearly a year.

Swiss chard is grown for its tender leaves. The plants grow 1 to 2 ft. tall and the crinkled leaves have prominent central ribs. These ribs can be cut from the rest of the leaves and cooked and served like asparagus. The remainder of the leaf is eaten as greens. For harvesting, cut the leaves at the base of the plant with a sharp knife. The undisturbed inner leaves should continue to grow and be ready for picking in a few days. Discard any old leaves, if they remain on the plant, they will decrease production.

Related web pages:

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Commercial suppliers:

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Electronic mailing lists:

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Chard - Beta vulgaris cicla

Chard (also known as Swiss chard) is a member of the beet family that can be successfully grown as a vegetable green. It is planted early because the seedlings are tolerant to moderate frost.

Chard will produce fresh greens throughout the summer. The large, fleshy leafstalks may be white or red with broad, crisp, green leaf blades. The leaf blades are prepared like spinach, and the midribs (or stalks) may be cooked in the same manner as asparagus. Chard is an attractive ornamental that adds to the beauty of a garden. Many gardeners like to grow chard because it is usually not available in food markets, and it yields well with few production problems.

Varieties

- Fordhook Giant, White Mid-Rib - 60 days to maturity, large leaf ribs or stalks.

- Lucullus, White Mid-Rib - 60 days to maturity, heat tolerant.

When to Plant

Chard does well on any soil where lettuce and spinach will grow. Plants may be started inside and transplanted in the garden after the danger of frost is past, but most gardeners plant seed directly into the garden in April and early May.

Spacing of Plants and Depth of Planting

For seeding outdoors, plant seed 1/2 to 3/4 inch deep (8 to 10 seed per foot of row) in rows far enough apart to cultivate. Thin the seedlings to 4 to 6 inches apart. An alternative method is to thin the seedlings to 2 to 3 inches apart, then harvest the excess plants when they are sufficiently large for greens (6 to 8 inches high), leaving a final spacing of 9 to 12 inches between plants. Transplants should be set in the garden 9 to 12 inches apart.

Harvesting

The most common method of harvesting chard is to cut off the outer leaves 1 1/2 inches above the ground while they are young and tender (about 8 to 12 inches long). Be careful not to damage the terminal bud.

Swiss Chard

Since Swiss chard is a close relative of beets, plant it the same time you do beets. Seeds should be planted 2 to 3 weeks before the average last killing spring frost. Swiss chard is unusual in that quite often a single planting can be harvested for nearly a year.

Swiss chard is grown for its tender leaves. The plants grow 1 to 2 ft. tall and the crinkled leaves have prominent central ribs. These ribs can be cut from the rest of the leaves and cooked and served like asparagus. The remainder of the leaf is eaten as greens. For harvesting, cut the leaves at the base of the plant with a sharp knife. The undisturbed inner leaves should continue to grow and be ready for picking in a few days. Discard any old leaves, if they remain on the plant, they will decrease production.

Related web pages:

- None identified.

Commercial suppliers:

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Electronic mailing lists:

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Chicory - Chicorium intybus

Chicory is an unusual plant in that, although it has been cultivated for over 1,000 years, it is still very wild-looking and shows but slight effects of its association with man. Chicory is a native of Europe but is as common as a weed in the United States.

Chicory is a hardy vegetable that is used in three basic forms. The roots are dried, roasted, and prepared as a coffee substitute or coffee blend. The slightly bitter, curled dandelion-like greens (called Italian dandelion) are grown and used as potherbs. Witloof chicory (also called French endive) is forced as a blanched, tender, fresh salad delicacy. It is sold in some produce markets at high prices.

Varieties

Catalogna/Cut Leaf Type:

- **Catalogna Special** - 40 days to maturity. Italian dandelion. Can be harvested "baby size" 3 or 4 weeks after transplanting, or left to grow into heavy tall bunches. Long, deep green, slender, deeply cut leave.

- **Magdefurgh** - 100 days to maturity. Italian dandelion. Medium green tender dandelion-like foliage. Excellent for Italian salads or leaves can be cooked like Spinach. Roots are tapered and white. Dried ground up roots can be used as a coffee substitute.

- **San Pasquale** - 70 days to maturity. Broader, more deeply cut leaves than Italian Dandelion. Large, yield more deeply cut leaves.

Forcing:

- **Toner** - 130 days to maturity. Highest quality chicons, least fussy variety for home production. Intended for fall harvest and forcing October to March.

- **Witloof Improved(French Endive)** - 110 days to maturity. May be used for commercial forcing in home gardens. Leaf stalks are broad, heads are very uniform.

-Turbo Hybrid - 110 days to maturity. Biennial. Produces a refined chicon for European restaurant sales. Slender well finished uniform heads tolerant to brown axes.

Radicchio:

- Giulio - 60 days to maturity. For spring planting. Compact plant with brilliant garnet colored, white ribbed head. Resistant to bolting.

- Adria - 75 days to maturity. Crimson heads, white veins, 60% marketable heads. Plant seeds 1/2 inch deep (12 to 15 seeds per foot of row). Allow 18 to 24 inches between rows. When the seedlings are 2 to 3 inches high, thin them to 9 to 12 inches apart for chicory roots and greens and 3 to 4 inches apart for Witloof. Plant in May for greens and roots and about 120 days before frost for production of roots for forcing.

- Greens - Young, tender leaves can be harvested for greens in 60 to 70 days when they are 6 to 8 inches long. Chicory may also be blanched by tying the outermost leaves in the same manner as endive and escarole.

- Chicory Root - Chicory root is grown as a long-season annual. Most commercial production is in Michigan, but chicory root is easily grown under Arkansas conditions. Dig roots in the late fall before they are frozen in the garden. The roots will be 5 to 7 inches in diameter at the crown and tapered into a taproot. The usable root will be 9 to 10 inches long. The roots are scrubbed to remove garden soil, cubed, and roasted for grinding.

Forcing Chicory

Do not plant seeds too early for forcing roots. The roots may grow too large or develop flower stalks, making them unsuitable for forcing. Roots with a diameter of 1 to 1 3/4 inches at the crown are preferred for forcing. When the weather becomes cold, dig the roots and cut off the tops about 2 inches above the crown (top of root). Store the roots in a cool place with high moisture such as an outdoor vegetable pit or underground cellar.

During the winter and early spring, roots can be prepared in a new forcing box every two to three weeks for a continuous supply. Most gardeners put their forcing boxes in the basement because lack of light does not affect the quality of the Witloof heads. Some gardeners use cold frames or hotbeds or force in a trench in the garden. A sheet of clear or black polyethylene film should be placed over the trench to increase soil temperature.

Cut off the slender tips so that the roots are a uniform length (6 to 8 inches) and place the roots close together in a box or other container.

Fill with sand or fine soil sifted in between the roots up to the tops of the crowns. Add 6 to 8 inches of sand or sawdust over the crowns.The blanched tops will grow into compact, pointed heads. The proper temperature for forcing is between 60 and 70 degrees F. Water thoroughly after preparing the forcing box. One or two additional waterings may be necessary. Forcing requires three to four weeks to develop firm heads.

When the heads break the surface, remove the sand or sawdust. Cut off the head with a knife at the point of attachment with the root. Prepare heads for the kitchen by removing dirty and loose outer leaves. Store the excess in a plastic bag in the refrigerator.Chicory heads will keep for two to four weeks.

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Chicory - Chicorium intybus

Chicory is an unusual plant in that, although it has been cultivated for over 1,000 years, it is still very wild-looking and shows but slight effects of its association with man. Chicory is a native of Europe but is as common as a weed in the United States.

Chicory is a hardy vegetable that is used in three basic forms. The roots are dried, roasted, and prepared as a coffee substitute or coffee blend. The slightly bitter, curled dandelion-like greens (called Italian dandelion) are grown and used as potherbs. Witloof chicory (also called French endive) is forced as a blanched, tender, fresh salad delicacy. It is sold in some produce markets at high prices.

Varieties

Catalogna/Cut Leaf Type:

- Catalogna Special - 40 days to maturity. Italian dandelion. Can be harvested "baby size" 3 or 4 weeks after transplanting, or left to grow into heavy tall bunches. Long, deep green, slender, deeply cut leave.

- Magdefurgh - 100 days to maturity. Italian dandelion. Medium green tender dandelion-like foliage. Excellent for Italian salads or leaves can be cooked like Spinach. Roots are tapered and white. Dried ground up roots can be used as a coffee substitute.

- San Pasquale - 70 days to maturity. Broader, more deeply cut leaves than Italian Dandelion. Large, yield more deeply cut leaves.

Forcing:

- Toner - 130 days to maturity. Highest quality chicons, least fussy variety for home production. Intended for fall harvest and forcing October to March.

- Witloof Improved(French Endive) - 110 days to maturity. May be used for commercial forcing in home gardens. Leaf stalks are broad, heads are very uniform.

-Turbo Hybrid - 110 days to maturity. Biennial. Produces a refined chicon for European restaurant sales. Slender well finished uniform heads tolerant to brown axes.

Radicchio:

- Giulio - 60 days to maturity. For spring planting. Compact plant with brilliant garnet colored,

white ribbed head. Resistant to bolting.

- Adria - 75 days to maturity. Crimson heads, white veins, 60% marketable heads. Plant seeds 1/2 inch deep (12 to 15 seeds per foot of row). Allow 18 to 24 inches between rows. When the seedlings are 2 to 3 inches high, thin them to 9 to 12 inches apart for chicory roots and greens and 3 to 4 inches apart for Witloof. Plant in May for greens and roots and about 120 days before frost for production of roots for forcing.

- Greens - Young, tender leaves can be harvested for greens in 60 to 70 days when they are 6 to 8 inches long. Chicory may also be blanched by tying the outermost leaves in the same manner as endive and escarole.

- Chicory Root - Chicory root is grown as a long-season annual. Most commercial production is in Michigan, but chicory root is easily grown under Arkansas conditions. Dig roots in the late fall before they are frozen in the garden. The roots will be 5 to 7 inches in diameter at the crown and tapered into a taproot. The usable root will be 9 to 10 inches long. The roots are scrubbed to remove garden soil, cubed, and roasted for grinding.

Forcing Chicory

Do not plant seeds too early for forcing roots. The roots may grow too large or develop flower stalks, making them unsuitable for forcing. Roots with a diameter of 1 to 1 3/4 inches at the crown are preferred for forcing. When the weather becomes cold, dig the roots and cut off the tops about 2 inches above the crown (top of root). Store the roots in a cool place with high moisture such as an outdoor vegetable pit or underground cellar.

During the winter and early spring, roots can be prepared in a new forcing box every two to three weeks for a continuous supply. Most gardeners put their forcing boxes in the basement because lack of light does not affect the quality of the Witloof heads. Some gardeners use cold frames or hotbeds or force in a trench in the garden. A sheet of clear or black polyethylene film should be placed over the trench to increase soil temperature.

Cut off the slender tips so that the roots are a uniform length (6 to 8 inches) and place the roots close together in a box or other container. Fill with sand or fine soil sifted in between the roots up to the tops of the crowns. Add 6 to 8 inches of sand or sawdust over the crowns.The blanched tops will grow into compact, pointed heads. The proper temperature for forcing is between 60 and 70 degrees F. Water thoroughly after preparing the forcing box. One or two additional waterings may be necessary. Forcing requires three to four weeks to develop firm heads.

When the heads break the surface, remove the sand or sawdust. Cut off the head with a knife at the point of attachment with the root. Prepare heads for the kitchen by removing dirty and loose outer leaves. Store the excess in a plastic bag in the refrigerator.Chicory heads will keep for two to four weeks.

Related web pages:

- None identified.

Commercial suppliers:

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Electronic mailing lists:

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Growing Chinese Cabbage

Frequently Asked Questions Other Information Sources Return to Garden Contents

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Chinese Cabbage - Brassica pekinensis, Brassica chinensis

Chinese cabbage is indigenous to China, where it has been cultivated since the 500 A.D. Its name is quite misleading; Chinese cabbage is more closely related to turnips and swedes than any sort of cabbage.

Chinese cabbage (also known as celery cabbage and Wong Bok) is grown in Arkansas mostly in the fall. Its mild flavor is similar to that of celery (although Chinese cabbage is not related to celery), and its leaves are thinner and more delicate than those of cabbage. Unfortunately, many gardeners do not consider growing Chinese cabbage as a salad vegetable due to failure of spring sowing to form desirable heads.

Chinese cabbage describes several greens which differ considerably. Like cabbage, they are cool season crops and bolt or go to seed in long days of late spring and summer. They grow best as a fall or early winter crop in most areas of Arkansas. Cultural practices are the same as for regular cabbage although Chinese cabbage matures quicker and may be ready in as few as 60 to 65 days from seeding. Chinese cabbage is used fresh in salads or cooked like regular cabbage.

Varieties

- **China Pride Hybrid** - 64 days to maturity. Best for fall planting.

- **Jade Pagoda Hybrid** - 72 days to maturity. Best for fall planting. Widely adapted, high yields.

- **Blues Hybrid** - 65 days to maturity. Best for spring and early summer.

When to plant

For best development, it is important not to interrupt growth. Since Chinese cabbage seedlings are more sensitive to transplanting than cabbage seedlings, the plants are best started in individual containers (peat pellets, pots, etc.) for spring planting. Transplant two to three weeks before the east frost-free date and before the plants are too old (four to five weeks). Sowing seed directly in the garden may not allow enough time for the seedlings to grow before warm summer days stimulate seedstalk formation and the plant is useless.

Chinese cabbage develops best during cool weather and is an excellent vegetable for fall gardeners. Start seed in early to midsummer and transplant at the same time as late cabbage.

Spacing of plants and depth of planting

Space plants 12 inches apart for upright varieties such as Michili and 15 to 24 inches apart for the larger heading types. For fall planting, sow seed directly in the garden 1/4 to 1/2 inch deep. Keep the soil moist and thin or transplant with care. If possible, start seed in a protected place and transplant on a cloudy day. Use a starter fertilizer solution when planting.

Care

Maintain sufficient soil moisture to keep the plants growing vigorously. Sidedress with nitrogen fertilizer when the plants are half grown.

Chinese cabbage quickly goes to seed during warm summer days. Dry weather accelerates the process. For best results, choose early varieties, start plants in individual containers, and transplant after the hard frost in the spring. Late spring-seeded Chinese cabbage will also go to seed.

Harvesting

The Pakchoi type develops long, loose, dark green leaves.The Pe-tsai type forms moderately firm one- to three-pound heads. The blanched inner leaves resemble lettuce. They are crisp, delicate in flavor, and an excellent salad green.

Cut the entire plant at groundline when the heads are compact and firm. Harvest before the seedstalks form in early summer and before hard freezing temperatures in the fall.

Related web pages:

- None identified.

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Growing Collards

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Collards - Brassica oleraceaacephala

Collards are one of the most primitive members of the cabbage group. These leafy, non-heading cabbages originated in the eastern Mediterranean or similar to Asia Minor and are the wild forms of cabbage first used for food in prehistoric times. They were cultivated by the ancient Greeks and Romans, and either the Romans or the Celts introduced them to Britain and France. They reached the British Isles in 400 B.C. The first mention of collards in America was in 1669, but they may have existed here much earlier.

Collards (also known as tree cabbage or non-heading cabbage) are cool-season vegetable greens. They grow better in warm weather and can tolerate more cold weather in the late fall than any other member of the cabbage family. Although collards are popular substitutes for cabbage in the South, they can also be grown in northern areas because of their tolerance to frost. Collards are close relatives to kale.

Collards are extremely nutritious because they have a high content of vitamins A and C. The taste is similar to cabbage. A light frost near harvest time improves the flavor of collard greens.

Varieties

- **Georgia** - 75 days to maturity. Large, crumpled blue-green leaves, tolerant to heat and cold, good yield.
- **Vates** - 75 days to maturity. Large, crumpled dark green leaves, holds color in cold weather, resistant to bolting, good yield.

Planting

Plant in early spring for summer harvest and again in midsummer for fall and early winter harvest.

Sow seed 1/4 to 1/2 inch deep. Thin seedlings to 6 to 12 inches apart to allow enough space for plants to mature. Thinned plants may be eaten. Allow at least 3 feet between rows because plants become large. For early production in fall or spring, use transplants.

If you maintain ample soil moisture during hot periods in the summer, collards will produce an abundant harvest.

Harvesting

All green parts of the plant are edible and may be harvested at any time during the growing season. Plants grown 6 inches apart can be cut at ground level when they reach 6 to 10 inches in height. As an alternative method of harvesting, you can pick the large leaves when the plants are 10 to 12 inches high. This harvesting method allows the younger leaves to develop for later use.

Some gardeners prefer the young, tender leaves and cut the inner rosette of young growth. This "loose head" may be blanched by tying the outer leaves together to keep out the sun. Frost improves the flavor in the fall.

Bacterial soft rot can enter through the broken areas where the leaves were removed. This can be controlled with a spray of Kocide 101 or copper bordeaux at harvesting.

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Growing Cucumbers

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Growing Dandelions

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Dandelions - Taraxacum officinale - Perennial

Dandelions are native to the temperate zones of all continents. However, most of the Taraxacum species are indigenous to Eurasia; two are indigenous to America.

Dandelions are hardy perennials whose leaves are gathered as pot herbs or greens. Young leaves are eaten in salads, boiled, steamed, sauteed, fried, braised, etc. The roots are eaten raw, or cooked and served like salsify. Dandelion wine is made from the flowers. Dandelion may be cultivated in the home garden when wild plants are not available.

Varieties

Broad Leaved - (Thick-Leaved or Cabbage-Leaved) 95 days to harvest. Large, broad, dark-green leaves; more deeply lobed along the axis of the leaf than those of the wild dandelion; thick and tender. In rich soil, each plant spreads 18 - 24 inches across.

Planting

Dandelion requires a long growing season and develops best at low temperatures. Sow seeds 1/4 to 1/2 inch deep in May to early summer and thin seedlings to 8 to 12 inches apart in the row. The plants form a rosette of leaves and overwinter in the garden. They will grow in any well-drained garden soil. A polyethylene tunnel can be placed over the row to force growth for late winter or early spring cutting.

Dandelions can be grown in the garden and should be treated similar to lettuce. If grown for a fall crop it should be planted in mid-summer. Dandelion is a perennial and can become a problem in gardens if allowed to grow unchecked.

Harvesting

Harvest in the fall when plants are of satisfactory size. Cut just below the crown with a sharp knife so that the leaves remain attached. Unharvested plants may be left for use in the following spring. Harvest in early spring before the plants form flower stalks and go to seed. If flowering occurs, the greens will become bitter and of poor quality. Some gardeners blanch the inner rosette of leaves by tying the outer leaves together over the plant. Blanching makes the leaves milder and less bitter.

Dandelion is extremely high in iron and vitamin A. The young tender leaves fresh from the garden are used in salads or served with vinegar, and crumbled bacon.

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Electronic mailing lists:

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Growing Eggplant

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Eggplant - Solanum melongena - Perennial

Eggplant is a native of India but is widely grown in the warmer regions of both hemispheres, especially in the West Indies and southern United States.

Eggplant (also known as guinea squash) is a very tender vegetable that requires a long, warm season for best yields. The culture of eggplant is similar to that of tomatoes, but eggplants are spaced closer together than tomato plants and are not staked. Eggplant require careful attention for a good harvest. Small-fruited and ornamental varieties can be grown in containers, or for decorative purposes.

Varieties

- **Classic** - 76 days to maturity. An extremely productive hybrid: long, slim, tapered fruit, glossy black color.
- **Jersey King Hybrid** - 73 days to maturity. Long, slim, tapered fruits, good quality.
- **Dusky Hybrid** - 63 days to maturity. Resistant to mosaic. Early hybrid; attractive oval fruit on compact plants.

Planting

Eggplants are best started by transplanting, and it is important to get the plant off to a proper start. Select plants that have soil with the roots. Do not plant too early. Transplant after the soil has warmed and the danger of frost has passed. Eggplants are more susceptible than tomato plants to injury from low temperatures.

Space plants 18 to 20 inches apart in the row. Three to six plants are usually sufficient for most families. Allow 30 to 36 inches between rows.

Use a starter fertilizer solution when transplanting. Sidedress nitrogen when the plants are half grown and again immediately after harvest of the first fruits. The plants will tolerate dry weather after they are well established, but you should irrigate during extended dry periods. Eggplant thrives during the heat of summer.

Harvesting

Days to maturity: 100-150 days from seed; 70-85 days from transplants

Harvest the fruits when they are 6 to 8 inches long and glossy. Fruit should be large, shiny, and a uniformly deep purple color. When the side of the fruit is pressed slightly with thumbnail and an indentation remains, the fruit is ripe. Long, slender, Japanese eggplant may be ready to harvest from finger or hotdog size. If fruit is a dull color and has brown seeds, it is too ripe and should be discarded. Use a knife or pruning shears rather than breaking or twisting the stems. Leave the large, usually green, calyx attached to the fruit.

When the fruits become dull and brown, they are too mature for culinary use and should be cut off and discarded. Overmature fruits are spongy and seedy. The fruit does not store well and should be eaten soon after it is harvested. Large, vigorous plants can yield as many as four to six fruits at the peak of the season.

Yields: (per 10 feet of row) 20 pounds

Amount per person: 12 lbs.

Storage: cool (45F-50F), moist (90% RH) conditions; 1 week

Preservation: freeze, pickle

Problems

Verticillium wilt causes yellowing, wilting, and death of the plants. **Flea beetles** cause tiny holes in the leaves, and damage can be severe if unchecked. These beetles can be controlled by applying an insecticide.

Diseases: Verticillium wilt

Insects: flea beetles, aphids, lace bugs, Colorado potato beetle, red spider mites

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Questions and Answers

I planted my eggplants early, but they did not grow very well. Why?

They probably were planted while the soil was too cold. It is better to hold the plants (but keep them growing) until the soil warms. Eggplant should be planted one week later than tomatoes. Mulching with black plastic film can help warm the soil.

The fruit on my eggplant was delicious during its early production. Now, the fruit we harvest is bitter and has brown areas on it.

The bitter fruit is caused by plant stress and subsequent slow growth stimulated by hot, dry weather. The brown area is caused by sun scalding. If the scalding is not too severe, it can be removed and the eggplant eaten.

What causes eggplant fruit to become misshapen and odd colored?

Poor-quality eggplant fruit are generally associated with low moisture and high temperature conditions. Overmature eggplant fruit will become dull-colored and often develop a bronze appearance. For maximum production, remove the eggplant fruit before they are fully mature to allow additional fruit to develop.

Recently one of my eggplants died within a few days. I found a white fungal mat at the base of the plant.What caused this?

This is southern blight, a soilborne disease which can be controlled by crop rotation and prompt removal of dead plant material.

The fruit of my eggplant develops a rotted area which extends deep into the fruit.

This is probably Alternaria fruit rot but could be caused by several things. This is not to be confused with Phomopsis fruit rot which produces a dish-shaped spot which turns brown and has ring-like structures around it. Alternaria fruit rot is controlled with the normal fungicide spray program.

My eggplants have quit producing. The upper leaves are turning yellow and falling off.

These are symptoms of spider mites. Check the underside of the leaves for small red mites.

Related web pages:

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- Saving Seeds : The Gardener's Guide to Growing and Storing Vegetable and Flower Seeds - by Marc Rogers, Polly Alexander (Illustrator) - Publication Date: March 1991 - List: $12.95
- Seed to Seed - by Suzanne Ashworth - Publication Date: January 1, 1995 - List: $20.00
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  Loewer examines the vast and often surprisingly complex world of seeds in an unparalleled thoroughness. In addition to the how-to of growing all kinds of plants and vegetables from seed, the book also considers the role of seeds in history, literature, and business. 100 line drawings.
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- Burpee : The Complete Vegetable & Herb Gardener : A Guide to Growing Your Garden
  Organically - by Karan Davis Cutler, Cavagnarok David (Photographer), Barbara W. Ellis - Publication Date: November 1997 - List: $29.95

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  Booknews, Inc. , 01/01/93:
  Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.
- Gardening Under Cover : A Northwest Guide to Solar Greenhouses, Cold Frames, and Cloches - by William Head - Publication Date: November 1989 - List: $10.95
  This is a complete guide to gardening with protective shelters that encourages both beginning and experienced gardeners to add months of gardening pleasure at small expense. With a little under-cover gardening know-how, Pacific Northwest gardeners can take advantage of our mild climate to produce flowers, herbs, and vegetables throughout the year.
- Grow It : The Beginner's Complete In-Harmony-With-Nature Small Farm Guide-From Vegetable and Grain Growing to Livestock Care - by Richard W. Langer, Susan McNeill (Illustrator) - Publication Date: January 1994 - List: $12.00
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Gardeners and Small Farmers - by Ron L. Engeland - Publication Date: July 1995 - List: $14.95

- Heirloom Vegetable Gardening : A Master Gardener's Guide to Planting, Growing, Seed Saving, and Cultural History - by William Woys Weaver - Publication Date: June 1997 - List: $45.00
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- Peppers : The Domesticated Capsicums - by Jean Andrews - Publication Date: October 1995 - List: $65.00
  Booknews, Inc. , 04/01/96:
  An updated edition (first, 1984) of an elegantly produced, scholarly reference on peppers--their history and dispersion, biology, taxonomy, cultivation, and medicinal, economic, and gastronomic uses. Illustrated with the author's botanically accurate, aesthetically pleasing paintings that show the blossoms, buds, young peppers, and mature specimens of 34 cultivars. A review of the literature, a photo glossary, and an extensive bibliography add to the volume's reference value. 9x12" Annotation c. by Book News, Inc., Portland, Or.

- Peppers of the World : An Identification Guide - by Dave

Dewitt, Paul W. Bosland - Publication Date: January 1997 - List: $19.95

- Plant Propagation : Principles and Practices - by Hudson Thomas Hartmann (Editor), Dale E. Kester, Fred T., Jr. Davies - Publication Date: January 1997 - List: $86.00
  The publisher, Prentice-Hall Career & Technology : Hallmarked as the most successful text of its kind, this remarkably thorough text covers all aspects of the propagation of plants - both sexual and asexual - with considerable attention given to human (vs natural) efforts to increase plant numbers.

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  This expansion of a now-classic guide originally published in 1989 is intended for the serious gardener or small-scale market farmer. It describes practical and sustainable ways of growing superb organic vegetables, with detailed coverage of scale and capital, marketing, livestock, the winter garden, soil fertility, weeds, and many other topics. Annotation c. by Book News, Inc., Portland, Or.

- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Eggplant - Solanum melongena - Perennial

Eggplant is a native of India but is widely grown in the warmer regions of both hemispheres, especially in the West Indies and southern United States.

Eggplant (also known as guinea squash) is a very tender vegetable that requires a long, warm season for best yields. The culture of eggplant is similar to that of tomatoes, but eggplants are spaced closer together than tomato plants and are not staked. Eggplant require careful attention for a good harvest. Small-fruited and ornamental varieties can be grown in containers, or for decorative purposes.

Varieties

- **Classic** - 76 days to maturity. An extremely productive hybrid: long, slim, tapered fruit, glossy black color.
- **Jersey King Hybrid** - 73 days to maturity. Long, slim, tapered fruits, good quality.
- **Dusky Hybrid** - 63 days to maturity. Resistant to mosaic. Early hybrid; attractive oval fruit on compact plants.

Planting

Eggplants are best started by transplanting, and it is important to get the plant off to a proper start. Select plants that have soil with the roots. Do not plant too early. Transplant after the soil has warmed and the danger of frost has passed. Eggplants are more susceptible than tomato plants to injury from low temperatures.

Space plants 18 to 20 inches apart in the row. Three to six plants are usually sufficient for most families. Allow 30 to 36 inches between rows.

Use a starter fertilizer solution when transplanting. Sidedress nitrogen when the plants are half grown and again immediately after harvest of the first fruits. The plants will tolerate dry weather after they are well established, but you should irrigate during extended dry periods. Eggplant thrives during the heat of summer.

Harvesting

Days to maturity: 100-150 days from seed; 70-85 days from transplants

Harvest the fruits when they are 6 to 8 inches long and glossy. Fruit should be large, shiny, and a uniformly deep purple color. When the side of the fruit is pressed slightly with thumbnail and an indentation remains, the fruit is ripe. Long, slender, Japanese eggplant may be ready to harvest from finger or hotdog size. If fruit is a dull color and has brown seeds, it is too ripe and should be discarded. Use a knife or pruning shears rather than breaking or twisting the stems. Leave the large, usually green, calyx attached to the fruit.

When the fruits become dull and brown, they are too mature for culinary use and should be cut off and discarded. Overmature fruits are spongy and seedy. The fruit does not store well and should be eaten soon after it is harvested. Large, vigorous plants can yield as many as four to six fruits at the peak of the season.

Yields: (per 10 feet of row) 20 pounds

Amount per person: 12 lbs.

Storage: cool (45F-50F), moist (90% RH) conditions; 1 week

Preservation: freeze, pickle

Problems

Verticillium wilt causes yellowing, wilting, and death of the plants. **Flea beetles** cause tiny holes in the leaves, and damage can be severe if unchecked. These beetles can be controlled by applying an insecticide.

Diseases: Verticillium wilt

Insects: flea beetles, aphids, lace bugs, Colorado potato beetle, red spider mites

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Questions and Answers

I planted my eggplants early, but they did not grow very well. Why?

They probably were planted while the soil was too cold. It is better to hold the plants (but keep them growing) until the soil warms. Eggplant should be planted one week later than tomatoes. Mulching with black plastic film can help warm the soil.

The fruit on my eggplant was delicious during its early production. Now, the fruit we harvest is bitter and has brown areas on it.

The bitter fruit is caused by plant stress and subsequent slow growth stimulated by hot, dry weather. The brown area is caused by sun scalding. If the scalding is not too severe, it can be removed and the eggplant eaten.

What causes eggplant fruit to become misshapen and odd colored?

Poor-quality eggplant fruit are generally associated with low moisture and high temperature conditions. Overmature eggplant fruit will become dull-colored and often develop a bronze appearance. For maximum production, remove the eggplant fruit before they are fully mature to allow additional fruit to develop.

Recently one of my eggplants died within a few days. I found a white fungal mat at the base of the plant.What caused this?

This is southern blight, a soilborne disease which can be controlled by crop rotation and prompt removal of dead plant material.

The fruit of my eggplant develops a rotted area which extends deep into the fruit.

This is probably Alternaria fruit rot but could be caused by several things. This is not to be confused with Phomopsis fruit rot which produces a dish-shaped spot which turns brown and has ring-like structures around it. Alternaria fruit rot is controlled with the normal fungicide spray program.

My eggplants have quit producing. The upper leaves are turning yellow and falling off.

These are symptoms of spider mites. Check the underside of the leaves for small red mites.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan - Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed. Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable information. Original.*
- Collecting Processing and Germinating Seeds of Wildland Plants - by Cheryl Young, James A. Young - Publication Date: October 1, 1986 - List: $24.95
- Enduring Seeds : Native American Agriculture and Wild Plant Conservation - by Gary Paul Nabhan - Publication Date: April 1, 1991 - List: $14.00
- From Seed to Plant - by Gail Gibbons - Publication Date: March 1, 1991 - List: $15.95
  Explores the intricate relationship between seeds and the plants which they produce.
- Kid's Gardening : A Kid's Guide to Messing Around in the Dirt/With Seeds - by Kevin Raftery, Kim Gilbert Raftery, Jim M'Guinness - Publication Date: May 1, 1989 - List: $13.95
  Now young readers will know from whence those carrots came. This full-color extravaganza contains nearly a hundred pages of wipe-clean cardstock, hundreds of illustrations, dozens of growing activities, plus 15 varieties of vegetable, flower, and herb seeds.
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Periodicals:

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Growing Garlic

Frequently Asked Questions Other Information Sources Return to Garden Contents

Frequently Asked Questions:

- How do you grow garlic?
- How do I know when my garlic is ready to harvest?

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- Commercial suppliers
- Electronic mailing lists
- Suggested references
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Culinary Herb Gardening

Herbs are easy to grow. Just as there are requirements for growing vegetables and flowers, there are specific needs for the maintenance of herbs.

Generally, in Massachusetts herbs must be treated as annuals, particularly in areas subject to winters with zero to sub-zero temperatures. Sage, mint, thyme and chives are exceptions. Most herb seeds germinate readily, and mature plants can withstand drying conditions; however, they do need watering during prolonged drought.

Maintaining a small herb garden takes a little work. Once the planting chores are completed, weeding, watering, and some insect and disease preventative treatments are required. Friable, fertile soil and good drainage are essential, and a sunny location is preferable. The garden need not be large: a few short rows incorporated into the vegetable garden, border plantings for your flower garden, small plants in window boxes, or just a patch beside the kitchen door. A few plants of each desired species will be sufficient for the average-size family's needs. Remember, herbs have strong aromas and flavors -- little more than a pinch should ever be used in flavoring.

When planning an herb garden, consider the mature growth habits of the selected species (tall or short, spreading or upright), and the growing season length of each species. Some herbs die with the first touch of frost while others survive up to solid freezing.

Before preparing your garden, have the soil tested for acidity and fertilizing requirements. In general, a pH reading of 6.2 to 6.7 favors good growth of garden plants, but herbs prefer more alkalinity, growing well in soil with pH readings of 7.0 to 7.2. Lime is used to adjust a low pH upward. Acidity rating: 7.0 is neutral, any reading below that is an

acid reaction; any reading higher than 7.0 is alkaline. Applying lime in the fall allows for the use of Agricultural (hydrated) lime, which reacts in the soil more rapidly than ground limestone but is more expensive. Agricultural lime will burn plants if carelessly applied during the growing season. Ground limestone may be used either in spring or fall, is slowly available to plants and soil, and will not burn.

Manures may be used for feeding herbs; a dried cow manure product is recommended over other manures. Commercial fertilizers with a 5-10-5 formulation can also be used in place of manure at rates recommended by your Cooperative Extension agent. These recommendations will be based on your soil test results.

Add organic material, such as peat or humus, along with the lime and fertilizer; turn in thoroughly, and with a spade, dig deep into the soil. If mint is to be included in your garden, be sure to put in metal restraining bands such as those used to edge lawns. One inch of metal should show above the soil level to keep these spreading plants from wandering.

Plan your garden on paper, keeping in mind the growth habits of the herbs you want to grow, and in the spring, you may anticipate a pleasant afternoon's work. With garden plan, seed and identification labels in hand, plant seed at a depth four times the seed's diameter. Cover with fine soil, firm in place, and gently water.

If you are transplanting seedlings or young plants, put them in late afternoon, early evening, or on a cloudy day because they wilt readily after transplanting under hot sun. To prevent disturbing the roots of these seedlings, include a ball of soil with each little plant. Place the plants in watered, drained holes which have been dug deep enough to accommodate the root and soil ball. Fill the hole with soil to the same level on the plant's stem as it was in the flat before tranlsplanting. Keep the garden moist for the next few days to help establish the roots.

Fresh herbs are used as garnish on salads, with shellfish, in casseroles, dips, and salads. Dried herbs flavor stews, soup, meat and chowders, and many substitute in salads when fresh greens are not available.

Herb flavors are retained longer if the harvested plant parts are cut at the right time, cured and stored properly. Tender young leaves may be used all during the growing season. To harvest for drying, pick the leaves when flowering begins, and dry as quickly as possible in an airy, dry, heated and darkened area, such as an attic. This will keep the green color in the leaves and prevent molding. Harvest seeds when they are brown. Herbs such as rosemary and thyme can be partially sundried without losing color, but do not overexpose them. When the plant parts are thoroughly dry, discard the debris of old stems. Pack the dried herbal material into dark glass or metal containers with tight-fitting tops. This will preserve those essential oils that give delicious flavors

and aromas.

Try growing some of these herbs as potted house plants for winter use. They are decorative as well as flavorful. Chives, parsley, and sweet basil are suggestions. Consider your geraniums as herbs too. Rather than trying to pot the entire plant from the garden, start your new house plants from cuttings or root divisions. When well established in pots, place them where they will receive plenty of sunlight.

BASIL (Ocimum basilicum)

Basil is an attractive annual, about 18 inches tall, that has light-green, fairly broad leaves. The flowers are small, white, and appear in spikes. There are several species of basil cultivated, one having purple leaves.Basil grows easily from seed planted after all danger of frost has passed. Pinch stems to promote bushy, compact growth. Avoid lush growth as it may reduce flavor.

Green leaves can be picked about 6 weeks following planting. It is best to cut leaves for drying just before flowers open.

Spicy-scented basil leaves are one of the most popular of all herbs used in cooking. Cooks favor basil for tomato dishes in either fresh or dried form.

BORAGE (Borago officinalis)

Borage is a decorative annual with coarse, very hairy leaves and stems and beautiful sky-blue flowers in a star-shape. The plant grows about 2 to 3 feet tall. Borage is easily grown from seed and will sow itself. This plant does best in dry, sunny places. Although it is difficult to transplant, you can stretch out the harvest by sowing three times at 4-week intervals.

Pick blossoms as they open. Use leaves fresh anytime; they are seldom dried.

Sprays of borage flowers and leaves are used to give a cool, cucumber-like flavor to summer drinks. Bees are attracted to the borage plant.

CHERVIL (Anthriscus cerefolium)

Chervil is an annual plant that grows up to 2 feet in height. It has lacy leaves resembling parsley but in a lighter shade of green. The flat heads have delicate white flowers. Chervil can be raised from seed sown in the garden in early spring. Seedlings are difficult to transplant. Thin

plants 3 to 4 inches apart. For denser foliage, cut the flower stems before bloom.

Pick leaves just before the buds break. Cut and dry the green, tender leaves.

Chervil leaves are used much as is parsley -- in soups, salads, sauces, egg dishes, and cheese souffles.

CHIVES (Allium schoenoprasum)

Chives are small, dainty, onion-like plants that grow in clumps reaching about 10 inches in height. They are a hardy-perennial with decorative, light purple flowers. Chives demand little care other than dividing when they become overcrowded. They are easily propagated by division or from seed and make attractive border plants.

Cut fresh leaves for use as they grow.

Chives are used to impart a delicious, subtle, onion-like flavor to foods.

DILL (Anethum graveolens)

Dill, a popular annual, has bluish-green stems that contrast with finely divided, yellow-green, plume-like leaves and yellowish flowers. Dill grows about 2 to 3 feet high. Dill is easily grown from seed sown in the garden in spring after all danger of frost has passed. Sow the seed where you want it to grow as it is difficult to transplant. Stake tall plants.

For best results, pick leaves just as flowers open. Pick seeds when they are flat and brown.

Both the leaves and seeds of dill are popular for flavoring pickles, sauerkraut, and beet dishes. It can be combined with garlic and pepper to produce a highly flavored Mediterranean or East European pork roast (often cooked over a spit outdoors). The seeds yield a fragrant oil.

GARLIC (Allium sativum)

A bulb growing 18 inches high with leaves resembling gladiolus. Garlic produces a group of cloves, encased in a sheath rather than a single bulb. Separate the cloves for planting. The larger outer cloves produce the best garlic. Garlic can be planted in fall (September) or in spring (May). Fall-planted garlic and spring-planted garlic are harvested at approximately the same time, but the fall-planted will be larger. Plant cloves with points up in rows 12 inches apart with the cloves spaced 5

to 6 inches apart. Fall-planted cloves should be planted 2 inches deep so frost will not heave them out of the soil whereas spring-planted garlic need only be planted 1 inch deep.

Harvest garlic when the tops die down. To prepare garlic for long term storage, cure the bulbs for 4 to 6 weeks in a warm, dry, shady location where there is very good air circulation. Pile bulbs no more than 2 to 3 inches deep. The purpose is to toughen the outside skin and drive out all moisture beneath the outer scales to prevent decay. After curing, store in a cool, dry, well-ventilated spot. When properly stored, garlic can be kept for many months.

Garlic can be used as a seasoning for meat, vegetables, and cheese dishes.

LOVAGE (Levisticum officinale)

Lovage is a hardy perennial with large, rich green leaves that resemble those of celery. The leaves are stronger tasting but sweeter than celery. Lovage does best in a rich, fairly moist soil and can be propagated from seed planted in late summer.

Use the leaves fresh, or dry them at any time.

The leaves and stems of lovage give a celery flavor to soups and salads. Blanch stem bases before eating.

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Sweet marjoram, usually grown as an annual, is one of the most fragrant and popular of all herbs. Its growth habit is low and spreading, and it reaches a height of about 8 to 12 inches. It has small, oval, gray-green leaves that are velvety to the touch. This plant can be easily grown from seed or cuttings. In colder climates it is best treated as an annual or kept over winter as a pot plant. Its color makes it an attractive border plant.

Sweet marjoram leaves can be used anytime. Cut the leafy stems as flowering and dry for future use.

Sweet marjoram leaves, fresh or dried, can be used as a flavoring in cooking. The oil derived from the leaves is used in making perfume.

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A hardy perennial with many different species. Some examples include spearmint (Mentha spicata), orange (M. citrata), peppermint (M.

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Cut parsley when the leaves are of suitable size. Leaves can be used fresh or dried.

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Use fresh leaves as needed.

Rosemary is a popular flavoring for meats and dressings or as a garnish on large roasts. Oil from leaves is used in medicine.

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Pick the leaves before or at blooming. Cut back the stems after blooming.

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Tarragon leaves have a distinctive flavor similar to anise and are used in salads, marinades, and sauces. Leaves yield flavor to vinegar when steeped.

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small clusters and leaves are very aromatic. This plant grows best in light, well-drained soil. Thin plants 8 to 12 inches apart. It is best to renew the plants every few years. Propagate with cuttings, divisions, or by direct seeding. Thyme is an attractive edging plant or a spreading plant among and over rocks.

Cut leafy tops and flower clusters when first blossoms open and dry.

Thyme is widely used as seasoning. Oil of thyme is used in medicines and perfumes. It goes well in gumbos, bouillabaisse, clam chowder, poultry stuffings, and slow-cooking beef dishes.

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- None identified.

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Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- The Herb Gardener : A Guide for All Seasons - by Susan McClure - Publication Date: February 1, 1996 - List: $29.95
  Synopsis:
  Thoughtfully organized according to season, this complete, easy-to-understand guide provides the facts on 75 different herbs and gives in-depth information on color and design of herb gardens, growing herbs in containers, harvesting, indoor herb gardening, and more. 100 color photos.
- The Spice Ingredients Cookbook : A Definitive Guide to Spices Blends and Aromatic Seeds and How to Use Them in the Kitchen - by Sallie Morris, Lesley MacKley - Publication Date: May 1, 1997 - List: $32.50
- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan - Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed. Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable information. Original.*
- Collecting Processing and Germinating Seeds of Wildland Plants - by Cheryl Young, James A. Young - Publication Date: October 1, 1986 - List: $24.95
- Enduring Seeds : Native American Agriculture and Wild Plant Conservation - by Gary Paul Nabhan - Publication Date: April 1, 1991 - List: $14.00
- From Seed to Plant - by Gail Gibbons - Publication Date: March 1, 1991 - List: $15.95 *Explores the intricate relationship between seeds and the plants which they produce.*
- Kid's Gardening : A Kid's Guide to Messing Around in the Dirt/With Seeds - by Kevin Raftery, Kim Gilbert Raftery, Jim M'Guinness - Publication Date: May 1, 1989 - List: $13.95
  Now young readers will know from whence those carrots came. This full-color extravaganza contains nearly a hundred pages of wipe-clean cardstock, hundreds of illustrations, dozens of growing activities, plus 15 varieties of vegetable, flower, and herb seeds.

- Principles of Seed Science and Technology - by Larry O. Copeland, Miller B. McDonald, Lawrence O. Copeland - Publication Date: March 1, 1995 - List: $74.95
- Saving Seeds : The Gardener's Guide to Growing and Storing Vegetable and Flower Seeds - by Marc Rogers, Polly Alexander (Illustrator) - Publication Date: March 1991 - List: $12.95
- Seed to Seed - by Suzanne Ashworth - Publication Date: January 1, 1995 - List: $20.00
- Seeds : The Definitive Guide to Growing, History, and Lore - by H. Peter Loewer, Peter Loewer - Publication Date: April 1, 1996 - List: $25.00
  Loewer examines the vast and often surprisingly complex world of seeds in an unparalleled thoroughness. In addition to the how-to of growing all kinds of plants and vegetables from seed, the book also considers the role of seeds in history, literature, and business. 100 line drawings.
- Seeds and Propagation (Smith & Hawken--The Hands-On Gardener) - by Susan McClure, Jim Anderson (Illustrator) - Publication Date: June 1, 1997 - List: $10.95
- The New Seed Starter's Handbook - by Nancy Bubel - Publication Date: April 1, 1988 - List: $15.95

- Gardening In Deer Country - by Vincent Drzewucki - Publication Date: January, 1998 - List: $9.95

- 200 Tips for Growing Vegetables in the Northeast - by Miranda Smith - Publication Date: February 1996 - List: $7.95

- 200 Tips for Growing Vegetables in the Pacific Northwest - by Maggie Stuckey - Publication Date: February 1996 - List: $7.95

- Building Your Own Greenhouse (Greenhouse Basics) - by Mark Freeman, Heather Bellanca (Illustrator) - Publication Date: April 1997 - List: $18.95

- Burpee : The Complete Vegetable & Herb Gardener : A Guide to Growing Your Garden
  Organically - by Karan Davis Cutler, Cavagnarok David (Photographer), Barbara W. Ellis - Publication Date: November 1997 - List: $29.95
  Synopsis:
  A companion to Burpee Complete Gardener, this book focuses on all aspects of growing organic vegetables and edible herbs in the home garden. Planting techniques and tools, garden design, and

more than 90 individual plant portraits are included. 300 full-color photos.

- Culinary Gardens : From Garden to Palate - by Susan McClure - Publication Date: September 1997 - List: $37.95
- Five Acres and Independence: A Handbook for Small Farm Management - by Maurice Grenville Kains, Maurice G. Kain - Publication Date: March 1978 - List: $7.95

- Four-Season Harvest : How to Harvest Fresh Organic Vegetables from Your Home Garden All Year Long - by Eliot Coleman, Kathy Bary (Illustrator) - Publication Date: October 1992 - List: $19.95
  Booknews, Inc. , 01/01/93:
  Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.

- Gardening Under Cover : A Northwest Guide to Solar Greenhouses, Cold Frames, and Cloches - by William Head - Publication Date: November 1989 - List: $10.95
  This is a complete guide to gardening with protective shelters that encourages both beginning and experienced gardeners to add months of gardening pleasure at small expense. With a little under-cover gardening know-how, Pacific Northwest gardeners can take advantage of our mild climate to produce flowers, herbs, and vegetables throughout the year.

- Grow It : The Beginner's Complete In-Harmony-With-Nature Small Farm Guide-From Vegetable and Grain Growing to Livestock Care - by Richard W. Langer, Susan McNeill (Illustrator) - Publication Date: January 1994 - List: $12.00
  Synopsis:
  An indispensable guide to small-scale organic farming that features advice on everything from building and stocking a pond to planting an orchard or making cheese. This extremely practical and easy-to-use guide, first published in 1972, is for full-time or part-time country dwellers/gardeners.

- Growing Great Garlic : The Definitive Guide for Organic Gardeners and Small Farmers - by Ron L. Engeland - Publication Date: July 1995 - List: $14.95

- Heirloom Vegetable Gardening : A Master Gardener's Guide to

Planting, Growing, Seed Saving, and Cultural History - by William Woys Weaver - Publication Date: June 1997 - List: $45.00
Synopsis:
Weaver focuses on 280 varieties of 37 vegetables in this encyclopedic guide to the history and cultivation of some of America's most treasured heirloom vegetables. 100+ color photos. 240 line drawings.

- A Dyer's Garden : From Plant to Pot Growing Dyes for Natural Fibers - by Rita Buchanan - Publication Date: August 1995 - List: $9.95

- A Produce Reference Guide to Fruits and Vegetables from Around the World : Nature's Harvest - by Donald D. Heaton - Publication Date: April 1997 - List: $29.95

- Growing Plants from Seed : A Comprehensive Beginners Handbook for Vegetables, Flowers, Herbs and More - by George Abraham, Katy Abraham, Doc Abraham - Publication Date: January 1992 - List: $13.95
Synopsis:
A guide for first-time seed growers addresses soil mixtures, lighting, types of seed, seed-starting kits, and more to help any gardener experience the rewarding feeling of growing flowers and vegetables from seed. Original.

- Peppers : The Domesticated Capsicums - by Jean Andrews - Publication Date: October 1995 - List: $65.00
Booknews, Inc. , 04/01/96:
An updated edition (first, 1984) of an elegantly produced, scholarly reference on peppers--their history and dispersion, biology, taxonomy, cultivation, and medicinal, economic, and gastronomic uses. Illustrated with the author's botanically accurate, aesthetically pleasing paintings that show the blossoms, buds, young peppers, and mature specimens of 34 cultivars. A review of the literature, a photo glossary, and an extensive bibliography add to the volume's reference value. 9x12" Annotation c. by Book News, Inc., Portland, Or.

- Peppers of the World : An Identification Guide - by Dave Dewitt, Paul W. Bosland - Publication Date: January 1997 - List: $19.95

- Plant Propagation : Principles and Practices - by Hudson

Thomas Hartmann (Editor), Dale E. Kester, Fred T., Jr. Davies - Publication Date: January 1997 - List: $86.00
The publisher, Prentice-Hall Career & Technology : Hallmarked as the most successful text of its kind, this remarkably thorough text covers all aspects of the propagation of plants - both sexual and asexual - with considerable attention given to human (vs natural) efforts to increase plant numbers.

- Forest Gardening : Cultivating an Edible Landscape - by Robert A. De J. Hart - Publication Date: September 1996 - List: $17.95

- Handbook of Organic Food Processing and Production - by Simon Wright (Editor) - Publication Date: October 1994 - List: $119.00

- Introduction to Permaculture - by Bill Mollison, Reny Mia Slay - Publication Date: November 1997 - List: $16.95

- Profitable Organic Farming - by Jon Newton - Publication Date: June 1995 - List: $36.95

- The New Organic Grower : A Master's Manual of Tools and Techniques for the Home and Market Gardener - by Eliot Coleman, Sheri Amsel (Illustrator), Molly Cook Field (Illustrator) - Publication Date: October 1995 - List: $24.95
Booknews, Inc. , 05/01/96:
This expansion of a now-classic guide originally published in 1989 is intended for the serious gardener or small-scale market farmer. It describes practical and sustainable ways of growing superb organic vegetables, with detailed coverage of scale and capital, marketing, livestock, the winter garden, soil fertility, weeds, and many other topics. Annotation c. by Book News, Inc., Portland, Or.

- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Culinary Herb Gardening

Herbs are easy to grow. Just as there are requirements for growing vegetables and flowers, there are specific needs for the maintenance of herbs.

Generally, in Massachusetts herbs must be treated as annuals, particularly in areas subject to winters with zero to sub-zero temperatures. Sage, mint, thyme and chives are exceptions. Most herb seeds germinate readily, and mature plants can withstand drying conditions; however, they do need watering during prolonged drought.

Maintaining a small herb garden takes a little work. Once the planting chores are completed, weeding, watering, and some insect and disease preventative treatments are required. Friable, fertile soil and good drainage are essential, and a sunny location is preferable. The garden need not be large: a few short rows incorporated into the vegetable garden, border plantings for your flower garden, small plants in window boxes, or just a patch beside the kitchen door. A few plants of each desired species will be sufficient for the average-size family's needs. Remember, herbs have strong aromas and flavors -- little more than a pinch should ever be used in flavoring.

When planning an herb garden, consider the mature growth habits of the selected species (tall or short, spreading or upright), and the growing season length of each species. Some herbs die with the first touch of frost while others survive up to solid freezing.

Before preparing your garden, have the soil tested for acidity and fertilizing requirements. In general, a pH reading of 6.2 to 6.7 favors good growth of garden plants, but herbs prefer more alkalinity, growing well in soil with pH readings of 7.0 to 7.2. Lime is used to adjust a low pH upward. Acidity rating: 7.0 is neutral, any reading below that is an acid reaction; any reading higher than 7.0 is alkaline. Applying lime in the fall allows for the use of Agricultural (hydrated) lime, which reacts in the soil more rapidly than ground limestone but is more expensive. Agricultural lime will burn plants if carelessly applied during the growing season. Ground limestone may be used either in spring or fall, is slowly available to plants and soil, and will not burn.

Manures may be used for feeding herbs; a dried cow manure product is recommended over other manures. Commercial fertilizers with a 5-10-5 formulation can also be used in place of manure at rates recommended by your Cooperative Extension agent. These recommendations will be based on your soil test results.

Add organic material, such as peat or humus, along with the lime and fertilizer; turn in thoroughly, and with a spade, dig deep into the soil. If mint is to be included in your garden, be sure to put in metal restraining bands such as those used to edge lawns. One inch of metal should show above

the soil level to keep these spreading plants from wandering.

Plan your garden on paper, keeping in mind the growth habits of the herbs you want to grow, and in the spring, you may anticipate a pleasant afternoon's work. With garden plan, seed and identification labels in hand, plant seed at a depth four times the seed's diameter. Cover with fine soil, firm in place, and gently water.

If you are transplanting seedlings or young plants, put them in late afternoon, early evening, or on a cloudy day because they wilt readily after transplanting under hot sun. To prevent disturbing the roots of these seedlings, include a ball of soil with each little plant. Place the plants in watered, drained holes which have been dug deep enough to accommodate the root and soil ball. Fill the hole with soil to the same level on the plant's stem as it was in the flat before tranlsplanting. Keep the garden moist for the next few days to help establish the roots.

Fresh herbs are used as garnish on salads, with shellfish, in casseroles, dips, and salads. Dried herbs flavor stews, soup, meat and chowders, and many substitute in salads when fresh greens are not available.

Herb flavors are retained longer if the harvested plant parts are cut at the right time, cured and stored properly. Tender young leaves may be used all during the growing season. To harvest for drying, pick the leaves when flowering begins, and dry as quickly as possible in an airy, dry, heated and darkened area, such as an attic. This will keep the green color in the leaves and prevent molding. Harvest seeds when they are brown. Herbs such as rosemary and thyme can be partially sundried without losing color, but do not overexpose them. When the plant parts are thoroughly dry, discard the debris of old stems. Pack the dried herbal material into dark glass or metal containers with tight-fitting tops. This will preserve those essential oils that give delicious flavors and aromas.

Try growing some of these herbs as potted house plants for winter use. They are decorative as well as flavorful. Chives, parsley, and sweet basil are suggestions. Consider your geraniums as herbs too. Rather than trying to pot the entire plant from the garden, start your new house plants from cuttings or root divisions. When well established in pots, place them where they will receive plenty of sunlight.

BASIL (Ocimum basilicum)

Basil is an attractive annual, about 18 inches tall, that has light-green, fairly broad leaves. The flowers are small, white, and appear in spikes. There are several species of basil cultivated, one having purple leaves.Basil grows easily from seed planted after all danger of frost has passed. Pinch stems to promote bushy, compact growth. Avoid lush growth as it may reduce flavor.

Green leaves can be picked about 6 weeks following planting. It is best to cut leaves for drying just before flowers open.

Spicy-scented basil leaves are one of the most popular of all herbs used in cooking. Cooks favor basil for tomato dishes in either fresh or dried form.

BORAGE (Borago officinalis)

Borage is a decorative annual with coarse, very hairy leaves and stems and beautiful sky-blue flowers in a star-shape. The plant grows about 2 to 3 feet tall. Borage is easily grown from seed and will sow itself. This plant does best in dry, sunny places. Although it is difficult to transplant, you can stretch out the harvest by sowing three times at 4-week intervals.

Pick blossoms as they open. Use leaves fresh anytime; they are seldom dried.

Sprays of borage flowers and leaves are used to give a cool, cucumber-like flavor to summer drinks. Bees are attracted to the borage plant.

CHERVIL (Anthriscus cerefolium)

Chervil is an annual plant that grows up to 2 feet in height. It has lacy leaves resembling parsley but in a lighter shade of green. The flat heads have delicate white flowers. Chervil can be raised from seed sown in the garden in early spring. Seedlings are difficult to transplant. Thin plants 3 to 4 inches apart. For denser foliage, cut the flower stems before bloom.

Pick leaves just before the buds break. Cut and dry the green, tender leaves.

Chervil leaves are used much as is parsley -- in soups, salads, sauces, egg dishes, and cheese souffles.

CHIVES (Allium schoenoprasum)

Chives are small, dainty, onion-like plants that grow in clumps reaching about 10 inches in height. They are a hardy-perennial with decorative, light purple flowers. Chives demand little care other than dividing when they become overcrowded. They are easily propagated by division or from seed and make attractive border plants.

Cut fresh leaves for use as they grow.

Chives are used to impart a delicious, subtle, onion-like flavor to foods.

DILL (Anethum graveolens)

Dill, a popular annual, has bluish-green stems that contrast with finely divided, yellow-green, plume-like leaves and yellowish flowers. Dill grows about 2 to 3 feet high. Dill is easily grown from seed sown in the garden in spring after all danger of frost has passed. Sow the seed where you want it to grow as it is difficult to transplant. Stake tall plants.

For best results, pick leaves just as flowers open. Pick seeds when they are flat and brown.

Both the leaves and seeds of dill are popular for flavoring pickles, sauerkraut, and beet dishes. It can be combined with garlic and pepper to produce a highly flavored Mediterranean or East European pork roast (often cooked over a spit outdoors). The seeds yield a fragrant oil.

GARLIC (Allium sativum)

A bulb growing 18 inches high with leaves resembling gladiolus. Garlic produces a group of cloves, encased in a sheath rather than a single bulb. Separate the cloves for planting. The larger outer cloves produce the best garlic. Garlic can be planted in fall (September) or in spring (May). Fall-planted garlic and spring-planted garlic are harvested at approximately the same time, but the fall-planted will be larger. Plant cloves with points up in rows 12 inches apart with the cloves spaced 5 to 6 inches apart. Fall-planted cloves should be planted 2 inches deep so frost will not heave them out of the soil whereas spring-planted garlic need only be planted 1 inch deep.

Harvest garlic when the tops die down. To prepare garlic for long term storage, cure the bulbs for 4 to 6 weeks in a warm, dry, shady location where there is very good air circulation. Pile bulbs no more than 2 to 3 inches deep. The purpose is to toughen the outside skin and drive out all moisture beneath the outer scales to prevent decay. After curing, store in a cool, dry, well-ventilated spot. When properly stored, garlic can be kept for many months.

Garlic can be used as a seasoning for meat, vegetables, and cheese dishes.

LOVAGE (Levisticum officinale)

Lovage is a hardy perennial with large, rich green leaves that resemble those of celery. The leaves are stronger tasting but sweeter than celery. Lovage does best in a rich, fairly moist soil and can be propagated from seed planted in late summer.

Use the leaves fresh, or dry them at any time.

The leaves and stems of lovage give a celery flavor to soups and salads. Blanch stem bases before eating.

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  Synopsis:
  Thoughtfully organized according to season, this complete, easy-to-understand guide provides the facts on 75 different herbs and gives in-depth information on color and design of herb gardens, growing herbs in containers, harvesting, indoor herb gardening, and more. 100 color photos.
- The Spice Ingredients Cookbook : A Definitive Guide to Spices Blends and Aromatic Seeds and How to Use Them in the Kitchen - by Sallie Morris, Lesley MacKley - Publication Date: May 1, 1997 - List: $32.50

- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan - Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed. Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable information. Original.*
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  Booknews, Inc. , 01/01/93:
  Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.

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  An updated edition (first, 1984) of an elegantly produced, scholarly reference on peppers--their history and dispersion, biology, taxonomy, cultivation, and medicinal, economic, and gastronomic uses. Illustrated with the author's botanically accurate, aesthetically pleasing paintings that show the blossoms, buds, young peppers, and mature specimens of 34 cultivars. A review of the literature, a photo glossary, and an extensive bibliography add to the volume's reference value. 9x12" Annotation c. by Book News, Inc., Portland, Or.

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Frequently Asked Questions:

Other Information Sources:

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Growing Lettuce

Several types of lettuce can be grown in the home garden adding variety, texture and color to the family diet.

Lettuce varieties can be loosely categorized into four groups: crisphead, butterhead, leaf, and romaine or cos. Each group has its own growth and taste characteristics.

Types of Lettuce

Crisphead lettuce is probably the most familiar of the four. It is characterized by a tight, firm head of crisp, light-green leaves. In general, crisphead lettuce is intolerant of hot weather, readily bolting or sending up a flower stalk under hot summer conditions. For this reason, plus the long growing period required, it is the most difficult of the lettuces to grow in the home garden.

Butterhead types have smaller, softer heads of loosely folded leaves. The outer leaves may be green or brownish with cream or butter colored inner leaves. There are several cultivars available that will do well in Ohio gardens.

Leaf lettuce has an open growth and does not form a head. Leaf form and color varies considerably. Some cultivars are frilled and crinkled and others deeply lobed. Color ranges from light green to red and bronze. Leaf lettuce matures quickly and is the easiest to grow.

Romaine or cos lettuces form upright, cylindrical heads of tightly folded leaves. The plants may reach up to 10 inches in height. The outer leaves are medium green with greenish white inner leaves. This is the sweeter of the four types.

Varieties

Crisphead

- Mesa 659 (fall)

- Ithaca

Butterhead

- Bibb
- Salad Bibb
- Summer Bibb
- Buttercrunch
- Tania
- Tom Thumb (miniature)

Leaf

- Salad Bowl
- Grand Rapids
- Black Seeded Simpson
- Slobolt
- Oakleaf
- Green Ice
- Prizehead
- Red Sails
- Lollo Rosso
- Ruby
- Red Fire

Romaine

- Valmaine
- Parris Island Cos

Climatic Requirements

Lettuce is a cool-season vegetable and develops best quality when grown under cool, moist conditions. Lettuce seedlings will tolerate a light frost. Temperatures between 45 F and 65 F are ideal. Such conditions usually prevail in Ohio in spring and fall. Seeds of leaf lettuce are usually planted in the spring as soon as the ground can be worked. Butterhead and romaine can be grown from either seeds or transplants. Due to its long-growing season, crisphead lettuce is grown from transplants. Transplants may be purchased or started indoors about six weeks before the preferred planting date.

Soil Requirements

Lettuce can be grown under a wide range of soils. Loose, fertile, sandy

loam soils, well-supplied with organic matter are best. The soil should be well-drained, moist, but not soggy. Heavy soils can be modified with well-rotted manure, compost, or by growing a cover crop. Like most other garden vegetables, lettuce prefers a slightly acidic pH of 6.0 to 6.5.

Cultural Practices

Since lettuce seed is very small, a well-prepared seedbed is essential. Large clods will not allow proper seed-to-soil contact, reducing germination. Lettuce does not have an extensive root system so an adequate supply of moisture and nutrients is also necessary for proper development.

Fertilizer and lime recommendations should be based on the results of a soil test. Contact your local Cooperative Extension office for information on soil testing. As a general rule, however, apply and work into the soil three to four pounds of 5-10-10 fertilizer per 100 square feet of garden area.

Seed may be sown in single rows or broadcast for wide row planting. Wide rows should be 12 to 15 inches across. Cover the seeds with 1/4 to 1/2 inch of soil. Water carefully but thoroughly. Several successive plantings of leaf lettuce will provide a more continuous harvest throughout the growing season. Leave 18 inches between the rows for leaf lettuce, and 24 inches for the other types. To achieve proper spacing of plants, thinning of lettuce seedlings is usually necessary. Thin plants of leaf lettuce four to six inches or more between plants depending on plant size. Butterhead and romaine should be thinned six to ten inches between plants. Finally, crisphead transplants should be spaced 10 to 12 inches apart in the row.

An organic mulch will help conserve moisture, suppress weeds, and keep soil temperatures cool. If weeds do become a problem, either pull by hand or cultivate very shallowly to avoid damage to lettuce roots. Planning your garden so that lettuce will be in the shade of taller plants, such as tomatoes or sweet corn, in the heat of the summer, may reduce bolting.

Insect pests and diseases can occasionally cause problems on lettuce. For proper identification and control recommendation, contact your local Cooperative Extension office.

Harvesting

All lettuce types should be harvested when full size but young and tender. Over-mature lettuce is bitter and woody. Leaf lettuce is

harvested by removing individual outer leaves so that the center leaves can continue to grow. Butterhead or romaine types can be harvested by removing the outer leaves, digging up the whole plant or cutting the plant about an inch above the soil surface. A second harvest is often possible this way. Crisphead lettuce is picked when the center is firm.

Related web pages:

- None identified.

Commercial suppliers:

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Electronic mailing lists:

- None identified.

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Growing Mushrooms

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Growing Potatoes

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Potatoes - Solanum Tuberosum

Potatoes are cool-season vegetables that rank with wheat and rice as one of the most important staples in the human diet. They are a native American species that were cultivated from Chile to New Grenada at the time the Spanish explorers reached this continent. The Spaniards introduced the species to Europe soon after 1580, and the popularity of potatoes spread all over Europe and the British Isles by the end of the 17th century. First introduced to New England by Irish immigrants in 1719, the white potato is now referred to as the "Irish potato" because of its association with the potato famine in Ireland in the 19th century.

Potatoes are not roots but specialized underground storage stems called "tubers". Maximum tuber formation occurs at soil temperatures between 60 and 70 degrees F. The tubers fail to form when the soil temperature reaches 80 degrees F. Potatoes will withstand light frost in the spring and can be grown throughout Arkansas.

Varieties

There are more than 100 varieties of potatoes. The horticulture varieties generally have white flesh and light brown or red skin. There are different types of potatoes with yellow to blue flesh and all different skin colors. An interesting one being grown now is yellow firm.

Russet Burbank is one of the most important varieties produced in the United States, but the weather in Arkansas is too warm and the moisture fluctuation is too great for the production of smooth tubers and good yields

The following varieties will produce well in Arkansas:

- **Kennebec** - 110 days to maturity. Smooth, oblong white tuber, heavy yields, good quality.

- **Irish Cobbler** - 95 days to maturity. Round white tuber, early, well adapted.

- **Pontiac** - 100 days to maturity. Round, oblong red tuber, heavy yields.

- **Superior** - 90 days to maturity. Early white round tubers, moderate heat tolerance.

When to Plant

Potatoes are among the earliest vegetables planted in the garden. Early, mid-season, and late varieties may be planted in early March to early April. Mid-season and late varieties may be planted as late as July to August 1 for fall production. Late potatoes are best for winter storage.

How to Plant

Potatoes are started from "seed pieces" rather than from true seed. Although there is a potato variety, Homestead Hybrid, which is true potato seed. Plant them in a window box or greenhouse to transplant, or plant directly in the garden about April 5-10. These seed pieces may be small whole potatoes or potatoes that are cut into 1 1/2 to 2-ounce pieces. Plant the pieces soon after cutting. Be sure that there is a least one good "eye" in each seed piece. Some garden centers and seed suppliers sell potato eyes that weigh less than an ounce; these are not the desired size. Small, whole, certified seed potatoes are the best choice for home gardeners.

Plant seed pieces 10 to 12 inches apart and cover in a furrow between 2 and 3 inches deep. Space row 24 to 36 inches apart. The 24-inch spacing is often beneficial because the plants will shade the soil and prevent high soil temperatures that inhibit tuber development.

Care

The soil should be fertile and well drained. Clay soils should be improved with organic matter and plowed in the fall. Use raised beds to improve soil drainage.

Mulching is usually helpful in growing potatoes. Organic mulch can be applied after the potato plants have emerged. Its benefits are to

conserve moisture, help keep down weeds, and cool the soil. Some gardeners cover rows of early potatoes with clear plastic film at planting to warm the soil and promote early growth when the soil temperature is low. After the plants emerge, remove the film to allow the plants to grow.

After the potatoes break the surface of the ground, gradually build up a low ridge of loose soil by cultivation and hoeing. This ridge, which may become 4 to 6 inches high by summer, reduces the number of sunburned (greened) tubers. The object of potato cultivation is to eliminate competition from weeds, to loosen and aerate the soil, and to build up the row. Misshapen potatoes occur when they develop in hard, compacted soil.

Irrigate to assure uniform moisture while the tubers are developing. A uniform moisture supply also helps to cool the ground and eliminate knobs caused by secondary growth.

Harvesting

Harvest potatoes after most of the vines have died. Handle as gently as possible during harvest. Leave the tubers exposed to the sun just long enough for the soil to dry and fall off. Too much direct sunlight will blister the tubers, cause them to green and cause rot in storage. Since the tubers develop 4 to 6 inches beneath the soil surface, a spade fork is a useful tool for digging potatoes.

Potatoes for use in early summer ("new" potatoes) may be dug before the vines die (usually in July). When the potatoes reach 1 to 2 inches in size, you may wish to dig a few hills to use for soups or to cook with peas, cream, or butter.

Late potatoes are usually dug in July. They will keep in the garage or basement for several weeks in their natural dormancy. Store over the winter in a dark room at a temperature between 38 and 40 degrees F. with high humidity. Check periodically for spoilage.

Common Problems

A number of diseases attack home garden potatoes, and many of these diseases can be prevented. For example, there is a disease of the potato tuber called scab. Potato scab causes the tubers to have a brown, rough, bumpy or corky surface. There is no cure for scab, but frequently it can be prevented by planting scab-resistant varieties such as Agassiz, Bison, Crystal, Norgold Russet or Redsen. Do not use animal manure or straw on potatoes as this will promote scab. Also, do not rotate potatoes with

beets on the same land if scab has been a problem. The potato scab disease (indicated by scabby, rough skin) does not develop when the soil pH is 5.6 or below. Plant resistant varieties when available.

When planting potatoes, here are a few hints that will help prevent disease problems. It is very important to plant good quality seed pieces, as poor quality seed or seed saved from last year's crop can be a source of many diseases. If possible, buy certified potato seed since this will reduce the chances of destructive bacterial diseases such as black leg and ring rot. It will also reduce the chances of getting virus diseases, some which do not even show up but still reduce yield. Other virus diseases, such as rugose mosaic, produce a blotchy or mosaic pattern of light and dark green on the leaves. Whenever this appears, even on just a few plants, you have fairly serious virus problems, because rugose mosaic is a combination of two viruses, both which reduce yields but give no visible signs of their presence, unless they are both infecting the same plant.

Later in the season, when the plants are growing well, watch for leaf spot diseases. There are two that can seriously damage the leaves, causing them to drop prematurely. The most common leaf spot problem is early blight. These spots become large, up to inch or even 1 inch in diameter. They are circular to irregular in shape and dark brown to black in color. Early blight spots have concentric rings arranged in a target pattern. The spots have a definite margin. Leaves with early blight spots turn yellow and drop off. As soon as early blight appears, the potato plants should be sprayed with a fungicide such as Captan (Orthocide) or Daconil 2787 (Ortho Multi-Purpose Fungicide). These fungicides are available at garden care centers. . Early blight is best controlled by weekly applications of suggested fungicides, beginning when the seedlings are 6 to 8 inches high.

Another leaf spot disease develops in years with cool, wet weather. This is late blight. When late blight attacks, the leaves develop large dark-colored wet spots. The whole leaf rots quickly. Late blight spots do not have definite margins. As soon as late blight is found, spray the plants with a fungicide. The same fungicides can be used as for early blight control.

Colorado potato beetles, flea beetles, and fleahoppers can significantly reduce potato yields. These insects can be controlled with suggested insecticides.

Diseases: early blight, scab, late blight, tuber rots, virus complex, fusarium, verticillium, and bacterial wilts.

Insects: Colorado potato beetles, flea beetles, leafhoppers

Cultural: green skin (sun exposure), hollow heart (alternate wet and

dry conditions), Black Walnut wilt (too close to a Black Walnut tree).

Scab of Potato Tubers

Scab is a disease of potato tubers that results in lowered tuber quality due to scab-like surface lesions. There are no aboveground symptoms. Two forms of scab occur. Common scab occurs in all production areas and is most severe in soils with a pH above 5.5. Another less common form, called acid scab, is important in acidic soils (below pH 5.5).

Symptoms

Scab symptoms are quite variable. Usually, roughly circular, raised, tan to brown, corky lesions of varying size develop randomly across tuber surfaces. Sometimes scab develops as a rather superficial layer of corky tissues covering large areas of the tuber surface. This is called russet scab. Pitted scab can also occur where lesions develop up to 1/2 inch deep. These deep lesions are dark brown to black, and the tissues underneath are often strawcolored and somewhat translucent. More than one of these lesion types may be present on a single tuber. Although scab symptoms are usually noticed late in the growing season or at harvest, tubers are susceptible to infection as soon as they are formed. Small brown, watersoaked, circular lesions are visible on tubers within a few weeks after infection. Mature tubers with a well-developed skin are no longer susceptible, but existing lesions will continue to expand as tubers enlarge. Thus disease severity increases throughout the growing season. Scab is most severe when tubers develop under warm, dry soil conditions. Coarse-textured soils that dry out quickly are therefore more conducive to scab than are fine-textured soils.

A few other conditions can be confused with scab. White, enlarged lenticles, which frequently occur on potato tubers harvested from wet soil, can be mistaken for scab. Usually this condition will disappear when tubers are dried. Patchy russeting, checking, or cracking of tuber surfaces caused by the fungus *Rhizocton~a* also may be confused with russet scab. A totally different but uncommon disease called powdery scab, caused by the fungus *Spongospora subterranea,* causes very similar scab-like symptoms. Laboratory examination may be necessary to identify these diseases.

Causal Organisms

Scab is caused by a group of filamentous bacteria called actinomycetes that occur commonly in soil. In soils with a pH above 5.5, *Streptomyces scabies is* usually responsible for common scab, and is capable of causing all the types of scab lesions described above. It is commonly introduced into fields on seed potatoes, and will survive indefinitely on decaying plant debris once the soil is contaminated. Because the organism can survive passage through the digestive tract of animals and

be distributed with manure, it survives well in old teed lots or in fields where manure has been applied. It is easily disseminated in infested soil adhering to farm implements or transported by wind and water. S. scabies also infects other root crops such as beet, turnip, rutabaga, radish, carrot, and parsnip. Acid scab, which develops in soils with a pH from 5.5 to as low as 4.5, is usually caused by the acid-tolerant species S. *acidiscabies.* This organism has a host range similar to that of S. *scabies* but is usually carried on infected tubers since it does not survive well in soil. Continuous cropping to potatoes, especially scab-susceptible cultivars, will often increase the populations of scab organisms with resultant increases in disease severity.

Management

- Select planting sites not heavily contaminated with the scab organisms.
- Maintain soil at or slightly below pH 5.5. Consider the potential for scab before liming any soils used for potato production.
- Avoid application of animal manure to land used to grow potatoes as this may contain the scab organisms and the high organic matter in manure may stimulate their growth leading to severe disease.
- Grow potatoes on a site only every third or fourth year, avoiding beets, carrots, radishes, and turnips in the crop rotation plan. Alfalfa, small grains, and soybeans are good rotational choices.
- Plant scab-free, certified seed tubers.
- Select less-susceptible varieties if available and adapted to local conditions. Varieties possessing some scab tolerance include: Atlantic, Conestoga, Islander, Kennebec, LaRouge, Monona, Norchip, Norland, Onaway, Ontario, Sebago, Superior, Viking, as well as most russet-skinned varieties. Varieties especially sensitive to scab include: Denali, Elba, Hampton, Irish Cobbler, Jemseg, Kanona, Katahdin, Red Pontiac, Shepody, and Yukon Gold.
- Treat cut seed with registered fungicides prior to planting. For current recommendations, see the Ohio Vegetable Production Guide (OSU Extension Bulletin 672).
- If irrigation is available, do not allow soil to become dry when tubers are first forming.

Bacterial Ring Rot of Potatoes

Bacterial ring rot is an important disease of potatoes and is one of the main reasons for rejection of seed potatoes from certification programs. This disease is particularly serious because it has the potential to spread quickly throughout a farm and may lead to severe losses if left

unchecked. Ring rot was originally found in Germany in the late 1800's. The causal bacteria were introduced into the United States in the early 1930's and by 1940 were found throughout the country.

Symptoms

Severe ring rot can result in wilting of leaves and stems along with yellowing and death of leaves. Lower leaves usually wilt first, are slightly rolled at the margins, and are paler green than healthy leaves. As wilting progresses, leaf tissues between veins become yellow. In the later stages of disease, margins of lower leaves die and become brittle, and eventually entire stems yellow and die. Frequently, only one or two stems in a hill will develop symptoms and, in some cases, there are no above-ground symptoms at all. Ring rot derives its name from a characteristic breakdown of the vascular ring within the tuber. This often appears as a creamy-yellow to light-brown, cheesy rot. The symptom is most frequently observed when a diseased tuber is cut crosswise at the stem end. In severe cases, the vascular ring may be separated, and a creamy or cheesy exudate can be forced out from this tissue when the tuber is squeezed. On the outer surface, severely diseased tubers may show slightly sunken, dry, cracked areas. Infected tubers are often invaded by secondary decay organisms which may lead to complete breakdown. Symptoms of ring rot in the vascular tissue of infected tubers are often less obvious than described above, appearing as only a broken, sporadically appearing dark line, or as a continuous, yellowish discoloration. Because of this, laboratory tests should always be performed to confirm a diagnosis of ring rot.

Causal Organism

Ring rot is caused by the bacterium *Clavibacter michiganense* subsp. *sepedonicus.* Ring-rot bacteria survive between seasons mainly in infected seed tubers. They are also capable of surviving 2-5 years in dried slime on surfaces of crates, bins, burlap sacks, or harvesting and grading machinery, even if exposed to temperatures well below freezing. Survival is longest under cool, dry conditions. Ring-rot bacteria do not survive in soil in the absence of potato debris, but can survive from season to season in volunteer potato plants. Wounds are necessary for penetration of the bacteria into seed pieces. The pathogen is easily transmitted from diseased tubers to healthy seed pieces during the seedcutting process. A knife that cuts one infected tuber can spread these bacteria to the next 2-100 seed pieces. Likewise, the bacteria may be spread during planting, particularly if a pickertype planter is used. Ring-rot bacteria can be moved in irrigation water and by chewing insects, such as Colorado potato beetles and flea beetles. After the bacteria become established in a plant, they multiply and move throughout the plant via the waterconducting tissues. Fortunately ring-rot bacteria are capable of causing disease only in potato, although they may be able to colonize roots of sugar beets.

Management

- Plant only certified disease-free seed tubers. In the U.S. and Canada, certified seed potatoes are produced under regulations mandating zero tolerance for ring rot. Although use of certified seed tubers will not guarantee total freedom from ring rot bacteria, it is the best assurance.
- Discontinue use of any lot of seed tubers in which ring rot is found. Seed lots known to be contaminated with ring-rot bacteria should never be planted.
- Before handling seed tubers, all containers, tools, knives and mechanical cutters, planters, and other equipment should be thoroughly washed with a detergent solution, rinsed, and then sanitized with a disinfectant (for current recommendations, see the Ohio Vegetable Production Guide, OSU Extension Bulletin 672). When cutting seed tubers, the cutting tool should be periodically washed and sanitized. It essential that this be done before cutting seed tubers from a different source. To be effective, disinfectants must be present for a minimum of 10 minutes (preferably 2-30 minutes) on any surface being treated. It is much easier to disinfect metal surfaces than wood or burlap. If ring rot is confirmed to be present, a thorough cleanup must be undertaken. Dispose of all infected tubers away from potato production areas. Clean all surfaces of storages and equipment to remove all mud, dirt and debris and then wash with a strong detergent in hot water applied by a highpressure washer. After cleaning, sanitize all storages and equipment with a disinfectant. Do not plant potatoes for two seasons in any field in which ring rot has been found.

Early Blight of Potato and Tomato

Early blight is a very common disease of both potato and tomato. It causes leaf spots and tuber blight on potato, and leaf spots, fruit rot and stem lesions on tomato. The disease can occur over a wide range of climatic conditions and can be very destructive if left uncontrolled, often resulting in complete defoliation of plants. In contrast to the name, it rarely develops early, but usually appears on mature foliage.

Symptoms

On leaves of both crops, the first symptoms usually appear on older leaves and consist of small, irregular, dark brown to black, dead spots ranging in size from a pinpoint to 1/2 inch in diameter. As the spots enlarge, concentric rings may form as a result of irregular growth patterns by the organism in the leaf tissue. This gives the lesion a characteristic "target-spot" or "bull's eye" appearance. There is often a narrow, yellow halo around each spot and lesions are usually bordered

by veins. When spots are numerous, they may grow together, causing infected leaves to turn yellow and die. Usually the oldest leaves become infected first and they dry up and drop from the plant as the disease progresses up the main stem.

On tomato, stem infections can occur at any age resulting in small, dark, slightly sunken areas that enlarge to form circular or elongated spots with lighter-colored centers. Concentric markings, similar to those on leaves, often develop on stem lesions. If infested seed are used to start tomato transplants, seedlings may damp off soon after emergence. When large lesions develop at the ground line on stems of transplants or seedlings, the plants may become girdled, a condition known as "collar rot." Such plants may die when set in the field or, if stems are weakened, may break over early in the season. Some plants may survive with reduced root systems if portions of stems above the canker develop roots where they contact the soil. Such plants, however, usually produce few or no fruits. Stem lesions are much less common and destructive on potato.

Blossom drop and spotting of fruit stems, along with loss of young fruit, may occur when early blight attacks tomatoes in the flowering stage. On older fruits, early blight causes dark, leathery sunken spots, usually at the point of stem attachment. These spots may enlarge to involve the entire upper portion of the fruit, often showing concentric markings like those on leaves. Affected areas may be covered with velvety black masses of spores. Fruits can also be infected in the green or ripe stage through growth cracks and other wounds. Infected fruits often drop before they reach maturity.

On potato tubers, early blight results in surface lesions that appear a little darker than adjacent healthy skin. Lesions are usually slightly sunken, circularor irregular, and vary in size up to 3/4 inch in diameter. There is usually a well defined and sometimes slightly raised margin between healthy and diseased tissue. Internally, the tissue shows a brown to black corky, dry rot, usually not more than 1/4 to 3/8 inch deep. Deep cracks may form in older lesions. Tuber infection is uncommon under Ohio conditions.

Causal Organism

Early blight is caused by the fungus, *Alternaria solani,* which survives in infected leaf or stem tissues on or in the soil. This fungus is universally present in fields where these crops have been grown. It can also be carried on tomato seed and in potato tubers. Spores form on infested plant debris at the soil surface or on active lesions over a fairly wide temperature range, especiallyunder alternating wet and dry conditions. They are easily carried by air currents, windblown soil, splashing rain, and irrigation water. Infection of susceptible leaf or stem tissues occurs in warm, humid weather with heavy dews or rain. Early

blight can develop quite rapidly in mid to late season and is more severe when plants are stressed by poor nutrition, drought, or other pests. Infection of potato tubers occurs through natural openings on the skin or through injuries. Tubers may come in contact with spores during harvest and lesions may continue to develop in storage.

Management

- Use a crop rotation that includes potatoes or tomatoes only every third or fourth year to allow infested plant debris to decompose in the soil. Rotations with small grains, corn or legumes are preferable.
- Use tillage practices such as fall plowing that bury all plant refuse.
- Select cultivars that have a lower susceptibility to early blight.
- Use certified disease-free tomato seed and transplants.
- If producing tomato transplants, disinfect soil in plant beds and control humidity in cold frames or greenhouses. Practice good sanitation throughout the transplant production operation.
- Use appropriate measures to control weeds and volunteer potatoes and tomatoes in production areas.
- Maintain fertility at optimal levels—nitrogen and phosphorus deficiency can increase susceptibility to early blight.
- Time applications of overhead irrigation to allow plants to dry before nightfall.
- Although the above measures are important to minimize infection, it is usually necessary to apply fungicide sprays to fully protect plants from early blight. Applications to tomato are usually begun 2-3 weeks following emergence or soon after transplanting if a calendar schedule is followed. Timing of fungicides can also be made using the TOM-CAST system. For potatoes, fungicide applications should be initiated when plants begin to flower. Thorough coverage is important. Adjust equipment for good vine penetration. For current fungicide recommendations and a description of the TOMCAST system consult the Ohio Vegetable Production Guide (OSU Extension Bulletin 672).

Storage

Days to Maturity: 100-120

Harvest: Dig early potatoes when tubers are large enough to eat.

Harvest potatoes for storage after the vines die down or just after the first light frost nips the vines, before heavy freezing. Avoid skinning tubers when digging and avoid long exposure to light.

Approximate Yield: (per 10 feet row) 6-15 lbs

Amount to raise per person: 75-100 pounds (plant about 15 pounds of seed potatoes per person)

Storage: medium-cool (40F-50F), moist (90% RH) conditions; 6-8 months. Sprouting is a problem at higher temperatures.

Preservation: usually stored in medium cool, moist conditions.

Questions & Answers

Should I save some of my potatoes for seed potatoes?

No. Saving your own seed potatoes can lead to a buildup of viruses and diseases.

My potato plants flowered and formed green fruits that resemble small tomatoes. What are they?

These small seeds balls are the fruits that contain the true seeds. They are not edible.

What causes green skins on my potatoes?

The green areas on tubers develop where the potato was exposed to the sun. This condition occurs when the potatoes were not planted deeply enough or not covered with straw. The green portions taste bitter because they contain an alkaloid. These green areas should be cut off and discarded. Exposure of potato tubers to fluorescent light or sunlight will cause greening during storage.

Can I make chips from homegrown potatoes?

Yes. Almost any potato variety can be used to make chips when the potatoes are freshly dug. Commercial chips are made from selected varieties that are carefully handled and stored. Chips made from inferior varieties or improperly stored potatoes will be brown and have a dark ring, because they contain excessive amounts of sugars.

I used potatoes purchased at the grocery store as seed for planting and they rotted without sprouting. Why?

Many potatoes sold for fresh market consumption have been treated to prevent sprouting in storage as well as after planting. Potatoes have a rest period which must be broken before the seed will sprout. Cool or extremely warm temperatures can break the rest period and allow

potatoes to sprout. Plant certified seed that has been properly stored to induce sprouting.

Can I save the small potatoes from my spring crop for planting in the fall in my garden?

Yes. This is commonly done but sometimes the potatoes saved from the spring garden fail to sprout when planted in the fall because of a natural dormancy in newly harvested potatoes. One recommended procedure for breaking the dormancy includes harvesting the potatoes and placing them in a cool storage area, preferably in the range of 50 degrees F. until about 3 to 4 weeks before the anticipated fall planting date. The small potatoes should be planted whole and not cut to prevent rotting.

What size piece should seed potatoes be cut into?

Each seed piece should contain at least 2 to 3 "eyes." Research has shown that the best size seed piece weighs approximately 2 ounces.

Sometimes my potatoes or the potatoes I see at supermarkets have a green color. Are these potatoes poisonous?

Potatoes that exhibit a green color contain a substance known as Solanine. This substance, if consumed in extremely large quantities can cause severe illness or death. This greening of potatoes is caused by exposure to light during the growing period or excessive exposure to artificial lights at grocery stores or supermarkets. In the garden, this is most common after heavy rains which uncover potatoes near the surface exposing them to sunlight.

How do I know when my potatoes are ready for harvesting?

Potatoes are generally mature when the plant starts to turn yellow. Potatoes require 75 to 140 days from planting to maturity depending upon variety and the season in which they are grown. Immature potatoes will often skin and bruise easily. Dig spring-planted potatoes before the soil becomes hot. Avoid harvesting the potatoes when the soil is wet to avoid storage diseases.

I have some seed potatoes left from my spring garden. Would it be all right to eat them?

No. Potato tubers purchased for seed purposes definitely should not be eaten because they frequently have been chemically treated. Like all treated seeds, seed potatoes should not be fed to humans or animals.

After harvesting, how should I handle my potatoes to result in the longest storage time possible?

Dig potatoes when the soil is dry. Be careful not to skin or bruise the tubers. Do not wash the potatoes. Place them in crates or some suitable

container and store them in a dark areas for about 10 days at a temperature of 60 degrees F. with a relatively high humidity. After this curing period, keep the potatoes at 40 to 45 degrees F. with humidity near 85 percent and provide good air circulation.

Can potatoes be left in the ground for storage?

Generally no. Cool, humid conditions (38 to 45 degrees F. and 85 percent relative humidity) are best for Irish potato storage. The potatoes would not stay dry enough in the soil to prevent second growth or sprouting. Several weeks at high temperatures can break the rest period in home-grown potatoes after which sprouts will develop on the tuber. It is better to dig the potatoes and put them in a cool, damp area.

Why do home-stored potatoes have a different flavor in the winter than in the summer?

Irish potatoes stored at temperatures below 45 degrees F. will taste sweeter and be stringier that those stored at warmer temperatures. At temperatures less than 45 degrees F., enzymes within the tuber convert starch into sugars causing the sweet taste and stringy consistency. Potatoes to be eaten should not be stored in the refrigerator. Sugars within the potatoes can be converted back into starch by storing the potatoes at temperatures above 65 degrees F. for a week or two prior to use.

My potato plants produced small tomatoes this year. I planted them next to my tomatoes. Could they have crossed or have my potatoes mutated?

The fruit on the potato plant is actually the fruiting structure of the potato plant. The potato and tomato belong to the same botanical family and have similar growth characteristics. The potato flower looks very much like the tomato flower and is pollinated and fertilized identical to the tomato flower.

The stems of my Irish potato plants are decayed. The plants weaken but do not die.

This is Rhizoctonia. It is a soilborne fungus that causes decay in stems and seed pieces. Approved seed-piece fungicides are the best control. Follow the label instructions closely.

After a rainfall, the plants in one area of my garden began to die rapidly. The stems are rotted. A dark discoloration is moving up the stem to the top of the plant, and the stem has a foul odor.

This is black leg of potatoes, one of the major bacterial potato problems. To prevent problem, plant only in well-drained areas. Seed piece treatment will also help prevent the entry of bacteria and other organisms.

When I dug my potatoes, they were covered by small, raised bumps.

These are root knot nematodes and pose a serious problem on potatoes. Control them with crop rotation.

After I dug my potatoes, I found that they were rough with deep scars.

This is potato scab, caused by a soilborne organism. Control by maintaining an acid soil, below pH 5.6, around your potato plants and a uniform moisture level from the time the potato is formed until it is harvested.

The lower foliage on my potato plants is beginning to turn yellow and is covered with brown spots.

This is early blight of potatoes and is similar to blight on tomatoes. Spray with a fungicide as soon as spots are observed and repeat at 7- to 14-day intervals for two to three sprays.

The foliage of my potato plants is distorted, rolled and is not as healthy as it should be.

Several viruses attack potatoes. The best prevention of potato viruses is to plant only certified seed pieces.

When I dug my potatoes, I noticed small holes chewed in the tubers. How do I prevent this?

Several soil-inhabiting insects such as wireworms and white grubs cause this type of damage. Use control measures for these pests before planting. Use insecticides only as directed on the label.

The leaves of my potatoes are disappearing fast. All I see on the plant is some pinkish worms.

These pinkish larvae are immature Colorado potato beetles. They can defoliate plants and can be controlled with insecticides. Use as directed on the label. In small plots, control by hand picking the larvae and destroying them.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan - Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed. Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable information. Original.*
- Collecting Processing and Germinating Seeds of Wildland Plants - by Cheryl Young, James A. Young - Publication Date: October 1, 1986 - List: $24.95
- Enduring Seeds : Native American Agriculture and Wild Plant Conservation - by Gary Paul Nabhan - Publication Date: April 1, 1991 - List: $14.00
- From Seed to Plant - by Gail Gibbons - Publication Date: March 1, 1991 - List: $15.95 *Explores the intricate relationship between seeds and the plants which they produce.*
- Kid's Gardening : A Kid's Guide to Messing Around in the Dirt/With Seeds - by Kevin Raftery, Kim Gilbert Raftery, Jim M'Guinness - Publication Date: May 1, 1989 - List: $13.95 *Now young readers will know from whence those carrots came. This full-color extravaganza contains nearly a hundred pages of wipe-clean cardstock, hundreds of illustrations, dozens of growing activities, plus 15 varieties of vegetable, flower, and herb seeds.*
- Principles of Seed Science and Technology - by Larry O. Copeland, Miller B. McDonald, Lawrence O. Copeland - Publication Date: March 1, 1995 - List: $74.95

- Saving Seeds : The Gardener's Guide to Growing and Storing Vegetable and Flower Seeds - by Marc Rogers, Polly Alexander (Illustrator) - Publication Date: March 1991 - List: $12.95
- Seed to Seed - by Suzanne Ashworth - Publication Date: January 1, 1995 - List: $20.00
- Seeds : The Definitive Guide to Growing, History, and Lore - by H. Peter Loewer, Peter Loewer - Publication Date: April 1, 1996 - List: $25.00
  Loewer examines the vast and often surprisingly complex world of seeds in an unparalleled thoroughness. In addition to the how-to of growing all kinds of plants and vegetables from seed, the book also considers the role of seeds in history, literature, and business. 100 line drawings.
- Seeds and Propagation (Smith & Hawken--The Hands-On Gardener) - by Susan McClure, Jim Anderson (Illustrator) - Publication Date: June 1, 1997 - List: $10.95
- The New Seed Starter's Handbook - by Nancy Bubel - Publication Date: April 1, 1988 - List: $15.95
- Gardening In Deer Country - by Vincent Drzewucki - Publication Date: January, 1998 - List: $9.95
- 200 Tips for Growing Vegetables in the Northeast - by Miranda Smith - Publication Date: February 1996 - List: $7.95
- 200 Tips for Growing Vegetables in the Pacific Northwest - by Maggie Stuckey - Publication Date: February 1996 - List: $7.95
- Building Your Own Greenhouse (Greenhouse Basics) - by Mark Freeman, Heather Bellanca (Illustrator) - Publication Date: April 1997 - List: $18.95
- Burpee : The Complete Vegetable & Herb Gardener : A Guide to Growing Your Garden
  Organically - by Karan Davis Cutler, Cavagnarok David (Photographer), Barbara W. Ellis - Publication Date: November 1997 - List: $29.95
  Synopsis:
  A companion to Burpee Complete Gardener, this book focuses on all aspects of growing organic vegetables and edible herbs in the home garden. Planting techniques and tools, garden design, and more than 90 individual plant portraits are included. 300 full-color photos.

- Culinary Gardens : From Garden to Palate - by Susan McClure - Publication Date: September 1997 - List: $37.95
- Five Acres and Independence: A Handbook for Small Farm Management - by Maurice Grenville Kains, Maurice G. Kain - Publication Date: March 1978 - List: $7.95
- Four-Season Harvest : How to Harvest Fresh Organic Vegetables from Your Home Garden All Year Long - by Eliot Coleman, Kathy Bary (Illustrator) - Publication Date: October 1992 - List: $19.95
  Booknews, Inc. , 01/01/93:
  Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.
- Gardening Under Cover : A Northwest Guide to Solar Greenhouses, Cold Frames, and Cloches - by William Head - Publication Date: November 1989 - List: $10.95
  This is a complete guide to gardening with protective shelters that encourages both beginning and experienced gardeners to add months of gardening pleasure at small expense. With a little under-cover gardening know-how, Pacific Northwest gardeners can take advantage of our mild climate to produce flowers, herbs, and vegetables throughout the year.
- Grow It : The Beginner's Complete In-Harmony-With-Nature Small Farm Guide-From Vegetable and Grain Growing to Livestock Care - by Richard W. Langer, Susan McNeill (Illustrator) - Publication Date: January 1994 - List: $12.00
  Synopsis:
  An indispensable guide to small-scale organic farming that features advice on everything from building and stocking a pond to planting an orchard or making cheese. This extremely practical and easy-to-use guide, first published in 1972, is for full-time or part-time country dwellers/gardeners.
- Growing Great Garlic : The Definitive Guide for Organic Gardeners and Small Farmers - by Ron L. Engeland - Publication Date: July 1995 - List: $14.95
- Heirloom Vegetable Gardening : A Master Gardener's Guide to Planting, Growing, Seed Saving, and Cultural History - by William Woys Weaver - Publication Date: June 1997 - List: $45.00

Synopsis:
Weaver focuses on 280 varieties of 37 vegetables in this encyclopedic guide to the history and cultivation of some of America's most treasured heirloom vegetables. 100+ color photos. 240 line drawings.

- A Dyer's Garden : From Plant to Pot Growing Dyes for Natural Fibers - by Rita Buchanan - Publication Date: August 1995 - List: $9.95

- A Produce Reference Guide to Fruits and Vegetables from Around the World : Nature's Harvest - by Donald D. Heaton - Publication Date: April 1997 - List: $29.95

- Growing Plants from Seed : A Comprehensive Beginners Handbook for Vegetables, Flowers, Herbs and More - by George Abraham, Katy Abraham, Doc Abraham - Publication Date: January 1992 - List: $13.95
  Synopsis:
  A guide for first-time seed growers addresses soil mixtures, lighting, types of seed, seed-starting kits, and more to help any gardener experience the rewarding feeling of growing flowers and vegetables from seed. Original.

- Peppers : The Domesticated Capsicums - by Jean Andrews - Publication Date: October 1995 - List: $65.00
  Booknews, Inc. , 04/01/96:
  An updated edition (first, 1984) of an elegantly produced, scholarly reference on peppers--their history and dispersion, biology, taxonomy, cultivation, and medicinal, economic, and gastronomic uses. Illustrated with the author's botanically accurate, aesthetically pleasing paintings that show the blossoms, buds, young peppers, and mature specimens of 34 cultivars. A review of the literature, a photo glossary, and an extensive bibliography add to the volume's reference value. 9x12" Annotation c. by Book News, Inc., Portland, Or.

- Peppers of the World : An Identification Guide - by Dave Dewitt, Paul W. Bosland - Publication Date: January 1997 - List: $19.95

- Plant Propagation : Principles and Practices - by Hudson Thomas Hartmann (Editor), Dale E. Kester, Fred T., Jr. Davies - Publication Date: January 1997 - List: $86.00
  The publisher, Prentice-Hall Career & Technology :

Hallmarked as the most successful text of its kind, this remarkably thorough text covers all aspects of the propagation of plants - both sexual and asexual - with considerable attention given to human (vs natural) efforts to increase plant numbers.

- Forest Gardening : Cultivating an Edible Landscape - by Robert A. De J. Hart - Publication Date: September 1996 - List: $17.95

- Handbook of Organic Food Processing and Production - by Simon Wright (Editor) - Publication Date: October 1994 - List: $119.00

- Introduction to Permaculture - by Bill Mollison, Reny Mia Slay - Publication Date: November 1997 - List: $16.95

- Profitable Organic Farming - by Jon Newton - Publication Date: June 1995 - List: $36.95

- The New Organic Grower : A Master's Manual of Tools and Techniques for the Home and Market Gardener - by Eliot Coleman, Sheri Amsel (Illustrator), Molly Cook Field (Illustrator) - Publication Date: October 1995 - List: $24.95
  Booknews, Inc. , 05/01/96:
  This expansion of a now-classic guide originally published in 1989 is intended for the serious gardener or small-scale market farmer. It describes practical and sustainable ways of growing superb organic vegetables, with detailed coverage of scale and capital, marketing, livestock, the winter garden, soil fertility, weeds, and many other topics. Annotation c. by Book News, Inc., Portland, Or.

- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Potatoes - Solanum Tuberosum

Potatoes are cool-season vegetables that rank with wheat and rice as one of the most important staples in the human diet. They are a native American species that were cultivated from Chile to New Grenada at the time the Spanish explorers reached this continent. The Spaniards introduced the species to Europe soon after 1580, and the popularity of potatoes spread all over Europe and the British Isles by the end of the 17th century. First introduced to New England by Irish immigrants in 1719, the white potato is now referred to as the "Irish potato" because of its association with the potato famine in Ireland in the 19th century.

Potatoes are not roots but specialized underground storage stems called "tubers". Maximum tuber formation occurs at soil temperatures between 60 and 70 degrees F. The tubers fail to form when the soil temperature reaches 80 degrees F. Potatoes will withstand light frost in the spring and can be grown throughout Arkansas.

Varieties

There are more than 100 varieties of potatoes. The horticulture varieties generally have white flesh and light brown or red skin. There are different types of potatoes with yellow to blue flesh and all different skin colors. An interesting one being grown now is yellow firm.

Russet Burbank is one of the most important varieties produced in the United States, but the weather in Arkansas is too warm and the moisture fluctuation is too great for the production of smooth tubers and good yields

The following varieties will produce well in Arkansas:

- **Kennebec** - 110 days to maturity. Smooth, oblong white tuber, heavy yields, good quality.

- **Irish Cobbler** - 95 days to maturity. Round white tuber, early, well adapted.

- **Pontiac** - 100 days to maturity. Round, oblong red tuber, heavy yields.

- **Superior** - 90 days to maturity. Early white round tubers, moderate heat tolerance.

When to Plant

Potatoes are among the earliest vegetables planted in the garden. Early, mid-season, and late varieties may be planted in early March to early April. Mid-season and late varieties may be planted as late as July to August 1 for fall production. Late potatoes are best for winter storage.

How to Plant

Potatoes are started from "seed pieces" rather than from true seed. Although there is a potato variety, Homestead Hybrid, which is true potato seed. Plant them in a window box or greenhouse to transplant, or plant directly in the garden about April 5-10. These seed pieces may be small whole potatoes or potatoes that are cut into 1 1/2 to 2-ounce pieces. Plant the pieces soon after cutting. Be sure that there is a least one good "eye" in each seed piece. Some garden centers and seed suppliers sell potato eyes that weigh less than an ounce; these are not the desired size. Small, whole, certified seed potatoes are the best choice for home gardeners.

Plant seed pieces 10 to 12 inches apart and cover in a furrow between 2 and 3 inches deep. Space row 24 to 36 inches apart. The 24-inch spacing is often beneficial because the plants will shade the soil and prevent high soil temperatures that inhibit tuber development.

Care

The soil should be fertile and well drained. Clay soils should be improved with organic matter and plowed in the fall. Use raised beds to improve soil drainage.

Mulching is usually helpful in growing potatoes. Organic mulch can be applied after the potato plants have emerged. Its benefits are to conserve moisture, help keep down weeds, and cool the soil. Some gardeners cover rows of early potatoes with clear plastic film at planting to warm the soil and promote early growth when the soil temperature is low. After the plants emerge, remove the film to allow the plants to grow.

After the potatoes break the surface of the ground, gradually build up a low ridge of loose soil by cultivation and hoeing. This ridge, which may become 4 to 6 inches high by summer, reduces the number of sunburned (greened) tubers. The object of potato cultivation is to eliminate competition from weeds, to loosen and aerate the soil, and to build up the row. Misshapen potatoes occur when they develop in hard, compacted soil.

Irrigate to assure uniform moisture while the tubers are developing. A uniform moisture supply also helps to cool the ground and eliminate knobs caused by secondary growth.

Harvesting

Harvest potatoes after most of the vines have died. Handle as gently as possible during harvest. Leave the tubers exposed to the sun just long enough for the soil to dry and fall off. Too much

direct sunlight will blister the tubers, cause them to green and cause rot in storage. Since the tubers develop 4 to 6 inches beneath the soil surface, a spade fork is a useful tool for digging potatoes.

Potatoes for use in early summer ("new" potatoes) may be dug before the vines die (usually in July). When the potatoes reach 1 to 2 inches in size, you may wish to dig a few hills to use for soups or to cook with peas, cream, or butter.

Late potatoes are usually dug in July. They will keep in the garage or basement for several weeks in their natural dormancy. Store over the winter in a dark room at a temperature between 38 and 40 degrees F. with high humidity. Check periodically for spoilage.

Common Problems

A number of diseases attack home garden potatoes, and many of these diseases can be prevented. For example, there is a disease of the potato tuber called scab. Potato scab causes the tubers to have a brown, rough, bumpy or corky surface. There is no cure for scab, but frequently it can be prevented by planting scab-resistant varieties such as Agassiz, Bison, Crystal, Norgold Russet or Redsen. Do not use animal manure or straw on potatoes as this will promote scab. Also, do not rotate potatoes with beets on the same land if scab has been a problem. The potato scab disease (indicated by scabby, rough skin) does not develop when the soil pH is 5.6 or below. Plant resistant varieties when available.

When planting potatoes, here are a few hints that will help prevent disease problems. It is very important to plant good quality seed pieces, as poor quality seed or seed saved from last year's crop can be a source of many diseases. If possible, buy certified potato seed since this will reduce the chances of destructive bacterial diseases such as black leg and ring rot. It will also reduce the chances of getting virus diseases, some which do not even show up but still reduce yield. Other virus diseases, such as rugose mosaic, produce a blotchy or mosaic pattern of light and dark green on the leaves. Whenever this appears, even on just a few plants, you have fairly serious virus problems, because rugose mosaic is a combination of two viruses, both which reduce yields but give no visible signs of their presence, unless they are both infecting the same plant.

Later in the season, when the plants are growing well, watch for leaf spot diseases. There are two that can seriously damage the leaves, causing them to drop prematurely. The most common leaf spot problem is early blight. These spots become large, up to inch or even 1 inch in diameter. They are circular to irregular in shape and dark brown to black in color. Early blight spots have concentric rings arranged in a target pattern. The spots have a definite margin. Leaves with early blight spots turn yellow and drop off. As soon as early blight appears, the potato plants should be sprayed with a fungicide such as Captan (Orthocide) or Daconil 2787 (Ortho Multi-Purpose Fungicide). These fungicides are available at garden care centers. . Early blight is best controlled by weekly applications of suggested fungicides, beginning when the seedlings are 6 to 8 inches high.

Another leaf spot disease develops in years with cool, wet weather. This is late blight. When late blight attacks, the leaves develop large dark-colored wet spots. The whole leaf rots quickly. Late blight spots do not have definite margins. As soon as late blight is found, spray the plants with a fungicide. The same fungicides can be used as for early blight control.

Colorado potato beetles, flea beetles, and fleahoppers can significantly reduce potato yields. These insects can be controlled with suggested insecticides.

Diseases: early blight, scab, late blight, tuber rots, virus complex, fusarium, verticillium, and bacterial wilts.

Insects: Colorado potato beetles, flea beetles, leafhoppers

Cultural: green skin (sun exposure), hollow heart (alternate wet and dry conditions), Black Walnut wilt (too close to a Black Walnut tree).

Scab of Potato Tubers

Scab is a disease of potato tubers that results in lowered tuber quality due to scab-like surface lesions. There are no aboveground symptoms. Two forms of scab occur. Common scab occurs in all production areas and is most severe in soils with a pH above 5.5. Another less common form, called acid scab, is important in acidic soils (below pH 5.5).

Symptoms

Scab symptoms are quite variable. Usually, roughly circular, raised, tan to brown, corky lesions of varying size develop randomly across tuber surfaces. Sometimes scab develops as a rather superficial layer of corky tissues covering large areas of the tuber surface. This is called russet scab. Pitted scab can also occur where lesions develop up to 1/2 inch deep. These deep lesions are dark brown to black, and the tissues underneath are often strawcolored and somewhat translucent. More than one of these lesion types may be present on a single tuber. Although scab symptoms are usually noticed late in the growing season or at harvest, tubers are susceptible to infection as soon as they are formed. Small brown, watersoaked, circular lesions are visible on tubers within a few weeks after infection. Mature tubers with a well-developed skin are no longer susceptible, but existing lesions will continue to expand as tubers enlarge. Thus disease severity increases throughout the growing season. Scab is most severe when tubers develop under warm, dry soil conditions. Coarse-textured soils that dry out quickly are therefore more conducive to scab than are fine-textured soils.

A few other conditions can be confused with scab. White, enlarged lenticles, which frequently occur on potato tubers harvested from wet soil, can be mistaken for scab. Usually this condition will disappear when tubers are dried. Patchy russeting, checking, or cracking of tuber surfaces caused by the fungus *Rhizocton~a* also may be confused with russet scab. A totally different but uncommon disease called powdery scab, caused by the fungus *Spongospora subterranea*, causes very similar scab-like symptoms. Laboratory examination may be necessary to identify these diseases.

Causal Organisms

Scab is caused by a group of filamentous bacteria called actinomycetes that occur commonly in soil. In soils with a pH above 5.5, *Streptomyces scabies is* usually responsible for common scab, and is capable of causing all the types of scab lesions described above. It is commonly introduced into fields on seed potatoes, and will survive indefinitely on decaying plant debris once the soil is

contaminated. Because the organism can survive passage through the digestive tract of animals and be distributed with manure, it survives well in old teed lots or in fields where manure has been applied. It is easily disseminated in infested soil adhering to farm implements or transported by wind and water. S. scabies also infects other root crops such as beet, turnip, rutabaga, radish, carrot, and parsnip. Acid scab, which develops in soils with a pH from 5.5 to as low as 4.5, is usually caused by the acid-tolerant species S. *acidiscabies.* This organism has a host range similar to that of S. *scabies* but is usually carried on infected tubers since it does not survive well in soil. Continuous cropping to potatoes, especially scab-susceptible cultivars, will often increase the populations of scab organisms with resultant increases in disease severity.

Management

- Select planting sites not heavily contaminated with the scab organisms.
- Maintain soil at or slightly below pH 5.5. Consider the potential for scab before liming any soils used for potato production.
- Avoid application of animal manure to land used to grow potatoes as this may contain the scab organisms and the high organic matter in manure may stimulate their growth leading to severe disease.
- Grow potatoes on a site only every third or fourth year, avoiding beets, carrots, radishes, and turnips in the crop rotation plan. Alfalfa, small grains, and soybeans are good rotational choices.
- Plant scab-free, certified seed tubers.
- Select less-susceptible varieties if available and adapted to local conditions. Varieties possessing some scab tolerance include: Atlantic, Conestoga, Islander, Kennebec, LaRouge, Monona, Norchip, Norland, Onaway, Ontario, Sebago, Superior, Viking, as well as most russet-skinned varieties. Varieties especially sensitive to scab include: Denali, Elba, Hampton, Irish Cobbler, Jemseg, Kanona, Katahdin, Red Pontiac, Shepody, and Yukon Gold.
- Treat cut seed with registered fungicides prior to planting. For current recommendations, see the Ohio Vegetable Production Guide (OSU Extension Bulletin 672).
- If irrigation is available, do not allow soil to become dry when tubers are first forming.

Bacterial Ring Rot of Potatoes

Bacterial ring rot is an important disease of potatoes and is one of the main reasons for rejection of seed potatoes from certification programs. This disease is particularly serious because it has the potential to spread quickly throughout a farm and may lead to severe losses if left unchecked. Ring rot was originally found in Germany in the late 1800's. The causal bacteria were introduced into the United States in the early 1930's and by 1940 were found throughout the country.

Symptoms

Severe ring rot can result in wilting of leaves and stems along with yellowing and death of leaves. Lower leaves usually wilt first, are slightly rolled at the margins, and are paler green than healthy leaves. As wilting progresses, leaf tissues between veins become yellow. In the later stages of disease, margins of lower leaves die and become brittle, and eventually entire stems yellow and

die. Frequently, only one or two stems in a hill will develop symptoms and, in some cases, there are no above-ground symptoms at all. Ring rot derives its name from a characteristic breakdown of the vascular ring within the tuber. This often appears as a creamy-yellow to light-brown, cheesy rot. The symptom is most frequently observed when a diseased tuber is cut crosswise at the stem end. In severe cases, the vascular ring may be separated, and a creamy or cheesy exudate can be forced out from this tissue when the tuber is squeezed. On the outer surface, severely diseased tubers may show slightly sunken, dry, cracked areas. Infected tubers are often invaded by secondary decay organisms which may lead to complete breakdown. Symptoms of ring rot in the vascular tissue of infected tubers are often less obvious than described above, appearing as only a broken, sporadically appearing dark line, or as a continuous, yellowish discoloration. Because of this, laboratory tests should always be performed to confirm a diagnosis of ring rot.

Causal Organism

Ring rot is caused by the bacterium *Clavibacter michiganense* subsp. *sepedonicus.* Ring-rot bacteria survive between seasons mainly in infected seed tubers. They are also capable of surviving 2-5 years in dried slime on surfaces of crates, bins, burlap sacks, or harvesting and grading machinery, even if exposed to temperatures well below freezing. Survival is longest under cool, dry conditions. Ring-rot bacteria do not survive in soil in the absence of potato debris, but can survive from season to season in volunteer potato plants. Wounds are necessary for penetration of the bacteria into seed pieces. The pathogen is easily transmitted from diseased tubers to healthy seed pieces during the seedcutting process. A knife that cuts one infected tuber can spread these bacteria to the next 2-100 seed pieces. Likewise, the bacteria may be spread during planting, particularly if a pickertype planter is used. Ring-rot bacteria can be moved in irrigation water and by chewing insects, such as Colorado potato beetles and flea beetles. After the bacteria become established in a plant, they multiply and move throughout the plant via the waterconducting tissues. Fortunately ring-rot bacteria are capable of causing disease only in potato, although they may be able to colonize roots of sugar beets.

Management

- Plant only certified disease-free seed tubers. In the U.S. and Canada, certified seed potatoes are produced under regulations mandating zero tolerance for ring rot. Although use of certified seed tubers will not guarantee total freedom from ring rot bacteria, it is the best assurance.
- Discontinue use of any lot of seed tubers in which ring rot is found. Seed lots known to be contaminated with ring-rot bacteria should never be planted.
- Before handling seed tubers, all containers, tools, knives and mechanical cutters, planters, and other equipment should be thoroughly washed with a detergent solution, rinsed, and then sanitized with a disinfectant (for current recommendations, see the Ohio Vegetable Production Guide, OSU Extension Bulletin 672). When cutting seed tubers, the cutting tool should be periodically washed and sanitized. It essential that this be done before cutting seed tubers from a different source. To be effective, disinfectants must be present for a minimum of 10 minutes (preferably 2-30 minutes) on any surface being treated. It is much easier to disinfect metal surfaces than wood or burlap. If ring rot is confirmed to be present, a thorough cleanup must be undertaken. Dispose of all infected tubers away from potato production areas. Clean all surfaces of storages and equipment to remove all mud, dirt and debris and then wash with a strong detergent in hot water applied by a highpressure washer.

After cleaning, sanitize all storages and equipment with a disinfectant. Do not plant potatoes for two seasons in any field in which ring rot has been found.

Early Blight of Potato and Tomato

Early blight is a very common disease of both potato and tomato. It causes leaf spots and tuber blight on potato, and leaf spots, fruit rot and stem lesions on tomato. The disease can occur over a wide range of climatic conditions and can be very destructive if left uncontrolled, often resulting in complete defoliation of plants. In contrast to the name, it rarely develops early, but usually appears on mature foliage.

Symptoms

On leaves of both crops, the first symptoms usually appear on older leaves and consist of small, irregular, dark brown to black, dead spots ranging in size from a pinpoint to 1/2 inch in diameter. As the spots enlarge, concentric rings may form as a result of irregular growth patterns by the organism in the leaf tissue. This gives the lesion a characteristic "target-spot" or "bull's eye" appearance. There is often a narrow, yellow halo around each spot and lesions are usually bordered by veins. When spots are numerous, they may grow together, causing infected leaves to turn yellow and die. Usually the oldest leaves become infected first and they dry up and drop from the plant as the disease progresses up the main stem.

On tomato, stem infections can occur at any age resulting in small, dark, slightly sunken areas that enlarge to form circular or elongated spots with lighter-colored centers. Concentric markings, similar to those on leaves, often develop on stem lesions. If infested seed are used to start tomato transplants, seedlings may damp off soon after emergence. When large lesions develop at the ground line on stems of transplants or seedlings, the plants may become girdled, a condition known as "collar rot." Such plants may die when set in the field or, if stems are weakened, may break over early in the season. Some plants may survive with reduced root systems if portions of stems above the canker develop roots where they contact the soil. Such plants, however, usually produce few or no fruits. Stem lesions are much less common and destructive on potato.

Blossom drop and spotting of fruit stems, along with loss of young fruit, may occur when early blight attacks tomatoes in the flowering stage. On older fruits, early blight causes dark, leathery sunken spots, usually at the point of stem attachment. These spots may enlarge to involve the entire upper portion of the fruit, often showing concentric markings like those on leaves. Affected areas may be covered with velvety black masses of spores. Fruits can also be infected in the green or ripe stage through growth cracks and other wounds. Infected fruits often drop before they reach maturity.

On potato tubers, early blight results in surface lesions that appear a little darker than adjacent healthy skin. Lesions are usually slightly sunken, circularor irregular, and vary in size up to 3/4 inch in diameter. There is usually a well defined and sometimes slightly raised margin between healthy and diseased tissue. Internally, the tissue shows a brown to black corky, dry rot, usually not more than 1/4 to 3/8 inch deep. Deep cracks may form in older lesions. Tuber infection is uncommon under Ohio conditions.

Causal Organism

Early blight is caused by the fungus, *Alternaria solani,* which survives in infected leaf or stem tissues on or in the soil. This fungus is universally present in fields where these crops have been grown. It can also be carried on tomato seed and in potato tubers. Spores form on infested plant debris at the soil surface or on active lesions over a fairly wide temperature range, especiallyunder alternating wet and dry conditions. They are easily carried by air currents, windblown soil, splashing rain, and irrigation water. Infection of susceptible leaf or stem tissues occurs in warm, humid weather with heavy dews or rain. Early blight can develop quite rapidly in mid to late season and is more severe when plants are stressed by poor nutrition, drought, or other pests. Infection of potato tubers occurs through natural openings on the skin or through injuries. Tubers may come in contact with spores during harvest and lesions may continue to develop in storage.

Management

- Use a crop rotation that includes potatoes or tomatoes only every third or fourth year to allow infested plant debris to decompose in the soil. Rotations with small grains, corn or legumes are preferable.
- Use tillage practices such as fall plowing that bury all plant refuse.
- Select cultivars that have a lower susceptibility to early blight.
- Use certified disease-free tomato seed and transplants.
- If producing tomato transplants, disinfect soil in plant beds and control humidity in cold frames or greenhouses. Practice good sanitation throughout the transplant production operation.
- Use appropriate measures to control weeds and volunteer potatoes and tomatoes in production areas.
- Maintain fertility at optimal levels—nitrogen and phosphorus deficiency can increase susceptibility to early blight.
- Time applications of overhead irrigation to allow plants to dry before nightfall.
- Although the above measures are important to minimize infection, it is usually necessary to apply fungicide sprays to fully protect plants from early blight. Applications to tomato are usually begun 2-3 weeks following emergence or soon after transplanting if a calendar schedule is followed. Timing of fungicides can also be made using the TOM-CAST system. For potatoes, fungicide applications should be initiated when plants begin to flower. Thorough coverage is important. Adjust equipment for good vine penetration. For current fungicide recommendations and a description of the TOMCAST system consult the Ohio Vegetable Production Guide (OSU Extension Bulletin 672).

Storage

Days to Maturity: 100-120

Harvest: Dig early potatoes when tubers are large enough to eat. Harvest potatoes for storage after

the vines die down or just after the first light frost nips the vines, before heavy freezing. Avoid skinning tubers when digging and avoid long exposure to light.

Approximate Yield: (per 10 feet row) 6-15 lbs

Amount to raise per person: 75-100 pounds (plant about 15 pounds of seed potatoes per person)

Storage: medium-cool (40F-50F), moist (90% RH) conditions; 6-8 months. Sprouting is a problem at higher temperatures.

Preservation: usually stored in medium cool, moist conditions.

Questions & Answers

Should I save some of my potatoes for seed potatoes?

No. Saving your own seed potatoes can lead to a buildup of viruses and diseases.

My potato plants flowered and formed green fruits that resemble small tomatoes. What are they?

These small seeds balls are the fruits that contain the true seeds. They are not edible.

What causes green skins on my potatoes?

The green areas on tubers develop where the potato was exposed to the sun. This condition occurs when the potatoes were not planted deeply enough or not covered with straw. The green portions taste bitter because they contain an alkaloid. These green areas should be cut off and discarded. Exposure of potato tubers to fluorescent light or sunlight will cause greening during storage.

Can I make chips from homegrown potatoes?

Yes. Almost any potato variety can be used to make chips when the potatoes are freshly dug. Commercial chips are made from selected varieties that are carefully handled and stored. Chips made from inferior varieties or improperly stored potatoes will be brown and have a dark ring, because they contain excessive amounts of sugars.

I used potatoes purchased at the grocery store as seed for planting and they rotted without sprouting. Why?

Many potatoes sold for fresh market consumption have been treated to prevent sprouting in storage as well as after planting. Potatoes have a rest period which must be broken before the seed will sprout. Cool or extremely warm temperatures can break the rest period and allow potatoes to sprout. Plant certified seed that has been properly stored to induce sprouting.

Can I save the small potatoes from my spring crop for planting in the fall in my garden?

Yes. This is commonly done but sometimes the potatoes saved from the spring garden fail to sprout when planted in the fall because of a natural dormancy in newly harvested potatoes. One recommended procedure for breaking the dormancy includes harvesting the potatoes and placing them in a cool storage area, preferably in the range of 50 degrees F. until about 3 to 4 weeks before

the anticipated fall planting date. The small potatoes should be planted whole and not cut to prevent rotting.

What size piece should seed potatoes be cut into?

Each seed piece should contain at least 2 to 3 "eyes." Research has shown that the best size seed piece weighs approximately 2 ounces.

Sometimes my potatoes or the potatoes I see at supermarkets have a green color. Are these potatoes poisonous?

Potatoes that exhibit a green color contain a substance known as Solanine. This substance, if consumed in extremely large quantities can cause severe illness or death. This greening of potatoes is caused by exposure to light during the growing period or excessive exposure to artificial lights at grocery stores or supermarkets. In the garden, this is most common after heavy rains which uncover potatoes near the surface exposing them to sunlight.

How do I know when my potatoes are ready for harvesting?

Potatoes are generally mature when the plant starts to turn yellow. Potatoes require 75 to 140 days from planting to maturity depending upon variety and the season in which they are grown. Immature potatoes will often skin and bruise easily. Dig spring-planted potatoes before the soil becomes hot. Avoid harvesting the potatoes when the soil is wet to avoid storage diseases.

I have some seed potatoes left from my spring garden. Would it be all right to eat them?

No. Potato tubers purchased for seed purposes definitely should not be eaten because they frequently have been chemically treated. Like all treated seeds, seed potatoes should not be fed to humans or animals.

After harvesting, how should I handle my potatoes to result in the longest storage time possible?

Dig potatoes when the soil is dry. Be careful not to skin or bruise the tubers. Do not wash the potatoes. Place them in crates or some suitable container and store them in a dark areas for about 10 days at a temperature of 60 degrees F. with a relatively high humidity. After this curing period, keep the potatoes at 40 to 45 degrees F. with humidity near 85 percent and provide good air circulation.

Can potatoes be left in the ground for storage?

Generally no. Cool, humid conditions (38 to 45 degrees F. and 85 percent relative humidity) are best for Irish potato storage. The potatoes would not stay dry enough in the soil to prevent second growth or sprouting. Several weeks at high temperatures can break the rest period in home-grown potatoes after which sprouts will develop on the tuber. It is better to dig the potatoes and put them in a cool, damp area.

Why do home-stored potatoes have a different flavor in the winter than in the summer?

Irish potatoes stored at temperatures below 45 degrees F. will taste sweeter and be stringier that those stored at warmer temperatures. At temperatures less than 45 degrees F., enzymes within the

tuber convert starch into sugars causing the sweet taste and stringy consistency. Potatoes to be eaten should not be stored in the refrigerator. Sugars within the potatoes can be converted back into starch by storing the potatoes at temperatures above 65 degrees F. for a week or two prior to use.

My potato plants produced small tomatoes this year. I planted them next to my tomatoes. Could they have crossed or have my potatoes mutated?

The fruit on the potato plant is actually the fruiting structure of the potato plant. The potato and tomato belong to the same botanical family and have similar growth characteristics. The potato flower looks very much like the tomato flower and is pollinated and fertilized identical to the tomato flower.

The stems of my Irish potato plants are decayed. The plants weaken but do not die.

This is Rhizoctonia. It is a soilborne fungus that causes decay in stems and seed pieces. Approved seed-piece fungicides are the best control. Follow the label instructions closely.

After a rainfall, the plants in one area of my garden began to die rapidly. The stems are rotted. A dark discoloration is moving up the stem to the top of the plant, and the stem has a foul odor.

This is black leg of potatoes, one of the major bacterial potato problems. To prevent problem, plant only in well-drained areas. Seed piece treatment will also help prevent the entry of bacteria and other organisms.

When I dug my potatoes, they were covered by small, raised bumps.

These are root knot nematodes and pose a serious problem on potatoes. Control them with crop rotation.

After I dug my potatoes, I found that they were rough with deep scars.

This is potato scab, caused by a soilborne organism. Control by maintaining an acid soil, below pH 5.6, around your potato plants and a uniform moisture level from the time the potato is formed until it is harvested.

The lower foliage on my potato plants is beginning to turn yellow and is covered with brown spots.

This is early blight of potatoes and is similar to blight on tomatoes. Spray with a fungicide as soon as spots are observed and repeat at 7- to 14-day intervals for two to three sprays.

The foliage of my potato plants is distorted, rolled and is not as healthy as it should be.

Several viruses attack potatoes. The best prevention of potato viruses is to plant only certified seed pieces.

When I dug my potatoes, I noticed small holes chewed in the tubers. How do I prevent this?

Several soil-inhabiting insects such as wireworms and white grubs cause this type of damage. Use control measures for these pests before planting. Use insecticides only as directed on the label.

The leaves of my potatoes are disappearing fast. All I see on the plant is some pinkish worms.

These pinkish larvae are immature Colorado potato beetles. They can defoliate plants and can be controlled with insecticides. Use as directed on the label. In small plots, control by hand picking the larvae and destroying them.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan - Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed. Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable information. Original.*
- Collecting Processing and Germinating Seeds of Wildland Plants - by Cheryl Young, James A. Young - Publication Date: October 1, 1986 - List: $24.95
- Enduring Seeds : Native American Agriculture and Wild Plant Conservation - by Gary Paul Nabhan - Publication Date: April 1, 1991 - List: $14.00
- From Seed to Plant - by Gail Gibbons - Publication Date: March 1, 1991 - List: $15.95 *Explores the intricate relationship between seeds and the plants which they produce.*
- Kid's Gardening : A Kid's Guide to Messing Around in the Dirt/With Seeds - by Kevin Raftery, Kim Gilbert Raftery, Jim M'Guinness - Publication Date: May 1, 1989 - List: $13.95
  Now young readers will know from whence those carrots came. This full-color extravaganza

contains nearly a hundred pages of wipe-clean cardstock, hundreds of illustrations, dozens of growing activities, plus 15 varieties of vegetable, flower, and herb seeds.

- Principles of Seed Science and Technology - by Larry O. Copeland, Miller B. McDonald, Lawrence O. Copeland - Publication Date: March 1, 1995 - List: $74.95
- Saving Seeds : The Gardener's Guide to Growing and Storing Vegetable and Flower Seeds - by Marc Rogers, Polly Alexander (Illustrator) - Publication Date: March 1991 - List: $12.95
- Seed to Seed - by Suzanne Ashworth - Publication Date: January 1, 1995 - List: $20.00
- Seeds : The Definitive Guide to Growing, History, and Lore - by H. Peter Loewer, Peter Loewer - Publication Date: April 1, 1996 - List: $25.00
  Loewer examines the vast and often surprisingly complex world of seeds in an unparalleled thoroughness. In addition to the how-to of growing all kinds of plants and vegetables from seed, the book also considers the role of seeds in history, literature, and business. 100 line drawings.
- Seeds and Propagation (Smith & Hawken--The Hands-On Gardener) - by Susan McClure, Jim Anderson (Illustrator) - Publication Date: June 1, 1997 - List: $10.95
- The New Seed Starter's Handbook - by Nancy Bubel - Publication Date: April 1, 1988 - List: $15.95

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- Burpee : The Complete Vegetable & Herb Gardener : A Guide to Growing Your Garden Organically - by Karan Davis Cutler, Cavagnarok David (Photographer), Barbara W. Ellis - Publication Date: November 1997 - List: $29.95
  Synopsis:
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Grenville Kains, Maurice G. Kain - Publication Date: March 1978 - List: $7.95

- Four-Season Harvest : How to Harvest Fresh Organic Vegetables from Your Home Garden All Year Long - by Eliot Coleman, Kathy Bary (Illustrator) - Publication Date: October 1992 - List: $19.95
  Booknews, Inc. , 01/01/93:
  Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.

- Gardening Under Cover : A Northwest Guide to Solar Greenhouses, Cold Frames, and Cloches - by William Head - Publication Date: November 1989 - List: $10.95
  This is a complete guide to gardening with protective shelters that encourages both beginning and experienced gardeners to add months of gardening pleasure at small expense. With a little under-cover gardening know-how, Pacific Northwest gardeners can take advantage of our mild climate to produce flowers, herbs, and vegetables throughout the year.

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- Growing Great Garlic : The Definitive Guide for Organic Gardeners and Small Farmers - by Ron L. Engeland - Publication Date: July 1995 - List: $14.95

- Heirloom Vegetable Gardening : A Master Gardener's Guide to Planting, Growing, Seed Saving, and Cultural History - by William Woys Weaver - Publication Date: June 1997 - List: $45.00
  Synopsis:
  Weaver focuses on 280 varieties of 37 vegetables in this encyclopedic guide to the history and cultivation of some of America's most treasured heirloom vegetables. 100+ color photos. 240 line drawings.

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  Booknews, Inc. , 04/01/96:
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- Peppers of the World : An Identification Guide - by Dave Dewitt, Paul W. Bosland - Publication Date: January 1997 - List: $19.95

- Plant Propagation : Principles and Practices - by Hudson Thomas Hartmann (Editor), Dale E. Kester, Fred T., Jr. Davies - Publication Date: January 1997 - List: $86.00
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Periodicals:

- None identified.

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Growing Strawberries

Frequently Asked Questions Other Information Sources Return to Garden Contents

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How do you get seeds from strawberries?

Strawberry seeds are easily separated from ripe fruit by placing them in a household blender with a cup of water and blending at high speed for just a few seconds. (Not too long, or the seeds may be damaged). The good seeds will settle to the bottom, and the fruit pulp and unripe seeds will float. Wait a minute or so for the seeds to settle, and pour off the liquid. The seeds can then be rinsed or scraped out and allowed to dry on a paper towel.

Strawberries

Strawberries are perhaps the most ideal fruit for the home garden or for a small-scale planting. They are easy to grow, relatively pest free, and require little space. Twenty-five plants should provide enough berries for a family of four.

Varieties

There are many varieties available that are suitable for Massachusetts. Be sure to purchase certified, virus-free plants. They cost a little more but produce healthier plants and greater yields of fruit. Verticillium-resistant and red stele-resistant varieties are advisable, especially where garden space is limited and other verticillium susceptible plants have been grown. Recommended strawberry varieties include:

- Early - Earlidawn, Catskill, Raritan
- Midseason - Surecrop, Redcheif, Midway
- Late - Guardian, Fletcher, Sparkle

Soil Preparation

Strawberries will grow in almost any soil type, but prefer a sandy loam. The important soil factors to consider are adequate water drainage and abundant organic matter. Soil should be well-cultivated and free of perennial weeds. At planting time, soil should be loosened and pulverized to a depth of eight inches and kept loosened to allow runners to take root. To avoid problems with verticillium wilt, do not plant strawberries where potatoes, tomatoes, peppers, eggplants strawberries or raspberries have grown within three years.

Fertilizing

Before planting - A soil pH range of 5.5 to 7.0 is preferred; 6.0 - 6.5 is ideal. Have your soil tested and follow the recommendations given. Lime (if needed) should be applied before planting and mixed thoroughly with the soil. Aged cow or horse manure at two to five bushels per 100 square feet, or compost, can be added to the soil to increase available organic matter. In addition, work into the soil about two pounds of 10-10-10 (four pounds 5-10-10, or equivalent) per 100 square feet to increase the nitrogen level.

After planting - Apply one to two pounds of 10-10-10 (or equivalent) per 100 square feet four to six weeks after planting and again in late August, depending on plant growth.

Fruiting year - Do not apply fertilizer the spring of fruiting year. Too much nitrogen results in large, soft berries and excessive vegetative growth.

After renovation - Immediately after renovation, apply four pounds of 10-10-10 (or equivalent) per 100 square feet over the rows when plants are dry. Fertilizer application to wet plants can result in phytotoxicity.

Planting

Complete preparation of the planting site is the most important consideration at planting time. Work the plant site as soon as possible in the spring. Purchase plants from a reputable nursery. To avoid disease problems, do not transplant from another strawberry field.

If your plants arrive by mail open the package immediately. Return moldy plants to the shipper. Plants can take fairly dry conditions without becoming damaged. If you cannot plant them immediately, wrap the plants in moist paper towels, place them in a plastic bag and store the bag in your refrigerator until it's time to plant. Plant as soon as the soil can be thoroughly worked in the spring.

There are several systems for planting strawberries. The most common is the matted row system in which mother plants are set 18 to 24 inches apart in rows that are three-to-four-and-a-half feet apart. Daughter plants, or runners, are allowed to root anywhere within the row. In the spaced row system, mother plants are set 12 to 15 inches apart, and runner plants are allowed to set at five-to-seven-inch spacings. Other systems include single and double hedgerow and hill systems.

Set the plant at the proper depth in the soil; just the tip of the crown should be exposed. Now, spread and set the roots vertically in the soil. Pack the soil firmly around the roots. It is essential to have all parts of the root in contact with the soil. Water plants immediately after planting.

If there is not a good rainfall, you'll need to water plants thoroughly at least twice a week.

Watering

After the plants are set out, during the period of fruit bud development in the fall, during production, and after renovation, extra water may be necessary. Generally, an inch of water per week, either supplied by normal rainfall or supplemental waterings, is recommended.

Weed Control

The most important aspect of strawberry culture is weed control. Proper site preparation will help control troublesome perennial weeds. After the plants become established, cultivating can begin. Shallow cultivation as close to the plants as possible, combined with hand hoeing, is the recommended practice. To give the strawberry plants maximum growth advantage, weeds should be removed as soon as they appear. Weed control should be practiced until growth stops in the fall.

In addition to weed control and watering, blossoms should be removed from newly set out plants. If fruit is allowed to form on new plants, these plants will not make maximum growth.

Mulching

After growth has stopped in the fall, apply at least a three-inch layer of straw, marsh hay, pine needles, sudan grass or other suitable material over the tops of the plants. Avoid sawdust and leaves because they pack too tightly and smother the plants. Watering the mulch lightly will help settle it and reduce loss from wind.

Mulching helps protect the plants during severe winters, delays growth in spring (to protect against frosts), helps conserve moisture, and helps with weed control.Apply a mulch when the temperature drops to about 20 degrees for several days in a row or several times in a week. The rule of thumb is to mulch after the soil is frozen to a depth of one-half inch.

Don't apply mulch after several warm, sunny days. If you mulch during warm weather, the plants may start growing again. Then the plants can be severely damaged when the weather turns cold.

Remove the mulch in spring as soon as new leaf growth begins to turn yellow (due to lack of sunlight); but not before there is still any danger of temperatures dipping into the 20's. Part the mulch over the top of the row, moving the mulch into the alleyways. Leave a thin layer of mulch on the plants to protect the developing berries and help with moisture conservation.

Renovation

If a strawberry bed is free of weed, disease, or insect problems and has borne a good crop of berries, you should consider fruiting the bed another year. After harvest, remove mulch and mow the foliage as close to the bed as possible. Remove weak and extra plants and weeds. Cultivate between the rows of plants. Apply fertilizer as indicated above. Treat as a "new" bed. Normally, mother plants and the first daughter plants to form are kept, because these are the most productive plants.

Pests and Diseases

The main insect pests are tarnished plant bugs, strawberry weevils, spittlebugs, and mites.

Two common diseases often present in the strawberry bed are fruit rots and leaf spot. These diseases are troublesome during moist conditions, especially after heavy spring rains, or during long periods of high humidity.

Fruit Rot

Fruit rots are fungus diseases. There are several types including gray mold (the most prevalent), tan rot, hard rot, leather rot, black seed rot and stem end rot. Their names describe their appearance. Infection occurs through germinating spores or by fungal strands spreading from already infected fruit. Usually the fungus first infects the fruit area adjacent to the berry top causing a light brown soft spot. This rotted

area turns dark brown and firm. In advanced stages gray, fuzzy spores appear on the infected area. This is characteristic of gray mold rot.

Several cultural practices can help to discourage fruit rot:

1. Place mulches, such as hay, pine needles, or straw, around the plants to keep ripening berries off the ground where rot often begins.
2. Plant in an area with good air circulation to help the plants dry out after rains, and prevent frost injury.
3. Thin strawberry beds from season to season; a dense planting encourages the spread of fruit rot.
4. Pick fruit as frequently as practical during harvest season, especially if weather is warm and humid.

Leaf Spot

Leaf spot is a term given to several specific disorders: leaf spot, leaf scorch and leaf blight. Infection occurs primarily during the fall. Leaf Spot usually attack immature growth. Bluish or tan areas appear on the undersurface of the leaf; while round, purple spots about 1/8 inch in diameter appear on the leaf's upper surface. With leaf spot disease the centers of the spots turn gray. However, if leaf scorch has infected the plant, the spots do not change color and all stages of leaf growth may be attacked. Leaf blight causes large, irregular spots on the leaves and also may attack the berry cap. As with fruit rot, good sanitation should be practiced to discourage leaf spot diseases. Also, remove and destroy infected plants because the disease overwinters in infected vegetation and can cause reinfection the following season.

Soil-Borne Diseases

There are several very destructive soil-borne organisms that can infect strawberry plants through their roots. Proper choice of strawberry bed sites and land management will help prevent problems with these diseases. Choosing disease resistant varieties (refer to "Varieties of Strawberries for Massachusetts" available from your local county Cooperative Extension office) and planting certified virus-free plants will also help. Strawberries will grow in a wide range of soil types, but prefer a well-drained sandy loam. Always choose an area with full sunlight so plants will dry out after rains, and have the advantage of optimal growing conditions.

Black root: Reduces plant vigor, resulting in decreased runner production. Small roots are affected first and are killed quickly. Dark patches occur on larger roots that eventually turn black. It is not known for sure what actually caused this problem. At the present time, no varieties are resistant to black root. Use only healthy, white-rooted

plants to establish a strawberry bed.

Verticillium wilt: First appears as wilting and drying of outer strawberry leaves. Infected plants often wilt completely if conditions are especially severe. Symptoms can appear when first-year plants are setting runners or when fruits begin to ripen on bearing plants. Plant verticillium-resistant varieties. Avoid planting in areas where potatoes, peppers, tomatoes, eggplants, raspberries or strawberries were planted in the past three years.

Red stele: Destroys small roots and, eventually, the entire root system of infected plants. Plants are stunted and wilted. Infected roots have a red core, or stele. (Healthy roots have a white stele). Small roots are destroyed. Plant red stele-resistant varieties.

Other Problems

Problem: Blossoms open, but center of the blossom is brown or black. Cause: Frost injury to flower bud.

Problem: Small, deformed berries with lots of seeds (achenes). Cause: Tarnished plant bug injury.

Problem: Poorly shaped berries without seeds (achenes). Cause: Poor pollination.

Harvesting

During the "height" of the season berries should be harvested daily. Strawberries should not be left in the hot sun, but should be kept in a cool, dry place - preferably refrigerated. Wet berries do not hold up well and mold quickly.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Strawberry Deficiency Symptoms : A Visual and Plant Analysis Guide to Fertilization - by Albert Ulrich - Publication Date: December 1980 - List: $15.00
- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan - Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed. Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable information. Original.*
- Collecting Processing and Germinating Seeds of Wildland Plants - by Cheryl Young, James A. Young - Publication Date: October 1, 1986 - List: $24.95
- Enduring Seeds : Native American Agriculture and Wild Plant Conservation - by Gary Paul Nabhan - Publication Date: April 1, 1991 - List: $14.00
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Complete preparation of the planting site is the most important consideration at planting time. Work the plant site as soon as possible in the spring. Purchase plants from a reputable nursery. To avoid disease problems, do not transplant from another strawberry field.

If your plants arrive by mail open the package immediately. Return moldy plants to the shipper. Plants can take fairly dry conditions without becoming damaged. If you cannot plant them immediately, wrap the plants in moist paper towels, place them in a plastic bag and store the bag in your refrigerator until it's time to plant. Plant as soon as the soil can be thoroughly worked in the spring.

There are several systems for planting strawberries. The most common is the matted row system in which mother plants are set 18 to 24 inches apart in rows that are three-to-four-and-a-half feet apart. Daughter plants, or runners, are allowed to root anywhere within the row. In the spaced row system, mother plants are set 12 to 15 inches apart, and runner plants are allowed to set at five-to-seven-inch spacings. Other systems include single and double hedgerow and hill systems.

Set the plant at the proper depth in the soil; just the tip of the crown should be exposed. Now, spread and set the roots vertically in the soil. Pack the soil firmly around the roots. It is essential to have all parts of the root in contact with the soil. Water plants immediately after planting.

If there is not a good rainfall, you'll need to water plants thoroughly at least twice a week.

Watering

After the plants are set out, during the period of fruit bud development in the fall, during production, and after renovation, extra water may be necessary. Generally, an inch of water per week, either supplied by normal rainfall or supplemental waterings, is recommended.

Weed Control

The most important aspect of strawberry culture is weed control. Proper site preparation will help control troublesome perennial weeds. After the plants become established, cultivating can begin. Shallow cultivation as close to the plants as possible, combined with hand hoeing, is the recommended practice. To give the strawberry plants maximum growth advantage, weeds should be removed as soon as they appear. Weed control should be practiced until growth stops in the fall.

In addition to weed control and watering, blossoms should be removed from newly set out plants. If fruit is allowed to form on new plants, these plants will not make maximum growth.

Mulching

After growth has stopped in the fall, apply at least a three-inch layer of straw, marsh hay, pine needles, sudan grass or other suitable material over the tops of the plants. Avoid sawdust and leaves because they pack too tightly and smother the plants. Watering the mulch lightly will help settle it and reduce loss from wind.

Mulching helps protect the plants during severe winters, delays growth in spring (to protect against frosts), helps conserve moisture, and helps with weed control.Apply a mulch when the temperature drops to about 20 degrees for several days in a row or several times in a week. The rule of thumb is to mulch after the soil is frozen to a depth of one-half inch.

Don't apply mulch after several warm, sunny days. If you mulch during warm weather, the plants may start growing again. Then the plants can be severely damaged when the weather turns cold.

Remove the mulch in spring as soon as new leaf growth begins to turn yellow (due to lack of sunlight); but not before there is still any danger of temperatures dipping into the 20's. Part the mulch over the top of the row, moving the mulch into the alleyways. Leave a thin layer of mulch on the plants to protect the developing berries and help with moisture conservation.

Renovation

If a strawberry bed is free of weed, disease, or insect problems and has borne a good crop of berries, you should consider fruiting the bed another year. After harvest, remove mulch and mow the foliage as close to the bed as possible. Remove weak and extra plants and weeds. Cultivate between the rows of plants. Apply fertilizer as indicated above. Treat as a "new" bed. Normally, mother plants and the first daughter plants to form are kept, because these are the most productive plants.

Pests and Diseases

The main insect pests are tarnished plant bugs, strawberry weevils, spittlebugs, and mites.

Two common diseases often present in the strawberry bed are fruit rots and leaf spot. These

diseases are troublesome during moist conditions, especially after heavy spring rains, or during long periods of high humidity.

Fruit Rot

Fruit rots are fungus diseases. There are several types including gray mold (the most prevalent), tan rot, hard rot, leather rot, black seed rot and stem end rot. Their names describe their appearance. Infection occurs through germinating spores or by fungal strands spreading from already infected fruit. Usually the fungus first infects the fruit area adjacent to the berry top causing a light brown soft spot. This rotted area turns dark brown and firm. In advanced stages gray, fuzzy spores appear on the infected area. This is characteristic of gray mold rot.

Several cultural practices can help to discourage fruit rot:

1. Place mulches, such as hay, pine needles, or straw, around the plants to keep ripening berries off the ground where rot often begins.
2. Plant in an area with good air circulation to help the plants dry out after rains, and prevent frost injury.
3. Thin strawberry beds from season to season; a dense planting encourages the spread of fruit rot.
4. Pick fruit as frequently as practical during harvest season, especially if weather is warm and humid.

Leaf Spot

Leaf spot is a term given to several specific disorders: leaf spot, leaf scorch and leaf blight. Infection occurs primarily during the fall. Leaf Spot usually attack immature growth. Bluish or tan areas appear on the undersurface of the leaf; while round, purple spots about 1/8 inch in diameter appear on the leaf's upper surface. With leaf spot disease the centers of the spots turn gray. However, if leaf scorch has infected the plant, the spots do not change color and all stages of leaf growth may be attacked. Leaf blight causes large, irregular spots on the leaves and also may attack the berry cap. As with fruit rot, good sanitation should be practiced to discourage leaf spot diseases. Also, remove and destroy infected plants because the disease overwinters in infected vegetation and can cause reinfection the following season.

Soil-Borne Diseases

There are several very destructive soil-borne organisms that can infect strawberry plants through their roots. Proper choice of strawberry bed sites and land management will help prevent problems with these diseases. Choosing disease resistant varieties (refer to "Varieties of Strawberries for Massachusetts" available from your local county Cooperative Extension office) and planting certified virus-free plants will also help. Strawberries will grow in a wide range of soil types, but prefer a well-drained sandy loam. Always choose an area with full sunlight so plants will dry out after rains, and have the advantage of optimal growing conditions.

Black root: Reduces plant vigor, resulting in decreased runner production. Small roots are affected first and are killed quickly. Dark patches occur on larger roots that eventually turn black.

It is not known for sure what actually caused this problem. At the present time, no varieties are resistant to black root. Use only healthy, white-rooted plants to establish a strawberry bed.

Verticillium wilt: First appears as wilting and drying of outer strawberry leaves. Infected plants often wilt completely if conditions are especially severe. Symptoms can appear when first-year plants are setting runners or when fruits begin to ripen on bearing plants. Plant verticillium-resistant varieties. Avoid planting in areas where potatoes, peppers, tomatoes, eggplants, raspberries or strawberries were planted in the past three years.

Red stele: Destroys small roots and, eventually, the entire root system of infected plants. Plants are stunted and wilted. Infected roots have a red core, or stele. (Healthy roots have a white stele). Small roots are destroyed. Plant red stele-resistant varieties.

Other Problems

Problem: Blossoms open, but center of the blossom is brown or black. Cause: Frost injury to flower bud.

Problem: Small, deformed berries with lots of seeds (achenes). Cause: Tarnished plant bug injury.

Problem: Poorly shaped berries without seeds (achenes). Cause: Poor pollination.

Harvesting

During the "height" of the season berries should be harvested daily. Strawberries should not be left in the hot sun, but should be kept in a cool, dry place - preferably refrigerated. Wet berries do not hold up well and mold quickly.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Strawberry Deficiency Symptoms : A Visual and Plant Analysis Guide to Fertilization - by Albert Ulrich - Publication Date: December 1980 - List: $15.00
- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan - Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed. Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable information. Original.*
- Collecting Processing and Germinating Seeds of Wildland Plants - by Cheryl Young, James A. Young - Publication Date: October 1, 1986 - List: $24.95
- Enduring Seeds : Native American Agriculture and Wild Plant Conservation - by Gary Paul Nabhan - Publication Date: April 1, 1991 - List: $14.00
- From Seed to Plant - by Gail Gibbons - Publication Date: March 1, 1991 - List: $15.95
  Explores the intricate relationship between seeds and the plants which they produce.
- Kid's Gardening : A Kid's Guide to Messing Around in the Dirt/With Seeds - by Kevin Raftery, Kim Gilbert Raftery, Jim M'Guinness - Publication Date: May 1, 1989 - List: $13.95
  Now young readers will know from whence those carrots came. This full-color extravaganza contains nearly a hundred pages of wipe-clean cardstock, hundreds of illustrations, dozens of growing activities, plus 15 varieties of vegetable, flower, and herb seeds.
- Principles of Seed Science and Technology - by Larry O. Copeland, Miller B. McDonald, Lawrence O. Copeland - Publication Date: March 1, 1995 - List: $74.95
- Saving Seeds : The Gardener's Guide to Growing and Storing Vegetable and Flower Seeds - by Marc Rogers, Polly Alexander (Illustrator) - Publication Date: March 1991 - List: $12.95
- Seed to Seed - by Suzanne Ashworth - Publication Date: January 1, 1995 - List: $20.00
- Seeds : The Definitive Guide to Growing, History, and Lore - by H. Peter Loewer, Peter Loewer - Publication Date: April 1, 1996 - List: $25.00
  Loewer examines the vast and often surprisingly complex world of seeds in an unparalleled thoroughness. In addition to the how-to of growing all kinds of plants and vegetables from seed, the book also considers the role of seeds in history, literature, and business. 100 line drawings.
- Seeds and Propagation (Smith & Hawken--The Hands-On Gardener) - by Susan McClure, Jim Anderson (Illustrator) - Publication Date: June 1, 1997 - List: $10.95

- The New Seed Starter's Handbook - by Nancy Bubel - Publication Date: April 1, 1988 - List: $15.95

- Gardening In Deer Country - by Vincent Drzewucki - Publication Date: January, 1998 - List: $9.95

- 200 Tips for Growing Vegetables in the Northeast - by Miranda Smith - Publication Date: February 1996 - List: $7.95

- 200 Tips for Growing Vegetables in the Pacific Northwest - by Maggie Stuckey - Publication Date: February 1996 - List: $7.95

- Building Your Own Greenhouse (Greenhouse Basics) - by Mark Freeman, Heather Bellanca (Illustrator) - Publication Date: April 1997 - List: $18.95

- Burpee : The Complete Vegetable & Herb Gardener : A Guide to Growing Your Garden Organically - by Karan Davis Cutler, Cavagnarok David (Photographer), Barbara W. Ellis - Publication Date: November 1997 - List: $29.95
  Synopsis:
  A companion to Burpee Complete Gardener, this book focuses on all aspects of growing organic vegetables and edible herbs in the home garden. Planting techniques and tools, garden design, and more than 90 individual plant portraits are included. 300 full-color photos.

- Culinary Gardens : From Garden to Palate - by Susan McClure - Publication Date: September 1997 - List: $37.95
- Five Acres and Independence: A Handbook for Small Farm Management - by Maurice Grenville Kains, Maurice G. Kain - Publication Date: March 1978 - List: $7.95

- Four-Season Harvest : How to Harvest Fresh Organic Vegetables from Your Home Garden All Year Long - by Eliot Coleman, Kathy Bary (Illustrator) - Publication Date: October 1992 - List: $19.95
  Booknews, Inc. , 01/01/93:
  Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.

- Gardening Under Cover : A Northwest Guide to Solar Greenhouses, Cold Frames, and Cloches - by William Head - Publication Date: November 1989 - List: $10.95
  This is a complete guide to gardening with protective shelters that encourages both beginning and experienced gardeners to add months of gardening pleasure at small expense. With a little under-cover gardening know-how, Pacific Northwest gardeners can take advantage of our mild climate to produce flowers, herbs, and vegetables throughout the

year.

- Grow It : The Beginner's Complete In-Harmony-With-Nature Small Farm Guide-From Vegetable and Grain Growing to Livestock Care - by Richard W. Langer, Susan McNeill (Illustrator) - Publication Date: January 1994 - List: $12.00
  Synopsis:
  An indispensable guide to small-scale organic farming that features advice on everything from building and stocking a pond to planting an orchard or making cheese. This extremely practical and easy-to-use guide, first published in 1972, is for full-time or part-time country dwellers/gardeners.

- Growing Great Garlic : The Definitive Guide for Organic Gardeners and Small Farmers - by Ron L. Engeland - Publication Date: July 1995 - List: $14.95

- Heirloom Vegetable Gardening : A Master Gardener's Guide to Planting, Growing, Seed Saving, and Cultural History - by William Woys Weaver - Publication Date: June 1997 - List: $45.00
  Synopsis:
  Weaver focuses on 280 varieties of 37 vegetables in this encyclopedic guide to the history and cultivation of some of America's most treasured heirloom vegetables. 100+ color photos. 240 line drawings.

- A Dyer's Garden : From Plant to Pot Growing Dyes for Natural Fibers - by Rita Buchanan - Publication Date: August 1995 - List: $9.95

- A Produce Reference Guide to Fruits and Vegetables from Around the World : Nature's Harvest - by Donald D. Heaton - Publication Date: April 1997 - List: $29.95

- Growing Plants from Seed : A Comprehensive Beginners Handbook for Vegetables, Flowers, Herbs and More - by George Abraham, Katy Abraham, Doc Abraham - Publication Date: January 1992 - List: $13.95
  Synopsis:
  A guide for first-time seed growers addresses soil mixtures, lighting, types of seed, seed-starting kits, and more to help any gardener experience the rewarding feeling of growing flowers and vegetables from seed. Original.

- Peppers : The Domesticated Capsicums - by Jean Andrews - Publication Date: October 1995 - List: $65.00
  Booknews, Inc. , 04/01/96:
  An updated edition (first, 1984) of an elegantly produced, scholarly reference on peppers--their history and dispersion, biology, taxonomy, cultivation, and medicinal, economic, and gastronomic uses. Illustrated with the author's botanically accurate, aesthetically pleasing paintings that show the blossoms, buds, young peppers, and mature specimens of 34 cultivars. A review of the literature, a photo glossary, and an extensive

bibliography add to the volume's reference value. 9x12" Annotation c. by Book News, Inc., Portland, Or.

- Peppers of the World : An Identification Guide - by Dave Dewitt, Paul W. Bosland - Publication Date: January 1997 - List: $19.95

- Plant Propagation : Principles and Practices - by Hudson Thomas Hartmann (Editor), Dale E. Kester, Fred T., Jr. Davies - Publication Date: January 1997 - List: $86.00
  The publisher, Prentice-Hall Career & Technology :
  Hallmarked as the most successful text of its kind, this remarkably thorough text covers all aspects of the propagation of plants - both sexual and asexual - with considerable attention given to human (vs natural) efforts to increase plant numbers.

- Forest Gardening : Cultivating an Edible Landscape - by Robert A. De J. Hart - Publication Date: September 1996 - List: $17.95

- Handbook of Organic Food Processing and Production - by Simon Wright (Editor) - Publication Date: October 1994 - List: $119.00

- Introduction to Permaculture - by Bill Mollison, Reny Mia Slay - Publication Date: November 1997 - List: $16.95

- Profitable Organic Farming - by Jon Newton - Publication Date: June 1995 - List: $36.95

- The New Organic Grower : A Master's Manual of Tools and Techniques for the Home and Market Gardener - by Eliot Coleman, Sheri Amsel (Illustrator), Molly Cook Field (Illustrator) - Publication Date: October 1995 - List: $24.95
  Booknews, Inc. , 05/01/96:
  This expansion of a now-classic guide originally published in 1989 is intended for the serious gardener or small-scale market farmer. It describes practical and sustainable ways of growing superb organic vegetables, with detailed coverage of scale and capital, marketing, livestock, the winter garden, soil fertility, weeds, and many other topics. Annotation c. by Book News, Inc., Portland, Or.

- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95

Periodicals:

- None identified.

This page was last updated on August 31, 2002

Growing Sweet Corn

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Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Sweet Corn - Gramineae Zeamays

The earliest written record of corn (maize) is found in the Popul Vuh, the sacred book of the Quiche Indians of western Guatemala. The records date back to the eighth century.

Modern-day maize agronomists sometimes divide corn into popcorn, sweet corn, dent corn, pod corn, flour corn, and flint corn, but this is an arbitrary, not a natural, classification. Sweet corn is distinguished from other corns by its high sugar content when in the milk, by its early dough stages and by its wrinkled, translucent kernels when dry.

Sweet corn is a warm-season vegetable that can be easily grown in any garden with sufficient space. It is especially popular with home gardeners because it is a vegetable that tastes appreciably better when it is harvested fresh from the garden. Successive planting will yield continuous harvests.

Sweet corn may be divided into three distinct types according to genetic background: standard, super sweet, and sugar enhanced.

Standard sweet corn varieties contain a "sugary gene" that is responsible for the sweetness and creamy texture of the kernels.

Super-sweet varieties contain a unique gene that makes the kernels sweeter than those of the standard varieties. The sugar of the super sweet varieties is also converted to starch more slowly, preserving the sweetness for a longer time. The kernels of the super-sweet varieties have a crispy texture and contain low amounts of the water-soluble polysaccharides that impart the creamy texture to other sweet corn varieties. Although this lack of creamy texture is not especially noticeable in fresh corn on the cob, it affects the quality of frozen and canned corn.

Sugar enhanced varieties (75% normal "sugary" kernels and approximately 25% super-sweet kernels) contain multiple gene combinations that impart a creamy texture and increase sweetness. The sugar content is not as high, however, as that of the super-sweet varieties.

Varieties

Nearly all sweet corn sold today is a hybrid. The maturity dates are relative; the actual number of days to harvest varies from year to year and location to location. All of the varieties recommended for Arkansas are in the standard sweet corn varieties.

- **Silver Queen** - 94 days to maturity. Tolerant maize dwarf mosaic virus. Large white ears, excellent quality, widely adapted.
- **Jubilee** - 84 days to maturity. Tolerant maize dwarf mosaic virus. Good yields, large yellow ears, good quality.
- **How Sweet It Is** - 80 days to maturity. White super sweet type, plant in warm soil. All-America winner.

Planting

Sweet corn requires warm soil for germination (above 55 degrees F. for standard sweet corn varieties). Early plantings should be made in mid-March if weather permits. Sweet corn may be planted from early spring to early August.

For a continuous supply of sweet corn throughout the summer, plant an early variety, a second early variety, and a main crop variety in the first planting. For example, you may want to select a 70-day maturity variety, an 80-day maturity, and a 90-day maturity. Make a second planting and successive plantings of your favorite main crop or late varieties when three to four leaves have appeared on the seedlings from the previous planting.

Plant the kernels (seeds) 1/2 inch deep in cool, moist soil and 1 to 1 1/2 inches deep in warm, dry soil. Space the kernels 9 to 12 inches apart in the row. Plant two or more rows of each variety side by side to insure good pollination and ear development. Allow 30 to 36 inches between rows.

Plan your garden arrangement and planting schedule to prevent cross-pollination between your sweet corn, field corn, and popcorn. If sweet corn is crossed with field corn or popcorn, it will not develop a high sugar content and will be starchy. Cross-pollination between

yellow and white sweet corn varieties affects only the appearance of the white corn, not the eating quality.

Care

Cultivate shallowly to control weeds. Although corn is a warm-season crop, lack of water at critical periods can seriously reduce quality and yield. If rainfall is deficient, irrigate thoroughly during emergence of the tassels, silking, and maturation of the ears.

Hot, dry conditions during pollination result in missing kernels, small ears, and poor development of the tips of the ears. Sidedress nitrogen fertilizer when the plants are 12 to 18 inches high.

Some sweet corn varieties produce more side shoots or "suckers" than others. Removing these side shoots does not improve yields.

The practice of removing the tassels from the stalk is a research and breeding practice and is not a gardening practice.

Problems

Corn earworms are a problem in sweet corn every year. Early plantings are not badly infested, but later harvests will usually have severe earworn damage unless timely control measures are followed. Corn earworm moths deposit eggs on the developing silks or on the leaves near the ear. The tiny caterpillars follow the silk down into the ear, where they feed on the tip. Once the worm is inside the protective husk covering, there is no effective control.

A suggested insecticide must be applied before the worms enter the silk channel. For good control in heavy infestations, make several applications two to three days apart from the time silks appear until they turn brown. To restrict worm infestation, tighten the tip of the husk with a rubber band or clothespin after the silk appears or insert mineral oil (1/2 medicine dropper full) in the silk tube which helps to decrease the damage.

European corn borers damage stalks, tassels, and ears. As their name indicates, corn borers bore into the plant; the stalks actually break off when damage becomes severe. Corn borers may also bore into the cob and be found after cooking. A suggested insecticide can be applied at five-day intervals, beginning with eggs hatching in mid-May. Spray applications for corn earworms usually will give adequate control of corn borers.

Flea beetles often attack early in the spring as the corn plants emerge

through the soil. They can be quite damaging in large quantity and may also carry Stewart's bacterial wilt disease. A suggested insecticide must be applied early to control flea beetles.

Stewart's wilt is a bacterial disease spread by the flea beetle. This disease causes yellow streaks in the leaves, stunts in growth, and death of young plants of susceptible varieties. The disease generally is not severe after cold weather or when resistant varieties are planted.

Smut is caused by a fungus that invades the kernels. It develops as a swollen black pustule (gall) in the ear and sometimes infects the tassel. Some sweet corn varieties are more tolerant of smut than others. Smut occurs most frequently on white varieties and is often severe when kernels are extremely dry and during tasseling. Remove and destroy smut galls while they are moist and firm. Do not discard these galls in or near the garden. Place in the garbage or burn them. The smut is not poisonous, and in certain areas it is cultivated and eaten. Break off the infected part of the ear. The remainder is suitable for eating.

Diseases: Stewart's wilt, a bacterial disease spread by flea beetles; smut (especially on white varieties); stunt (transmitted by leafhoppers).

Insects: Corn earworm, European corn borer, flea beetles, Japanese beetles (eat silks), corn sap beetles (damage kernels after husk is loosened).

Cultural: Poor kernel development - failure to fill out to the tip, caused by dry weather during silking states, planting too close, poor fertility (especially potassium deficiency), too few rows in a block, resulting in poor pollination. Lodging (falling over) from too much nitrogen.

Harvesting

Days to Maturity: 63-100

When to Harvest: Each cornstalk should produce at least one large ear. Under good growing conditions (correct spacing; freedom from weeds, insects, and diseases; adequate moisture and fertility), many varieties will produce a second ear. This second ear is usually smaller and develops later than the first ear.

Sweet corn ears should be picked during the "milk stage" when the kernels are not fully mature. This stage occurs about 20 days after the appearance of the first silk strands. The kernels are smooth and plump, and the juice in the kernels appears milky when punctured with a thumbnail. (if liquid is clear the corn is immature, if milky it's ready, and if no sap, you're too late). Cover unharvested ears checked by this method with paper bag to prevent insect or bird damage. Experienced

gardeners can feel the outside of the husk and tell when the cob has filled out. Corn matures 17-24 days after first silk strands appear, more quickly in hot weather, slower in cool weather.

Sweet corn remains in the milk stage less than a week. As harvest time approaches, check frequently to make sure that the kernels do not become too mature and doughy. Other signs that indicate when the corn is ready for harvest are drying and browning of the silks, fullness of the tip kernels, and firmness of the unhusked ears.

To harvest, snap off the ears by hand with a quick, firm, downward push; twist and pull. The ears should be eaten as soon as possible, processed, or refrigerated. At summer temperatures, the sugar in sweet corn quickly decreases and starch increases.

Cut or pull out the cornstalks immediately after harvest and put them in a compost pile. Cut the stalks in one-foot long lengths or shred them to hasten decay.

Approximate Yields: (per 10' row) 5-10 pounds or roughly 10-20 ears

Amount to raise per person: 20-30 pounds or about 40-60 ears

Storage: Refrigerate immediately to prevent sugars from turning to starch; cold (32F), moist (95% RH) conditions; will keep 4-8 days, but standard varieties will become starchy after a few days.

Preservation: Frozen on cob or off; canned.

Questions and Answers

How long does it take sweet corn to develop from the first appearance of silk to harvest?

About five days are required for complete pollination after the first silk appears.Harvesting begins approximately 20 days after first silking.

The germination of some varieties is low. How can I get a better stand?

The sweet corn seed is shrunken especially the supersweet types and do not germinate as well as smooth seed. Do not plant too early in the spring, wait until the soil is warm, about 65 degrees F. Sow the seed more thickly and thin if necessary. A fungicide seed treatment may also be helpful.

Why didn't my sweet corn ears fill out to the tips?

Several conditions can cause poor kernel development at the tip of the ear: dry or cool wet weather during silking and pollination; planting too close; poor fertilization, especially lack of potassium; and poor natural

pollination. These conditions may be overcome by watering in dry weather, planting at recommended spacing (9-12 inches. apart in the row), proper fertilization and planting short rows in blocks of two or more for self-pollination.

What is the best way to grow early corn?

Choose an early maturing variety, plant early and shallow (about ½ inch deep) and cover the row with clear polyethylene film. Remove the film, or cut slits and carefully pull the plants through before the weather becomes too hot. Floating row covers can also be used effectively for early corn production.

Should garden corn be planted in several short rows rather than in one or two long rows?

Yes. Corn is a wind pollinated plant. Planting corn in blocks rather than in long rows makes it easier for the plants to pollinate one another during tasseling.

Should the suckers, or side shoots, which emerge near the ground level on sweet corn be removed?

It is not necessary but modern cultivars of sweet corn have been developed to have a minimum number tillers.

How long does it take for most sweet corn varieties to produce edible ears?

Most sweet corn varieties will mature between 65 to 90 days after seeding. Maturity rate varies from season to season depending on temperatures.

Why are ears of corn underdeveloped at the tip end?

The causes for this condition include nutrient deficiency, cool temperatures during ear maturity and low moisture. Corn is pollinated by wind-borne pollen from the male flowers or tassels at the top of the plant to the female flowers or silks about midway up the stalks. Each kernel develops from an individually pollinated silk. Kernels which develop near the middle and base when conditions occur such as those mentioned above, those kernels pollinated first will take precedence over those pollinated last. This often results in failure of the kernels near the tip to develop properly, or in irregular kernel development.

Is there a best time of day to harvest sweet corn?

Harvesting during early morning is recommended to insure the sugar will be at its highest level if the corn is mature but not overripe. Cool the corn quickly to prevent loss of sugar.

How often should sweet corn be fertilized to produce high yields of

good quality corn?

Sweet corn should be lightly fertilized prior to planting. It should be fertilized again when the plants are approximately 4 inches tall and when they are 8 to 10 inches tall. Approximately 1/4 lb. of complete fertilizer for every 10 ft. of garden row is sufficient.

This year my sweet corn produced yellow and white kernels on the same cob. What's wrong?

This could be caused by a bicolored varieties, such as Honey and Cream. New varieties, such as those with an super sweet character, produce white and yellow kernels on the small cob.

What is meant by advertisements in catalogs referring to "Super Sweet" varieties of sweet corn?

Newly developed "Super Sweet" hybrid varieties may contain up to 40 percent more sugar than some of the standard varieties. Super Sweet hybrid carry a gene (sh2) which results in a high sugar content. The super sweet character is lost if the corn is pollinated by ordinary sweet corn or field corn, so the super sweet hybrids should be planted away from any other type of corn. Another type is the SE or sugar enhanced sweet corn.

What is the difference between roasting ears and sweet corn?

Roasting ears a field corn harvested at an immature stage. Field corn is preferred by some because the ears are larger and the corn is not as chewy.

My sweet corn produced normally. However, as the ear formed, the tip of it became covered with a large white mass that grew until it broke open and exposed a black, powdery mass.

This is corn ear smut, a type of fungus carried in the seed. To avoid this, use only high-quality seed from a reputable source. There is no chemical control for this disease.

My sweet corn grew for a while and then had a mosaic appearance. The corn did not develop properly. The ears that formed were poorly filled.

This is maize dwarf mosaic virus. It overwinters in johnson grass around a garden. To control the problem, remove the johnson grass, and follow a good insect control program. Some varieties are more resistant to this disease than others.

I planted corn in my garden this fall and it turned out beautifully, but the corn ear worms ate more corn than I did. What can I do to prevent this?

Spray or dust the ear silks with Sevin (carbaryl) to prevent adult insects from entering and laying eggs. Begin dusting and spraying at an early stage and repeat every two days. A drop of mineral oil on the silks is recommended to prevent earworm damage.

Are there any earworm resistant varieties of sweet corn available?

No. Some varieties seem to be bothered less by corn earworms than others, but none are truly resistant. Varieties of sweet corn which have a tight shuck near the silk end seem to be bothered less by earworms than those that have loose and open ends.

The center of my corn plants are full of little green insects. What do I do about them?

Corn leaf aphids infest the sworl of young corn plants. The plants will tolerate large numbers of these aphids. If plants begin to wilt or die, spray them with malathion. Use as directed on the label.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan - Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed. Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable*

information. Original.

- Collecting Processing and Germinating Seeds of Wildland Plants - by Cheryl Young, James A. Young - Publication Date: October 1, 1986 - List: $24.95
- Enduring Seeds : Native American Agriculture and Wild Plant Conservation - by Gary Paul Nabhan - Publication Date: April 1, 1991 - List: $14.00
- From Seed to Plant - by Gail Gibbons - Publication Date: March 1, 1991 - List: $15.95 *Explores the intricate relationship between seeds and the plants which they produce.*
- Kid's Gardening : A Kid's Guide to Messing Around in the Dirt/With Seeds - by Kevin Raftery, Kim Gilbert Raftery, Jim M'Guinness - Publication Date: May 1, 1989 - List: $13.95
  Now young readers will know from whence those carrots came. This full-color extravaganza contains nearly a hundred pages of wipe-clean cardstock, hundreds of illustrations, dozens of growing activities, plus 15 varieties of vegetable, flower, and herb seeds.
- Principles of Seed Science and Technology - by Larry O. Copeland, Miller B. McDonald, Lawrence O. Copeland - Publication Date: March 1, 1995 - List: $74.95
- Saving Seeds : The Gardener's Guide to Growing and Storing Vegetable and Flower Seeds - by Marc Rogers, Polly Alexander (Illustrator) - Publication Date: March 1991 - List: $12.95
- Seed to Seed - by Suzanne Ashworth - Publication Date: January 1, 1995 - List: $20.00
- Seeds : The Definitive Guide to Growing, History, and Lore - by H. Peter Loewer, Peter Loewer - Publication Date: April 1, 1996 - List: $25.00
  Loewer examines the vast and often surprisingly complex world of seeds in an unparalleled thoroughness. In addition to the how-to of growing all kinds of plants and vegetables from seed, the book also considers the role of seeds in history, literature, and business. 100 line drawings.
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- Building Your Own Greenhouse (Greenhouse Basics) - by Mark Freeman, Heather Bellanca (Illustrator) - Publication Date: April 1997 - List: $18.95

- Burpee : The Complete Vegetable & Herb Gardener : A Guide to Growing Your Garden
  Organically - by Karan Davis Cutler, Cavagnarok David (Photographer), Barbara W. Ellis - Publication Date: November 1997 - List: $29.95
  Synopsis:
  A companion to Burpee Complete Gardener, this book focuses on all aspects of growing organic vegetables and edible herbs in the home garden. Planting techniques and tools, garden design, and more than 90 individual plant portraits are included. 300 full-color photos.

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  Booknews, Inc. , 01/01/93:
  Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.

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can take advantage of our mild climate to produce flowers, herbs, and vegetables throughout the year.

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- Introduction to Permaculture - by Bill Mollison, Reny Mia Slay - Publication Date: November 1997 - List: $16.95

- Profitable Organic Farming - by Jon Newton - Publication Date: June 1995 - List: $36.95

- The New Organic Grower : A Master's Manual of Tools and Techniques for the Home and Market Gardener - by Eliot Coleman, Sheri Amsel (Illustrator), Molly Cook Field (Illustrator) - Publication Date: October 1995 - List: $24.95
  Booknews, Inc. , 05/01/96:

This expansion of a now-classic guide originally published in 1989 is intended for the serious gardener or small-scale market farmer. It describes practical and sustainable ways of growing superb organic vegetables, with detailed coverage of scale and capital, marketing, livestock, the winter garden, soil fertility, weeds, and many other topics. Annotation c. by Book News, Inc., Portland, Or.

- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Sweet Corn - Gramineae Zeamays

The earliest written record of corn (maize) is found in the Popul Vuh, the sacred book of the Quiche Indians of western Guatemala. The records date back to the eighth century.

Modern-day maize agronomists sometimes divide corn into popcorn, sweet corn, dent corn, pod corn, flour corn, and flint corn, but this is an arbitrary, not a natural, classification. Sweet corn is distinguished from other corns by its high sugar content when in the milk, by its early dough stages and by its wrinkled, translucent kernels when dry.

Sweet corn is a warm-season vegetable that can be easily grown in any garden with sufficient space. It is especially popular with home gardeners because it is a vegetable that tastes appreciably better when it is harvested fresh from the garden. Successive planting will yield continuous harvests.

Sweet corn may be divided into three distinct types according to genetic background: standard, super sweet, and sugar enhanced.

Standard sweet corn varieties contain a "sugary gene" that is responsible for the sweetness and creamy texture of the kernels.

Super-sweet varieties contain a unique gene that makes the kernels sweeter than those of the standard varieties. The sugar of the super sweet varieties is also converted to starch more slowly, preserving the sweetness for a longer time. The kernels of the super-sweet varieties have a crispy texture and contain low amounts of the water-soluble polysaccharides that impart the creamy texture to other sweet corn varieties. Although this lack of creamy texture is not especially noticeable in fresh corn on the cob, it affects the quality of frozen and canned corn.

Sugar enhanced varieties (75% normal "sugary" kernels and approximately 25% super-sweet kernels) contain multiple gene combinations that impart a creamy texture and increase sweetness. The sugar content is not as high, however, as that of the super-sweet varieties.

Varieties

Nearly all sweet corn sold today is a hybrid. The maturity dates are relative; the actual number of days to harvest varies from year to year and location to location. All of the varieties recommended for Arkansas are in the standard sweet corn varieties.

- **Silver Queen** - 94 days to maturity. Tolerant maize dwarf mosaic virus. Large white ears,

excellent quality, widely adapted.

- **Jubilee** - 84 days to maturity. Tolerant maize dwarf mosaic virus. Good yields, large yellow ears, good quality.
- **How Sweet It Is** - 80 days to maturity. White super sweet type, plant in warm soil. All-America winner.

Planting

Sweet corn requires warm soil for germination (above 55 degrees F. for standard sweet corn varieties). Early plantings should be made in mid-March if weather permits. Sweet corn may be planted from early spring to early August.

For a continuous supply of sweet corn throughout the summer, plant an early variety, a second early variety, and a main crop variety in the first planting. For example, you may want to select a 70-day maturity variety, an 80-day maturity, and a 90-day maturity. Make a second planting and successive plantings of your favorite main crop or late varieties when three to four leaves have appeared on the seedlings from the previous planting.

Plant the kernels (seeds) 1/2 inch deep in cool, moist soil and 1 to 1 1/2 inches deep in warm, dry soil. Space the kernels 9 to 12 inches apart in the row. Plant two or more rows of each variety side by side to insure good pollination and ear development. Allow 30 to 36 inches between rows.

Plan your garden arrangement and planting schedule to prevent cross-pollination between your sweet corn, field corn, and popcorn. If sweet corn is crossed with field corn or popcorn, it will not develop a high sugar content and will be starchy. Cross-pollination between yellow and white sweet corn varieties affects only the appearance of the white corn, not the eating quality.

Care

Cultivate shallowly to control weeds. Although corn is a warm-season crop, lack of water at critical periods can seriously reduce quality and yield. If rainfall is deficient, irrigate thoroughly during emergence of the tassels, silking, and maturation of the ears.

Hot, dry conditions during pollination result in missing kernels, small ears, and poor development of the tips of the ears. Sidedress nitrogen fertilizer when the plants are 12 to 18 inches high.

Some sweet corn varieties produce more side shoots or "suckers" than others. Removing these side shoots does not improve yields.

The practice of removing the tassels from the stalk is a research and breeding practice and is not a gardening practice.

Problems

Corn earworms are a problem in sweet corn every year. Early plantings are not badly infested, but later harvests will usually have severe earworn damage unless timely control measures are followed. Corn earworm moths deposit eggs on the developing silks or on the leaves near the ear. The tiny caterpillars follow the silk down into the ear, where they feed on the tip. Once the worm is inside the protective husk covering, there is no effective control.

A suggested insecticide must be applied before the worms enter the silk channel. For good control in heavy infestations, make several applications two to three days apart from the time silks appear until they turn brown. To restrict worm infestation, tighten the tip of the husk with a rubber band or clothespin after the silk appears or insert mineral oil (1/2 medicine dropper full) in the silk tube which helps to decrease the damage.

European corn borers damage stalks, tassels, and ears. As their name indicates, corn borers bore into the plant; the stalks actually break off when damage becomes severe. Corn borers may also bore into the cob and be found after cooking. A suggested insecticide can be applied at five-day intervals, beginning with eggs hatching in mid-May. Spray applications for corn earworms usually will give adequate control of corn borers.

Flea beetles often attack early in the spring as the corn plants emerge through the soil. They can be quite damaging in large quantity and may also carry Stewart's bacterial wilt disease. A suggested insecticide must be applied early to control flea beetles.

Stewart's wilt is a bacterial disease spread by the flea beetle. This disease causes yellow streaks in the leaves, stunts in growth, and death of young plants of susceptible varieties. The disease generally is not severe after cold weather or when resistant varieties are planted.

Smut is caused by a fungus that invades the kernels. It develops as a swollen black pustule (gall) in the ear and sometimes infects the tassel. Some sweet corn varieties are more tolerant of smut than others. Smut occurs most frequently on white varieties and is often severe when kernels are extremely dry and during tasseling. Remove and destroy smut galls while they are moist and firm. Do not discard these galls in or near the garden. Place in the garbage or burn them. The smut is not poisonous, and in certain areas it is cultivated and eaten. Break off the infected part of the ear. The remainder is suitable for eating.

Diseases: Stewart's wilt, a bacterial disease spread by flea beetles; smut (especially on white varieties); stunt (transmitted by leafhoppers).

Insects: Corn earworm, European corn borer, flea beetles, Japanese beetles (eat silks), corn sap beetles (damage kernels after husk is loosened).

Cultural: Poor kernel development - failure to fill out to the tip, caused by dry weather during silking states, planting too close, poor fertility (especially potassium deficiency), too few rows in a block, resulting in poor pollination. Lodging (falling over) from too much nitrogen.

Harvesting

Days to Maturity: 63-100

When to Harvest: Each cornstalk should produce at least one large ear. Under good growing conditions (correct spacing; freedom from weeds, insects, and diseases; adequate moisture and fertility), many varieties will produce a second ear. This second ear is usually smaller and develops later than the first ear.

Sweet corn ears should be picked during the "milk stage" when the kernels are not fully mature. This stage occurs about 20 days after the appearance of the first silk strands. The kernels are smooth and plump, and the juice in the kernels appears milky when punctured with a thumbnail. (if liquid is clear the corn is immature, if milky it's ready, and if no sap, you're too late). Cover unharvested ears checked by this method with paper bag to prevent insect or bird damage. Experienced gardeners can feel the outside of the husk and tell when the cob has filled out. Corn matures 17-24 days after first silk strands appear, more quickly in hot weather, slower in cool weather.

Sweet corn remains in the milk stage less than a week. As harvest time approaches, check frequently to make sure that the kernels do not become too mature and doughy. Other signs that indicate when the corn is ready for harvest are drying and browning of the silks, fullness of the tip kernels, and firmness of the unhusked ears.

To harvest, snap off the ears by hand with a quick, firm, downward push; twist and pull. The ears should be eaten as soon as possible, processed, or refrigerated. At summer temperatures, the sugar in sweet corn quickly decreases and starch increases.

Cut or pull out the cornstalks immediately after harvest and put them in a compost pile. Cut the stalks in one-foot long lengths or shred them to hasten decay.

Approximate Yields: (per 10' row) 5-10 pounds or roughly 10-20 ears

Amount to raise per person: 20-30 pounds or about 40-60 ears

Storage: Refrigerate immediately to prevent sugars from turning to starch; cold (32F), moist (95% RH) conditions; will keep 4-8 days, but standard varieties will become starchy after a few days.

Preservation: Frozen on cob or off; canned.

Questions and Answers

How long does it take sweet corn to develop from the first appearance of silk to harvest?

About five days are required for complete pollination after the first silk appears.Harvesting begins approximately 20 days after first silking.

The germination of some varieties is low. How can I get a better stand?

The sweet corn seed is shrunken especially the supersweet types and do not germinate as well as smooth seed. Do not plant too early in the spring, wait until the soil is warm, about 65 degrees F. Sow the seed more thickly and thin if necessary. A fungicide seed treatment may also be helpful.

Why didn't my sweet corn ears fill out to the tips?

Several conditions can cause poor kernel development at the tip of the ear: dry or cool wet weather during silking and pollination; planting too close; poor fertilization, especially lack of potassium; and poor natural pollination. These conditions may be overcome by watering in dry weather, planting at recommended spacing (9-12 inches. apart in the row), proper fertilization and planting short rows in blocks of two or more for self-pollination.

What is the best way to grow early corn?

Choose an early maturing variety, plant early and shallow (about ½ inch deep) and cover the row with clear polyethylene film. Remove the film, or cut slits and carefully pull the plants through before the weather becomes too hot. Floating row covers can also be used effectively for early corn production.

Should garden corn be planted in several short rows rather than in one or two long rows?

Yes. Corn is a wind pollinated plant. Planting corn in blocks rather than in long rows makes it easier for the plants to pollinate one another during tasseling.

Should the suckers, or side shoots, which emerge near the ground level on sweet corn be removed?

It is not necessary but modern cultivars of sweet corn have been developed to have a minimum number tillers.

How long does it take for most sweet corn varieties to produce edible ears?

Most sweet corn varieties will mature between 65 to 90 days after seeding. Maturity rate varies from season to season depending on temperatures.

Why are ears of corn underdeveloped at the tip end?

The causes for this condition include nutrient deficiency, cool temperatures during ear maturity and low moisture. Corn is pollinated by wind-borne pollen from the male flowers or tassels at the top of the plant to the female flowers or silks about midway up the stalks. Each kernel develops from an individually pollinated silk. Kernels which develop near the middle and base when conditions occur such as those mentioned above, those kernels pollinated first will take precedence over those pollinated last. This often results in failure of the kernels near the tip to develop properly, or in irregular kernel development.

Is there a best time of day to harvest sweet corn?

Harvesting during early morning is recommended to insure the sugar will be at its highest level if the corn is mature but not overripe. Cool the corn quickly to prevent loss of sugar.

How often should sweet corn be fertilized to produce high yields of good quality corn?

Sweet corn should be lightly fertilized prior to planting. It should be fertilized again when the plants are approximately 4 inches tall and when they are 8 to 10 inches tall. Approximately 1/4 lb. of complete fertilizer for every 10 ft. of garden row is sufficient.

This year my sweet corn produced yellow and white kernels on the same cob. What's wrong?

This could be caused by a bicolored varieties, such as Honey and Cream. New varieties, such as those with an super sweet character, produce white and yellow kernels on the small cob.

What is meant by advertisements in catalogs referring to "Super Sweet" varieties of sweet corn?

Newly developed "Super Sweet" hybrid varieties may contain up to 40 percent more sugar than some of the standard varieties. Super Sweet hybrid carry a gene (sh2) which results in a high sugar content. The super sweet character is lost if the corn is pollinated by ordinary sweet corn or field corn, so the super sweet hybrids should be planted away from any other type of corn. Another type is the SE or sugar enhanced sweet corn.

What is the difference between roasting ears and sweet corn?

Roasting ears a field corn harvested at an immature stage. Field corn is preferred by some because the ears are larger and the corn is not as chewy.

My sweet corn produced normally. However, as the ear formed, the tip of it became covered with a large white mass that grew until it broke open and exposed a black, powdery mass.

This is corn ear smut, a type of fungus carried in the seed. To avoid this, use only high-quality seed from a reputable source. There is no chemical control for this disease.

My sweet corn grew for a while and then had a mosaic appearance. The corn did not develop properly. The ears that formed were poorly filled.

This is maize dwarf mosaic virus. It overwinters in johnson grass around a garden. To control the problem, remove the johnson grass, and follow a good insect control program. Some varieties are more resistant to this disease than others.

I planted corn in my garden this fall and it turned out beautifully, but the corn ear worms ate more corn than I did. What can I do to prevent this?

Spray or dust the ear silks with Sevin (carbaryl) to prevent adult insects from entering and laying eggs. Begin dusting and spraying at an early stage and repeat every two days. A drop of mineral oil on the silks is recommended to prevent earworm damage.

Are there any earworm resistant varieties of sweet corn available?

No. Some varieties seem to be bothered less by corn earworms than others, but none are truly resistant. Varieties of sweet corn which have a tight shuck near the silk end seem to be bothered less by earworms than those that have loose and open ends.

The center of my corn plants are full of little green insects. What do I do about them?

Corn leaf aphids infest the sworl of young corn plants. The plants will tolerate large numbers of these aphids. If plants begin to wilt or die, spray them with malathion. Use as directed on the label.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

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- Handbook of Organic Food Processing and Production - by Simon Wright (Editor) - Publication Date: October 1994 - List: $119.00

- Introduction to Permaculture - by Bill Mollison, Reny Mia Slay - Publication Date: November 1997 - List: $16.95

- Profitable Organic Farming - by Jon Newton - Publication Date: June 1995 - List: $36.95

- The New Organic Grower : A Master's Manual of Tools and Techniques for the Home and Market Gardener - by Eliot Coleman, Sheri Amsel (Illustrator), Molly Cook Field (Illustrator) - Publication Date: October 1995 - List: $24.95
  Booknews, Inc. , 05/01/96:
  This expansion of a now-classic guide originally published in 1989 is intended for the serious gardener or small-scale market farmer. It describes practical and sustainable ways of growing superb organic vegetables, with detailed coverage of scale and capital, marketing, livestock, the winter garden, soil fertility, weeds, and many other topics. Annotation c. by Book News, Inc., Portland, Or.

- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Growing Tomatoes

Frequently Asked Questions Other Information Sources Return to Garden Contents

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Tomatoes - Lycopersicon esculentum - Perennial

Tomatoes were probably originally confined to the Peru-Ecuador area, from which they spread northward in pre-Columbian times to Mexico, where they were first domesticated. The Spanish explorers carried the plants to Southern Europe, where they were eaten for a long time before being utilized by the people of Northern Europe and the United States. For many years, they were considered poisonous and were grown only for ornamental purposes under the names "tomatl", "love apple", or "pomme d'amour". Today 95 percent of all American gardens grow tomatoes; they are the most popular garden vegetables in Arkansas.

Tomatoes are easy to grow. A few plants will provide adequate harvest for most families. The tomato plant is a tender, warm-season perennial that is handled like an annual for growing in summer and fall gardens.

Varieties

Hundreds of varieties of tomatoes are now available for the home gardener. They range widely in size, shape, color, plant type, disease resistance, and seasons of maturity. Catalogs, garden centers, and greenhouses offer a large selection of tomato varieties, and selecting the best one or two varieties can be extremely difficult. Choose the varieties best suited for your intended use and method of culture.

- **Floradel** - 80 days to maturity. Resistant to fusarium wilt. Large red fruit, crack resistant, good yield and quality.

- **Better Boy** - 72 days to maturity. Resistant to fusarium and verticillium wilt and root knot nematodes. Bright red, globe-shaped fruit, vigorous plant growth with good fruit protection.

- Floramerica - 76 days to maturity. Resistant to fusarium wilt and verticillium wilt. All-America winner, large fruited red hybrid determinate plants.

- Ozark Pink - 75 days to maturity. Resistant to verticillium wilt and fusarium wilt. 1988 release by Ark. Agri. Exp. Sta.; smooth pink fruit, crack resistant; similar to Traveler 76.

- Mountain Pride - 77 Days to maturity. Resistant to fusarium wilt and verticillium wilt. Hybrid, determinate vine, deep red fruit, crack resistant.

- Celebrity - 70 days to maturity. Resistant to verticillium, fusarium TMV and nematodes. Crack resistant, determinate, large firm fruit. All-America winner.

SMALL FRUITED:

- Large Red Cherry - 72 days to maturity. Good quality, small round fruit.

- Sweet Chelsea - 65 days to maturity. Resistant to fusarium/verticillium wilt, nematodes and TMV. Produces excellent quality 1" diameter red fruit. Hybrid, large cherry type fruit, sets in heat.

- Container and patio varieties - These tomatoes are popular for use in containers or hanging baskets in garden or patio locations where space is limited. Their ornamental value is considered more important than fruit quality. They have red fruit and are not suitable for pruning. Patio (hybrid), Pixie (hybrid), Salad Top (cherry type), Small Fry (hybrid, cherry type), Tiny Tim (cherry type), Toy Boy (hybrid).

When to Plant

Transplanting tomatoes gets them off to the best start and saves several weeks of growing time. Start plants in the hot house or cold frame five to six weeks before the first frost-free date. Some gardeners transplant their tomatoes soon after the soil is prepared for spring gardening when there is a high risk of damage from freezing. In this case, be prepared to cover early set plants overnight to protect them from frost. There are many different ways to protect young tomato plants. Some of these methods include hot caps, floating row covers, and water-filled plastic cones. For best results, plant when the soil is warm, soon after the frost-free date. Plant development, not the age of the plant, determines when tomatoes bear fruit.

Late plantings may be made in mid-summer for fall harvest and early

winter storage of tomatoes. These plants have the advantage of increased vigor and freedom from early diseases. They often produce better quality tomatoes than late picking from early spring plantings. Time late plantings for maximum yields before killing frost arrives in your area (about 100 days from transplanting for most varieties).

The space required depends upon the variety and method of culture. Space dwarf plants 12 inches apart in the row, staked plants 15 - 24 inches apart, and wirecage or groundbed plants 24 - 36 inches apart.

Care

Apply starter fertilizer solution when transplanting. Hoe or cultivate shallowly to keep down weeds without damaging roots. Mulch is recommended, especially for gardeners who wish to maintain their plants for full-season harvest. Black plastic or organic materials are suitable for mulching.

Water the plants thoroughly every seven to 10 days during dry periods. Plants confined in containers need daily watering. Sidedress with nitrogen fertilizer (ammonia nitrate) at the rate of one pound per 100 feet of row (equivalent to one tablespoon per plant) after the first tomatoes have grown to the size of golf balls. Make two more applications at three and six weeks later. If the weather is dry following these applications, water the plants thoroughly. Do not get fertilizer on the leaves.

Many gardeners train their tomato plants to stakes, trellises, or cages with great success. All varieties are not equally suitable for staking and pruning.

Staking and Pruning Methods

Wire cages placed over small tomato plants will hold the vines and fruit off the ground. Short cages (2 2/1 to 3 feet high) usually support themselves when the wire prongs at the bottom are pushed into the ground. Taller cages require a stake, post, or wire for support. Large (6" x 6") mesh wire permits easy harvesting. Tomato plants must be tied to supporting stakes or to a trellis because, unlike cucumber plants, they do not support themselves with tendrils. Loop ordinary soft twine, cord, or cloth loosely around the main stem and tie it tightly to the stake. Tying the stems too tightly will injure them.

You may wish to prune staked or caged tomato plants to stimulate early maturity. Be sure that your variety is suitable for pruning. To prune the plant properly, remove the shoots (suckers) when they are one to two

inches long. The shoots develop in the axil of each leaf (the angle between the leaf petiole and the stem above it).

Breaking off the shoots by hand is preferred to cutting them. Bend the shoots in opposite directions until they snap. Prune the plants every five to seven days. Be careful not to prune the developing flower clusters that grow from the main stem or to pinch off the growing tip (terminal) of the plant. Remember, the more severely you prune the foliage, the more you limit plant growth (including root development). Double-stem or multiple-stem pruning systems sacrifice some of the earliness and fruit size for less risk of cracking, blossom-end rot, and sunburn.

When pruning to two stems, remove all of the shoots (suckers) when they are 1 to 2 inches long, leaving only the first shoot below the first fruit cluster. This is the best shoot to develop into a second stem.

Harvesting

Tomatoes should be firm and fully colored. They are of highest quality when they ripen on healthy vines and when daily summer temperatures average about 75 degrees F. When temperatures are high (air temperature of 90 degrees F. or more), the softening process is accelerated and color development is retarded.

During hot summer weather, pick tomatoes every day or every other day. Harvest the fruit when it has a healthy pink color and ripen it further indoors (at 70 to 75 degrees F.). Harvest all green mature fruit in the fall on the day before a killing frost is expected. Wrap the tomatoes individually in paper and store at 60 to 65 degrees F. They will ripen slowly during the next several weeks. Immature green tomatoes may be harvested and used for frying or processed for relish, pickles, etc.

Common Problems

Insects: Tomato hornworms are large (two to three inches long when fully grown), green worms with white stripes on their bodies. A horn protrudes from the top, rear end of the worm. Tomato hornworms feed on the leaves and fruit, and several worms on one plant can quickly defoliate it. They are difficult to see when small. Hand pick the worms or use a suggested biological insecticide.

Tomato fruit worms are almost sure to be found in the garden. The moth lays the eggs in the terminal (top growth of the plant), then the larvae (small worms) hatch and make their way to the fruit. Once the larva is inside the fruit, it's too late to save that fruit. Use the

recommended insecticide every seven days.

Diseases: Verticillium and fusarium wilt are seedborne diseases that cause yellowing of the leaves, wilting, and premature dying of the plant. These diseases will persist in gardens where susceptible plants are grown. Once they build up, the only practical control is the use of resistant (VF) varieties.

Early blight is characterized by dead brown spots that usually start on the lower leaves and spread up the plant. Upon close inspection, you can see concentric rings within the spots. Although early blight is most severe on the leaves, it sometimes occurs on the stems; it can cause defoliation. You may need to use fungicide sprays to achieve high yields and quality fruit. Some varieties are more tolerant of early blight than others. Remove diseased leaves from the garden and dispose of them.

Septoria leafspot is characterized by numerous small black spots on the leaves. The center of these spots later turn white, and tiny black dots appear in the white center. The disease starts on the bottom leaves and may become severe in wet weather. Use suggested fungicides for control.

Physiological disorders: Blossom-end rot, a dry, leathery rot of the blossom end of the fruit, is common in home-grown tomatoes. It is caused by a combination of calcium deficiency with wide fluctuations in soil moisture. Severe pruning causes stress to the plants that increases the incidence of blossom-end rot. Some tomatoes are much more susceptible to this condition than others. Mulching and uniform watering will help prevent blossom-end rot.

Poor color and sunscald occur when high temperatures retard the development of full red color in tomatoes exposed directly to the sun. Sunscald appears on the fruit during hot, dry weather as a large, whitish area. It becomes a problem when foliage has been lost through other diseases, such as early blight.

Diseases: early blight, septoria leafspot, verticillium and fusarium wilts, late blight, tobacco mosaic virus, bacterial spot, tomato spotted wilt virus.

Insects: flea beetle, hornworm, stink bugs, Colorado potato beetle, fruitworm, aphids, mites, whiteflies, cutworms

Other Pests: nematodes

Cultural: blossom-end rot, irregular soil moisture or calcium deficiency; poor color, yellow spots or large whitish-grey spots, sunscald from lack of foliage cover; leaf roll; fruit cracking, irregular soil moisture; Black Walnut wilt, caused by roots of tomato plants

coming in contact with roots of black walnut trees

Storage

Days to Maturity: 55-105

Harvest: Harvest fully ripened but still firm; most varieties are dark red. Picked tomatoes should be placed in shade. Light is not necessary for ripening immature tomatoes. Mature green tomatoes may be picked before the first killing frost and stored in a cool (55F), moist (90% RH) place. When desired, ripen fruits at 70F.

Approximate Yield: (per 10 feet of row) 15-45 lbs

Amount per Person: 20-25 lbs for fresh use; 25-40 lbs for canning

Storage: Green tomatoes - medium cool (50-70F), moist (90% RH) conditions; 1-3 weeks. Ripe tomatoes - cool (40-45F), moist (90% RH) conditions; 7-10 days.

Preservation: Can or freeze as sauces or in chunks (whole or quartered), peeled.

Questions & Answers

What causes the lower leaves of my tomato plants to roll up?

Leaf roll (curling of the leaflets) is a physiological condition that occurs most commonly when plants are trained and pruned. It does not affect fruiting or quality, and it is not a disease. Leaf roll is a common genetic tract in some varieties such as mountain delight and mountain spring.

What is a tree tomato?

The tree-like plant sold as a "tree tomato" is Cyphomandra, betacea, also called Tamarillo, a different species from garden tomatoes. it is a woody tree that grows eight feet or more in height and bears fruit after two years. The tree tomato is a tropical plant, and will not overwinter outside under Arkansas conditions.

What causes small, irregular cloudy-white spots just under the skin of my tomatoes?

The spots on green or ripe fruit are caused by the feeding of stink bugs.

What causes the flowers to drop off my tomato plants?

During unfavorable weather (night temperatures lower than 55 degrees F. or above 70 degrees F. and day temperatures above 95 degrees F. with dry, hot winds) tomatoes do not set and the flowers drop. The problem usually disappears as the weather improves.

What cause the young leaves of my plants to become pointed and irregular in shape? I noticed the twisting of the leaves and stems after spraying the plants for the first time.

Judging from your description, it seems likely that your tomato plants have been injured by 2, 4-D or similar weed killer. Never use the same sprayer for weed control in your vegetable garden that you use in your lawn. Drift from herbicides originating one-half mile or more away can also injure your tomato plants.

When should I start my seed indoors to produce tomato transplants for my garden?

Depending upon temperature and how the plants are grown, it takes from 6 to 8 weeks to produce a healthy, 6-inch tall transplant to set out in your garden. The plants should be grown in a warm area and receive 6 to 8 hours of sunlight daily or tall, poor quality, leggy plants will result.

How do you select good transplants at nurseries or garden centers?

First, select the right variety, look for plants that appear healthy, dark green in color, and do not have any spots or holes in the leaves. The ideal tomato transplant should have five leaves and no flowers. Avoid tall, spindly plants with weak stems and leathery purple leaves.

How often should my tomatoes be fertilized?

It is necessary to fertilize the garden before planting tomatoes. Apply the fertilizer again when fruit first sets. From that point on, an additional fertilization (sidedress) every week to 10 days is recommended. Plants grown on sandy soils should be fertilized more frequently than those grown on heavy, clay soils. A general sidedress fertilizer recommendation is one to two tablespoons of a complete fertilizer scattered around the plant and worked into the soil. If using a fertilizer high in nitrogen such as ammonium nitrate, reduce the rate to one tablespoon per plant.

Should tomato plants be staked, caged or left unsupported?

Plants with foliage and fruit supported off the ground will produce more than unsupported plants. Caging has several advantages. It involves less work than staking. Once the cage is placed over the plant there is no further manipulation of the plant - no pruning or tying. The fruits are simply harvested as they ripen. In some areas, staking and pruning of the plant to a single or multiple stem results in sunburn when the developing fruit is exposed to excessive sunlight. Caged tomato vines produce more fruits of a smaller size, where staked and tied plants produce less fruits which mature earlier and are larger. Plants need to be raised off the ground to reduce disease and insect problems.

My tomato plants look great. They are dark green, vigorous and healthy. However, flowers are not forming any fruit. What is the problem?

Several conditions can cause tomatoes to not set fruit. Too much nitrogen fertilizer, nighttime temperatures over 70 degrees F., low temperatures below 50 degrees F., irregular watering, insects such as thrips or planting the wrong variety may result in poor fruit set. Any of these conditions can cause poor fruit set.

Are there really low-acid tomato varieties?

There are some varieties that are slightly less acidic than others. Some yellow-fruited types are slightly less acidic than the normal red varieties. Flavor differences which exist between varieties are not because of differences in acid content, but balances of the sugar to acid ratio. In general, cherry tomatoes are higher in both sugar and acid levels.

What does determinate mean and can you tell if a tomato is determinate by looking at it?

Determinate means the plant will stop growing and be smaller. A determinate vine is distinguished by a repeating pattern of two leaves followed by a flower or fruiting cluster. After 6 or 7 clusters the plant will stop growing. An indeterminate vine has a repeating pattern of three or four leaves, then a cluster and keeps growing.

Can I save seeds from my tomatoes from next season's plantings, and if so how?

You can save seed from tomatoes if the variety is not a hybrid. Hybrid tomatoes do not come true from seed. The plants and fruits from seeds saved from your home garden may or may not resemble the parent. However, for true breeding or open pollinated varieties, such as Ozard Pink, it is easy to save seed. To save seed from tomatoes or any other home vegetable fruit crop, leave the fruit on the plant until it is mature, pull it, squeeze juice with seed into a glass, let this ferment for several days adding water if needed. Rinse the seeds two or three times to remove debris. Seeds will settle to the bottom. After rinsing the seeds, blot them and place them on newspaper to dry. Store the seeds under cool, dry conditions.

When caging tomatoes, how large should the cage be?

The diameter of the cage should be at least 18 to 20 inches at the top. Smaller cages often restrict plant growth and reduce yields. Height of the cage will vary but generally 3 1/2 feet is sufficient for the recommended varieties. However, if vining types such as Better Boy, Cherry or Grande, are used, a cage 5 feet in height is preferred.

Regardless of variety, the 3 1/2 feet tall cage is sufficient for most fall garden tomatoes.

How do you stake tomatoes?

Staking involves pruning the plant to either one or two main stalks. Tomatoes grown without support develop a bush shape. The small suckers which develop between the axil of the leaf and the stem are removed to develop a vine structure rather than a bush. A wooden stake of 1-inch diameter and 6 feet long is driven into the ground beside the plant and allows it to be loosely attached to the stake as it grows. Do not damage the root system when inserting the stake in the ground. The plant can be attached to the stake with twist-ties, soft string, strips of cloth or panty hose. The plant is sufficiently supported if it is attached to the stake at 12- to 14-inch intervals. Continued to remove suckering to prevent the plant from developing more than one or two central stems. If a double-stalk plant is desired, leave the sucker produced below the first flower cluster since it will be the most vigorous.

What causes a tomato to crack? Is there anything I can do to prevent it?

Cracking is a physiological disorder caused by soil moisture fluctuations. When the tomato reaches the mature green stage and the water supply to the plant is reduced or cut off, the tomato will begin to ripen. At this time the skin around the outer surface of the tomato becomes thicker and more rigid to protect the tomato during and after harvest. If the water supply is restored after ripening begins, the plant will resume translocation of nutrients and moisture into the fruit. This will cause the fruit to enlarge. Thus, skin splits around the fruit and results in cracking. The best control for cracking is a constant and regular water supply. Apply a layer of organic mulch to the base of the plant as this serves as a buffer and prevents soil moisture fluctuation. Water plants thoroughly every week especially when the fruits are maturing. Some varieties are resistant to cracking and we try to recommend these varieties.

What could cause the leaves of my tomatoes to turn brown along the edges?

Leaf-burn or scorch generally indicates root injury, quite often caused by heavy amounts of fertilizer applied too near the roots. This injury often results in browning and dieback of the ends and margins of the leaves.

About the time my tomatoes ripen and turn red, I lose at least half my crop to bird damage. What can prevent this?

Bird damage is common, and one control method which works quite well is to take old nylon stockings and cut them into pieces 10 to 12

inches long. Tie a knot in one end of the stocking and slip the open end over the entire cluster of tomatoes. Secure the end above the tomato cluster with a rubber band or twist-tie. Birds will not be able to peck through the nylon. Slip the stocking off the cluster and harvest the ripe fruit and replace it to protect later-ripening fruit. Also, birds damage fully mature fruit more readily than breaker fruit. Harvest in breaker stage. Other methods include using mylar tape over the plants, strips of aluminum foil, and balloons that resemble owl's eyes.

What causes the black spots on the bottom of my tomatoes?

Blossom end rot, caused by improper moisture and calcium deficiencies. Check that the soil pH is above 6.0. Maintain uniform soil moisture as the fruit nears maturity. Remove affected fruit. Use Calcium Nitrate to fertilize the plants.

What causes some of my early tomato fruit from the spring garden to be oddly shaped and of poor quality?

This condition is usually caused by low temperatures during bloom and pollination. Fruit that set when temperatures are 55 degrees F. or below often are odd-shaped and of poor quality. The blooms these tomatoes develop from often are abnormal because of temperature conditions and grow into abnormal, odd-shape fruit. Another name for this disorder is catfacing.

Should you allow tomatoes to become fully ripe and red on the vine before harvesting?

Generally, yields will be increased by harvesting the fruit at first blush of pink instead of leaving them on the plant to ripen fully. A tomato picked at first sign of color and ripened at room temperature will be just as tasty as one left to fully mature on the vine. Picking tomatoes before they turn red reduces damage from birds.

If tomatoes are picked green or before they are fully mature, how should they be handled to insure proper ripening and full flavor?

Never refrigerate tomatoes when picked immature. Place them in a single layer at room temperature and allowed them to develop full color. When they are full ripe, place them in the refrigerator where they will store for several weeks. Those handled in this manner will be of high quality and full flavor.

What is a husk tomato?

Husk tomato is Physallis, also called Ground Cherry. It is grown the same way as regular tomatoes and produces a fruit the size of a cherry tomato. The fruits are produced inside a paper-like husk which, when ripe, turns brown and the fruit drops from the plant. If left in the husk, the fruit will keep for several weeks. Like tomatoes, they are sensitive

to cold weather and should be set out from plants after all danger of frost in the spring. Space the plants 1 1/2 feet apart in rows at least 3 feet apart. The ripened small fruit can be used in pies, jams or may be dried in sugar and used like raisins.

I have the best tomato crop I have ever had, but the large tomatoes are falling off the vines. Even the ones that stay on the vine are jarred off easily. What is the problem?

Cool fall temperatures cause the abscission zone, the area where the tomato is attached to the plant, to weaken and the heavy fruit subsequently falls. Gather fallen tomatoes as soon as possible, wipe them clean and store them in a warm place to ripen.

I have large translucent areas on my tomato fruit. What's going on?

This is an environmental problem. The translucent area is caused by sun scald. Heat from direct intense sunlight destroys the color pigments of the tomato. This damage does not make the tomato inedible, but it is unsightly.

Can I propagate tomatoes for the fall garden from existing vines?

If necessary, use suckers or layering (cover with soil until roots appear) of existing vine. Do this several weeks before the determined recommended transplanting date for fall tomatoes, and use early tomato varieties. This is not a generally recommended practice. This practice does not work well with indeterminate varieties.

How do you tell when a green tomato harvested early to prevent freeze damage will ever turn red and ripen?

This can simply be done with a sharp kitchen knife. Harvest a tomato typical of the majority of green tomatoes on your plants. Look at size but pay particular attention to fruit color. Slice through the center of the tomato. Closely examine the seed within the fruit. If the seeds are covered with a clear gell which cause them to move away from the knife, then that fruit will eventually turn red and ripen. If the seeds are cut by the knife then those fruit will never properly ripen. Compare the color and size of the tested fruit when harvesting tomatoes on your plants. Most similar fruit will eventually ripen and turn red.

Is a tomato a fruit or a vegetable?

The tomato is a legally-declared vegetable as determined by the Supreme Court of the United States. A vegetable is a herbaceous (non-woody) plant or plant part which can be eaten without processing and is usually consumed with the main meal. However, botanically it is the fruit of the plant.

The foliage on my tomatoes is infected by irregularly shaped spots which cause it to turn yellow and drop off. This occur in all seasons and is on the top as well as the bottom leaves.

Several types of leaf spots will attack tomatoes. Septoria leaf spot is seen quite often and can be controlled with a fungicide spray program. Begin the spray program early in the life of the plant.

The leaves on my tomato plants are distorted. Why?

This is caused tobacco mosaic virus. If the virus is severe, remove the plants to prevent spread to other plants. Working around the infected plants can spread the virus to nearby healthy plants. Many viruses are insect transmitted, so carry out a good insect control program on tomatoes. Cucumber mosaic virus causes symptoms similar to 2-4-D injury.

My tomato plants are stunted and have a pale yellow foliage. The root system has knots or swellings on the roots.

These are root knot nematodes. Some varieties such as Celebrity and Better Boy resist this problem. It is best to use only nematode resistant varieties. Nematode resistance is indicated by the letter N after the name. Example: Celebrity VFN.

My tomatoes were healthy during the spring and early summer, yet after a recent rain, they wilted and died very rapidly. I found a white fungal growth at the base of the plant.

This is southern blight. It is a soilborne fungus that lives on organic material in the soil. Deep burial of undecomposed organic material in the soil will reduce this problem. Control foliage diseases of tomato plants because the fallen leaves around the base of the plant will feed the fungus, and it will build up this area and cause damage later. Crop rotation will also reduce the incidence of southern blight.

My tomato plants wilted rapidly. When I cut the stem open, I found a brown ring around the inside.

This is Fusarium wilt caused by a soilborne fungus that attacks tomatoes and other crops. It is controlled only through the use of resistant varieties. Most commercial tomato varieties are resistant. Before you plant a variety, make sure it is resistant to Fusarium wilt. This resistance is denoted by the letter F after the name. Example: Celebrity VFN.

What do the letters "VFN" associated with particular tomato varieties indicate?

VFN indicates the tomato variety is resistant to three types of diseases: Verticilum wilt, Fusarium wilt and nematodes. Many of the new hybrid

varieties are VFN types.

The lower foliage on my tomatoes is beginning to turn yellow and drop. The leaves have circular, dark brown to black spots.

This is Alternaria leaf spot or early blight, a common problem on tomatoes and causes defoliation, usually during periods of high rainfall. Plant tomatoes on a raised bed to improve water drainage and spaced them enough so air can move and dry the foliage and prevent diseases. Follow a spray program using a fungicide beginning when the fruit is set and continuing at 1 week intervals during the growing season until harvest.

My tomato fruits have small yellow specks on the surface. When the fruit are peeled, those yellow specks form a tough spot that must be cut off before eating the tomatoes. What's wrong?

The yellow speckling is caused by sucking insects such as stinkbugs or leaf-footed bugs. Early control of sucking insects that feed on the fruit is helpful in alleviating the problem.

We planted tomatoes in our small garden. They are loaded and are the best tomatoes we have ever had; however, there are some small holes near the stem end of the tomato. When we cut the tomato open, there is a small worm inside. What is it and what can we do?

Your fruits have been invaded by the tomato pinworm. They usually do not damage all fruit and can be controlled only by a preventive insecticide spray every 7 to 10 days. When the damage is evident, it is too late to do anything about it.

What causes my tomato leaves to turn yellowish and fall off?

Many conditions may cause these symptoms including spider mites, diseases and nutrient deficiencies. Examine the underside of the leaves for small red to greenish mites. If mites are found, treat with two to three applications of an insecticides at 5-day intervals.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- A Colour Atlas of Tomato Diseases : Observation, Identification and Control - by D. Blancard - Publication Date: May 1994 - List: $99.95
  The publisher, John Wiley & Sons :
  This unique and comprehensive guide is designed to enable readers to diagnose and combat, through effective measures, both parasitic and non-parasitic diseases of the tomato plant and fruit. Using an easy-to-assimilate format, the text illustrates and describes the essential features of each disease. Considerable importance is placed on the symptoms of the roots and stems. Features over 300 magnificent color photographs to help users learn the processes and acquire the skills necessary for reliable diagnosis.

- Burpee Tomatoes - by Robert Hendrickson - Publication Date: March 1997 - List: $16.95
  Synopsis:
  For more than 100 years Burpee has specialized in tomato variety development. From the legendary "Big Boy" to lesser known varieties, Burpee tomatoes can be found in vegetable gardens all over the country. Written for beginning enthusiasts or experienced aficionados, there is something for everyone in Burpee Tomatoes. 75 color photos.

- Genetic Improvement of Tomato (Monographs on Theoretical and Applied Genetics, Vol 14) - by G. Kalloo (Editor) - Publication Date: February 1992 - List: $169.00

- Molecular Biology of Tomato : Fundamental Advances and Crop Improvement - by John I. Yoder (Editor) - Publication Date: June 1993 - List: $99.95

- In Praise of Tomatoes : A Year in the Life of a Home Tomato

Grower - by Steven Shepherd - Publication Date: July 1996 - List: $22.00

- Compendium of Tomato Diseases (Aps Disease Compendium Series) - by J.B. Jones, John Paul Jones, R.E. Stall, T.A. Zitter (Editor) - Publication Date: June 1991 - List: $35.00
- Tomato Production, Processing & Technology - by Wilbur A. Gould - Publication Date: January 1992 - List: $93.00
- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan - Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed. Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable information. Original.*
- Collecting Processing and Germinating Seeds of Wildland Plants - by Cheryl Young, James A. Young - Publication Date: October 1, 1986 - List: $24.95
- Enduring Seeds : Native American Agriculture and Wild Plant Conservation - by Gary Paul Nabhan - Publication Date: April 1, 1991 - List: $14.00
- From Seed to Plant - by Gail Gibbons - Publication Date: March 1, 1991 - List: $15.95 *Explores the intricate relationship between seeds and the plants which they produce.*
- Kid's Gardening : A Kid's Guide to Messing Around in the Dirt/With Seeds - by Kevin Raftery, Kim Gilbert Raftery, Jim M'Guinness - Publication Date: May 1, 1989 - List: $13.95 *Now young readers will know from whence those carrots came. This full-color extravaganza contains nearly a hundred pages of wipe-clean cardstock, hundreds of illustrations, dozens of growing activities, plus 15 varieties of vegetable, flower, and herb seeds.*
- Principles of Seed Science and Technology - by Larry O. Copeland, Miller B. McDonald, Lawrence O. Copeland - Publication Date: March 1, 1995 - List: $74.95
- Saving Seeds : The Gardener's Guide to Growing and Storing Vegetable and Flower Seeds - by Marc Rogers, Polly Alexander (Illustrator) - Publication Date: March 1991 - List: $12.95
- Seed to Seed - by Suzanne Ashworth - Publication Date: January 1, 1995 - List: $20.00
- Seeds : The Definitive Guide to Growing, History, and Lore - by H. Peter Loewer, Peter Loewer - Publication Date: April 1, 1996

- List: $25.00
Loewer examines the vast and often surprisingly complex world of seeds in an unparalleled thoroughness. In addition to the how-to of growing all kinds of plants and vegetables from seed, the book also considers the role of seeds in history, literature, and business. 100 line drawings.

- Seeds and Propagation (Smith & Hawken--The Hands-On Gardener) - by Susan McClure, Jim Anderson (Illustrator) - Publication Date: June 1, 1997 - List: $10.95
- The New Seed Starter's Handbook - by Nancy Bubel - Publication Date: April 1, 1988 - List: $15.95
- Gardening In Deer Country - by Vincent Drzewucki - Publication Date: January, 1998 - List: $9.95
- 200 Tips for Growing Vegetables in the Northeast - by Miranda Smith - Publication Date: February 1996 - List: $7.95
- 200 Tips for Growing Vegetables in the Pacific Northwest - by Maggie Stuckey - Publication Date: February 1996 - List: $7.95
- Building Your Own Greenhouse (Greenhouse Basics) - by Mark Freeman, Heather Bellanca (Illustrator) - Publication Date: April 1997 - List: $18.95
- Burpee : The Complete Vegetable & Herb Gardener : A Guide to Growing Your Garden
  Organically - by Karan Davis Cutler, Cavagnarok David (Photographer), Barbara W. Ellis - Publication Date: November 1997 - List: $29.95
  Synopsis:
  A companion to Burpee Complete Gardener, this book focuses on all aspects of growing organic vegetables and edible herbs in the home garden. Planting techniques and tools, garden design, and more than 90 individual plant portraits are included. 300 full-color photos.
- Culinary Gardens : From Garden to Palate - by Susan McClure - Publication Date: September 1997 - List: $37.95
- Five Acres and Independence: A Handbook for Small Farm Management - by Maurice Grenville Kains, Maurice G. Kain - Publication Date: March 1978 - List: $7.95
- Four-Season Harvest : How to Harvest Fresh Organic Vegetables

from Your Home Garden All Year Long - by Eliot Coleman, Kathy Bary (Illustrator) - Publication Date: October 1992 - List: $19.95
Booknews, Inc. , 01/01/93:
Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.

- Gardening Under Cover : A Northwest Guide to Solar Greenhouses, Cold Frames, and Cloches - by William Head - Publication Date: November 1989 - List: $10.95
This is a complete guide to gardening with protective shelters that encourages both beginning and experienced gardeners to add months of gardening pleasure at small expense. With a little under-cover gardening know-how, Pacific Northwest gardeners can take advantage of our mild climate to produce flowers, herbs, and vegetables throughout the year.

- Grow It : The Beginner's Complete In-Harmony-With-Nature Small Farm Guide-From Vegetable and Grain Growing to Livestock Care - by Richard W. Langer, Susan McNeill (Illustrator) - Publication Date: January 1994 - List: $12.00
Synopsis:
An indispensable guide to small-scale organic farming that features advice on everything from building and stocking a pond to planting an orchard or making cheese. This extremely practical and easy-to-use guide, first published in 1972, is for full-time or part-time country dwellers/gardeners.

- Growing Great Garlic : The Definitive Guide for Organic Gardeners and Small Farmers - by Ron L. Engeland - Publication Date: July 1995 - List: $14.95

- Heirloom Vegetable Gardening : A Master Gardener's Guide to Planting, Growing, Seed Saving, and Cultural History - by William Woys Weaver - Publication Date: June 1997 - List: $45.00
Synopsis:
Weaver focuses on 280 varieties of 37 vegetables in this encyclopedic guide to the history and cultivation of some of America's most treasured heirloom vegetables. 100+ color photos. 240 line drawings.

- A Dyer's Garden : From Plant to Pot Growing Dyes for Natural

Fibers - by Rita Buchanan - Publication Date: August 1995 - List: $9.95

- A Produce Reference Guide to Fruits and Vegetables from Around the World : Nature's Harvest - by Donald D. Heaton - Publication Date: April 1997 - List: $29.95

- Growing Plants from Seed : A Comprehensive Beginners Handbook for Vegetables, Flowers, Herbs and More - by George Abraham, Katy Abraham, Doc Abraham - Publication Date: January 1992 - List: $13.95
  Synopsis:
  A guide for first-time seed growers addresses soil mixtures, lighting, types of seed, seed-starting kits, and more to help any gardener experience the rewarding feeling of growing flowers and vegetables from seed. Original.

- Peppers : The Domesticated Capsicums - by Jean Andrews - Publication Date: October 1995 - List: $65.00
  Booknews, Inc. , 04/01/96:
  An updated edition (first, 1984) of an elegantly produced, scholarly reference on peppers--their history and dispersion, biology, taxonomy, cultivation, and medicinal, economic, and gastronomic uses. Illustrated with the author's botanically accurate, aesthetically pleasing paintings that show the blossoms, buds, young peppers, and mature specimens of 34 cultivars. A review of the literature, a photo glossary, and an extensive bibliography add to the volume's reference value. 9x12" Annotation c. by Book News, Inc., Portland, Or.

- Peppers of the World : An Identification Guide - by Dave Dewitt, Paul W. Bosland - Publication Date: January 1997 - List: $19.95

- Plant Propagation : Principles and Practices - by Hudson Thomas Hartmann (Editor), Dale E. Kester, Fred T., Jr. Davies - Publication Date: January 1997 - List: $86.00
  The publisher, Prentice-Hall Career & Technology :
  Hallmarked as the most successful text of its kind, this remarkably thorough text covers all aspects of the propagation of plants - both sexual and asexual - with considerable attention given to human (vs natural) efforts to increase plant numbers.

- Forest Gardening : Cultivating an Edible Landscape - by Robert A. De J. Hart - Publication Date: September 1996 - List: $17.95

- Handbook of Organic Food Processing and Production - by Simon Wright (Editor) - Publication Date: October 1994 - List: $119.00

- Introduction to Permaculture - by Bill Mollison, Reny Mia Slay - Publication Date: November 1997 - List: $16.95

- Profitable Organic Farming - by Jon Newton - Publication Date: June 1995 - List: $36.95

- The New Organic Grower : A Master's Manual of Tools and Techniques for the Home and Market Gardener - by Eliot Coleman, Sheri Amsel (Illustrator), Molly Cook Field (Illustrator) - Publication Date: October 1995 - List: $24.95
  Booknews, Inc. , 05/01/96:
  This expansion of a now-classic guide originally published in 1989 is intended for the serious gardener or small-scale market farmer. It describes practical and sustainable ways of growing superb organic vegetables, with detailed coverage of scale and capital, marketing, livestock, the winter garden, soil fertility, weeds, and many other topics. Annotation c. by Book News, Inc., Portland, Or.

- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Tomatoes - Lycopersicon esculentum - Perennial

Tomatoes were probably originally confined to the Peru-Ecuador area, from which they spread northward in pre-Columbian times to Mexico, where they were first domesticated. The Spanish explorers carried the plants to Southern Europe, where they were eaten for a long time before being utilized by the people of Northern Europe and the United States. For many years, they were considered poisonous and were grown only for ornamental purposes under the names "tomatl", "love apple", or "pomme d'amour". Today 95 percent of all American gardens grow tomatoes; they are the most popular garden vegetables in Arkansas.

Tomatoes are easy to grow. A few plants will provide adequate harvest for most families. The tomato plant is a tender, warm-season perennial that is handled like an annual for growing in summer and fall gardens.

Varieties

Hundreds of varieties of tomatoes are now available for the home gardener. They range widely in size, shape, color, plant type, disease resistance, and seasons of maturity. Catalogs, garden centers, and greenhouses offer a large selection of tomato varieties, and selecting the best one or two varieties can be extremely difficult. Choose the varieties best suited for your intended use and method of culture.

- **Floradel** - 80 days to maturity. Resistant to fusarium wilt. Large red fruit, crack resistant, good yield and quality.

- **Better Boy** - 72 days to maturity. Resistant to fusarium and verticillium wilt and root knot nematodes. Bright red, globe-shaped fruit, vigorous plant growth with good fruit protection.

- **Floramerica** - 76 days to maturity. Resistant to fusarium wilt and verticillium wilt. All-America winner, large fruited red hybrid determinate plants.

- **Ozark Pink** - 75 days to maturity. Resistant to verticillium wilt and fusarium wilt. 1988 release by Ark. Agri. Exp. Sta.; smooth pink fruit, crack resistant; similar to Traveler 76.

- **Mountain Pride** - 77 Days to maturity. Resistant to fusarium wilt and verticillium wilt. Hybrid, determinate vine, deep red fruit, crack resistant.

- **Celebrity** - 70 days to maturity. Resistant to verticillium, fusarium TMV and nematodes. Crack resistant, determinate, large firm fruit. All-America winner.

SMALL FRUITED:

- Large Red Cherry - 72 days to maturity. Good quality, small round fruit.

- Sweet Chelsea - 65 days to maturity. Resistant to fusarium/verticillium wilt, nematodes and TMV. Produces excellent quality 1" diameter red fruit. Hybrid, large cherry type fruit, sets in heat.

- Container and patio varieties - These tomatoes are popular for use in containers or hanging baskets in garden or patio locations where space is limited. Their ornamental value is considered more important than fruit quality. They have red fruit and are not suitable for pruning. Patio (hybrid), Pixie (hybrid), Salad Top (cherry type), Small Fry (hybrid, cherry type), Tiny Tim (cherry type), Toy Boy (hybrid).

When to Plant

Transplanting tomatoes gets them off to the best start and saves several weeks of growing time. Start plants in the hot house or cold frame five to six weeks before the first frost-free date. Some gardeners transplant their tomatoes soon after the soil is prepared for spring gardening when there is a high risk of damage from freezing. In this case, be prepared to cover early set plants overnight to protect them from frost. There are many different ways to protect young tomato plants. Some of these methods include hot caps, floating row covers, and water-filled plastic cones. For best results, plant when the soil is warm, soon after the frost-free date. Plant development, not the age of the plant, determines when tomatoes bear fruit.

Late plantings may be made in mid-summer for fall harvest and early winter storage of tomatoes. These plants have the advantage of increased vigor and freedom from early diseases. They often produce better quality tomatoes than late picking from early spring plantings. Time late plantings for maximum yields before killing frost arrives in your area (about 100 days from transplanting for most varieties).

The space required depends upon the variety and method of culture. Space dwarf plants 12 inches apart in the row, staked plants 15 - 24 inches apart, and wirecage or groundbed plants 24 - 36 inches apart.

Care

Apply starter fertilizer solution when transplanting. Hoe or cultivate shallowly to keep down weeds without damaging roots. Mulch is recommended, especially for gardeners who wish to maintain their plants for full-season harvest. Black plastic or organic materials are suitable for mulching.

Water the plants thoroughly every seven to 10 days during dry periods. Plants confined in containers need daily watering. Sidedress with nitrogen fertilizer (ammonia nitrate) at the rate of one pound per 100 feet of row (equivalent to one tablespoon per plant) after the first tomatoes have grown to the size of golf balls. Make two more applications at three and six weeks later. If the

weather is dry following these applications, water the plants thoroughly. Do not get fertilizer on the leaves.

Many gardeners train their tomato plants to stakes, trellises, or cages with great success. All varieties are not equally suitable for staking and pruning.

Staking and Pruning Methods

Wire cages placed over small tomato plants will hold the vines and fruit off the ground. Short cages (2 2/1 to 3 feet high) usually support themselves when the wire prongs at the bottom are pushed into the ground. Taller cages require a stake, post, or wire for support. Large (6" x 6") mesh wire permits easy harvesting. Tomato plants must be tied to supporting stakes or to a trellis because, unlike cucumber plants, they do not support themselves with tendrils. Loop ordinary soft twine, cord, or cloth loosely around the main stem and tie it tightly to the stake. Tying the stems too tightly will injure them.

You may wish to prune staked or caged tomato plants to stimulate early maturity. Be sure that your variety is suitable for pruning. To prune the plant properly, remove the shoots (suckers) when they are one to two inches long. The shoots develop in the axil of each leaf (the angle between the leaf petiole and the stem above it).

Breaking off the shoots by hand is preferred to cutting them. Bend the shoots in opposite directions until they snap. Prune the plants every five to seven days. Be careful not to prune the developing flower clusters that grow from the main stem or to pinch off the growing tip (terminal) of the plant. Remember, the more severely you prune the foliage, the more you limit plant growth (including root development). Double-stem or multiple-stem pruning systems sacrifice some of the earliness and fruit size for less risk of cracking, blossom-end rot, and sunburn.

When pruning to two stems, remove all of the shoots (suckers) when they are 1 to 2 inches long, leaving only the first shoot below the first fruit cluster. This is the best shoot to develop into a second stem.

Harvesting

Tomatoes should be firm and fully colored. They are of highest quality when they ripen on healthy vines and when daily summer temperatures average about 75 degrees F. When temperatures are high (air temperature of 90 degrees F. or more), the softening process is accelerated and color development is retarded.

During hot summer weather, pick tomatoes every day or every other day. Harvest the fruit when it has a healthy pink color and ripen it further indoors (at 70 to 75 degrees F.). Harvest all green mature fruit in the fall on the day before a killing frost is expected. Wrap the tomatoes individually in paper and store at 60 to 65 degrees F. They will ripen slowly during the next several weeks. Immature green tomatoes may be harvested and used for frying or processed for relish, pickles,

etc.

Common Problems

Insects: Tomato hornworms are large (two to three inches long when fully grown), green worms with white stripes on their bodies. A horn protrudes from the top, rear end of the worm. Tomato hornworms feed on the leaves and fruit, and several worms on one plant can quickly defoliate it. They are difficult to see when small. Hand pick the worms or use a suggested biological insecticide.

Tomato fruit worms are almost sure to be found in the garden. The moth lays the eggs in the terminal (top growth of the plant), then the larvae (small worms) hatch and make their way to the fruit. Once the larva is inside the fruit, it's too late to save that fruit. Use the recommended insecticide every seven days.

Diseases: Verticillium and fusarium wilt are seedborne diseases that cause yellowing of the leaves, wilting, and premature dying of the plant. These diseases will persist in gardens where susceptible plants are grown. Once they build up, the only practical control is the use of resistant (VF) varieties.

Early blight is characterized by dead brown spots that usually start on the lower leaves and spread up the plant. Upon close inspection, you can see concentric rings within the spots. Although early blight is most severe on the leaves, it sometimes occurs on the stems; it can cause defoliation. You may need to use fungicide sprays to achieve high yields and quality fruit. Some varieties are more tolerant of early blight than others. Remove diseased leaves from the garden and dispose of them.

Septoria leafspot is characterized by numerous small black spots on the leaves. The center of these spots later turn white, and tiny black dots appear in the white center. The disease starts on the bottom leaves and may become severe in wet weather. Use suggested fungicides for control.

Physiological disorders: Blossom-end rot, a dry, leathery rot of the blossom end of the fruit, is common in home-grown tomatoes. It is caused by a combination of calcium deficiency with wide fluctuations in soil moisture. Severe pruning causes stress to the plants that increases the incidence of blossom-end rot. Some tomatoes are much more susceptible to this condition than others. Mulching and uniform watering will help prevent blossom-end rot.

Poor color and sunscald occur when high temperatures retard the development of full red color in tomatoes exposed directly to the sun. Sunscald appears on the fruit during hot, dry weather as a large, whitish area. It becomes a problem when foliage has been lost through other diseases, such as early blight.

Diseases: early blight, septoria leafspot, verticillium and fusarium wilts, late blight, tobacco mosaic virus, bacterial spot, tomato spotted wilt virus.

Insects: flea beetle, hornworm, stink bugs, Colorado potato beetle, fruitworm, aphids, mites, whiteflies, cutworms

Other Pests: nematodes

Cultural: blossom-end rot, irregular soil moisture or calcium deficiency; poor color, yellow spots or large whitish-grey spots, sunscald from lack of foliage cover; leaf roll; fruit cracking, irregular soil moisture; Black Walnut wilt, caused by roots of tomato plants coming in contact with roots of black walnut trees

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Storage

Days to Maturity: 55-105

Harvest: Harvest fully ripened but still firm; most varieties are dark red. Picked tomatoes should be placed in shade. Light is not necessary for ripening immature tomatoes. Mature green tomatoes may be picked before the first killing frost and stored in a cool (55F), moist (90% RH) place. When desired, ripen fruits at 70F.

Approximate Yield: (per 10 feet of row) 15-45 lbs

Amount per Person: 20-25 lbs for fresh use; 25-40 lbs for canning

Storage: Green tomatoes - medium cool (50-70F), moist (90% RH) conditions; 1-3 weeks. Ripe tomatoes - cool (40-45F), moist (90% RH) conditions; 7-10 days.

Preservation: Can or freeze as sauces or in chunks (whole or quartered), peeled.

Questions & Answers

What causes the lower leaves of my tomato plants to roll up?

Leaf roll (curling of the leaflets) is a physiological condition that occurs most commonly when plants are trained and pruned. It does not affect fruiting or quality, and it is not a disease. Leaf roll is a common genetic tract in some varieties such as mountain delight and mountain spring.

What is a tree tomato?

The tree-like plant sold as a "tree tomato" is Cyphomandra, betacea, also called Tamarillo, a different species from garden tomatoes. it is a woody tree that grows eight feet or more in height and bears fruit after two years. The tree tomato is a tropical plant, and will not overwinter outside under Arkansas conditions.

What causes small, irregular cloudy-white spots just under the skin of my tomatoes?

The spots on green or ripe fruit are caused by the feeding of stink bugs.

What causes the flowers to drop off my tomato plants?

During unfavorable weather (night temperatures lower than 55 degrees F. or above 70 degrees F. and day temperatures above 95 degrees F. with dry, hot winds) tomatoes do not set and the flowers drop. The problem usually disappears as the weather improves.

What cause the young leaves of my plants to become pointed and irregular in shape? I noticed the twisting of the leaves and stems after spraying the plants for the first time.

Judging from your description, it seems likely that your tomato plants have been injured by 2, 4-D or similar weed killer. Never use the same sprayer for weed control in your vegetable garden that you use in your lawn. Drift from herbicides originating one-half mile or more away can also injure your tomato plants.

When should I start my seed indoors to produce tomato transplants for my garden?

Depending upon temperature and how the plants are grown, it takes from 6 to 8 weeks to produce a healthy, 6-inch tall transplant to set out in your garden. The plants should be grown in a warm area and receive 6 to 8 hours of sunlight daily or tall, poor quality, leggy plants will result.

How do you select good transplants at nurseries or garden centers?

First, select the right variety, look for plants that appear healthy, dark green in color, and do not have any spots or holes in the leaves. The ideal tomato transplant should have five leaves and no flowers. Avoid tall, spindly plants with weak stems and leathery purple leaves.

How often should my tomatoes be fertilized?

It is necessary to fertilize the garden before planting tomatoes. Apply the fertilizer again when fruit first sets. From that point on, an additional fertilization (sidedress) every week to 10 days is recommended. Plants grown on sandy soils should be fertilized more frequently than those grown on heavy, clay soils. A general sidedress fertilizer recommendation is one to two tablespoons of a complete fertilizer scattered around the plant and worked into the soil. If using a fertilizer high in nitrogen such as ammonium nitrate, reduce the rate to one tablespoon per plant.

Should tomato plants be staked, caged or left unsupported?

Plants with foliage and fruit supported off the ground will produce more than unsupported plants. Caging has several advantages. It involves less work than staking. Once the cage is placed over the plant there is no further manipulation of the plant - no pruning or tying. The fruits are simply harvested as they ripen. In some areas, staking and pruning of the plant to a single or multiple stem results in sunburn when the developing fruit is exposed to excessive sunlight. Caged tomato vines produce more fruits of a smaller size, where staked and tied plants produce less fruits which mature earlier and are larger. Plants need to be raised off the ground to reduce disease and insect problems.

My tomato plants look great. They are dark green, vigorous and healthy. However, flowers are not forming any fruit. What is the problem?

Several conditions can cause tomatoes to not set fruit. Too much nitrogen fertilizer, nighttime temperatures over 70 degrees F., low temperatures below 50 degrees F., irregular watering, insects such as thrips or planting the wrong variety may result in poor fruit set. Any of these conditions can cause poor fruit set.

Are there really low-acid tomato varieties?

There are some varieties that are slightly less acidic than others. Some yellow-fruited types are slightly less acidic than the normal red varieties. Flavor differences which exist between varieties are not because of differences in acid content, but balances of the sugar to acid ratio. In general,

cherry tomatoes are higher in both sugar and acid levels.

What does determinate mean and can you tell if a tomato is determinate by looking at it?

Determinate means the plant will stop growing and be smaller. A determinate vine is distinguished by a repeating pattern of two leaves followed by a flower or fruiting cluster. After 6 or 7 clusters the plant will stop growing. An indeterminate vine has a repeating pattern of three or four leaves, then a cluster and keeps growing.

Can I save seeds from my tomatoes from next season's plantings, and if so how?

You can save seed from tomatoes if the variety is not a hybrid. Hybrid tomatoes do not come true from seed. The plants and fruits from seeds saved from your home garden may or may not resemble the parent. However, for true breeding or open pollinated varieties, such as Ozard Pink, it is easy to save seed. To save seed from tomatoes or any other home vegetable fruit crop, leave the fruit on the plant until it is mature, pull it, squeeze juice with seed into a glass, let this ferment for several days adding water if needed. Rinse the seeds two or three times to remove debris. Seeds will settle to the bottom. After rinsing the seeds, blot them and place them on newspaper to dry. Store the seeds under cool, dry conditions.

When caging tomatoes, how large should the cage be?

The diameter of the cage should be at least 18 to 20 inches at the top. Smaller cages often restrict plant growth and reduce yields. Height of the cage will vary but generally 3 1/2 feet is sufficient for the recommended varieties. However, if vining types such as Better Boy, Cherry or Grande, are used, a cage 5 feet in height is preferred. Regardless of variety, the 3 1/2 feet tall cage is sufficient for most fall garden tomatoes.

How do you stake tomatoes?

Staking involves pruning the plant to either one or two main stalks. Tomatoes grown without support develop a bush shape. The small suckers which develop between the axil of the leaf and the stem are removed to develop a vine structure rather than a bush. A wooden stake of 1-inch diameter and 6 feet long is driven into the ground beside the plant and allows it to be loosely attached to the stake as it grows. Do not damage the root system when inserting the stake in the ground. The plant can be attached to the stake with twist-ties, soft string, strips of cloth or panty hose. The plant is sufficiently supported if it is attached to the stake at 12- to 14-inch intervals. Continued to remove suckering to prevent the plant from developing more than one or two central stems. If a double-stalk plant is desired, leave the sucker produced below the first flower cluster since it will be the most vigorous.

What causes a tomato to crack? Is there anything I can do to prevent it?

Cracking is a physiological disorder caused by soil moisture fluctuations. When the tomato reaches the mature green stage and the water supply to the plant is reduced or cut off, the tomato will begin to ripen. At this time the skin around the outer surface of the tomato becomes thicker and more rigid to protect the tomato during and after harvest. If the water supply is restored after ripening begins, the plant will resume translocation of nutrients and moisture into the fruit. This will cause the fruit to enlarge. Thus, skin splits around the fruit and results in cracking. The best

control for cracking is a constant and regular water supply. Apply a layer of organic mulch to the base of the plant as this serves as a buffer and prevents soil moisture fluctuation. Water plants thoroughly every week especially when the fruits are maturing. Some varieties are resistant to cracking and we try to recommend these varieties.

What could cause the leaves of my tomatoes to turn brown along the edges?

Leaf-burn or scorch generally indicates root injury, quite often caused by heavy amounts of fertilizer applied too near the roots. This injury often results in browning and dieback of the ends and margins of the leaves.

About the time my tomatoes ripen and turn red, I lose at least half my crop to bird damage. What can prevent this?

Bird damage is common, and one control method which works quite well is to take old nylon stockings and cut them into pieces 10 to 12 inches long. Tie a knot in one end of the stocking and slip the open end over the entire cluster of tomatoes. Secure the end above the tomato cluster with a rubber band or twist-tie. Birds will not be able to peck through the nylon. Slip the stocking off the cluster and harvest the ripe fruit and replace it to protect later-ripening fruit. Also, birds damage fully mature fruit more readily than breaker fruit. Harvest in breaker stage. Other methods include using mylar tape over the plants, strips of aluminum foil, and balloons that resemble owl's eyes.

What causes the black spots on the bottom of my tomatoes?

Blossom end rot, caused by improper moisture and calcium deficiencies. Check that the soil pH is above 6.0. Maintain uniform soil moisture as the fruit nears maturity. Remove affected fruit. Use Calcium Nitrate to fertilize the plants.

What causes some of my early tomato fruit from the spring garden to be oddly shaped and of poor quality?

This condition is usually caused by low temperatures during bloom and pollination. Fruit that set when temperatures are 55 degrees F. or below often are odd-shaped and of poor quality. The blooms these tomatoes develop from often are abnormal because of temperature conditions and grow into abnormal, odd-shape fruit. Another name for this disorder is catfacing.

Should you allow tomatoes to become fully ripe and red on the vine before harvesting?

Generally, yields will be increased by harvesting the fruit at first blush of pink instead of leaving them on the plant to ripen fully. A tomato picked at first sign of color and ripened at room temperature will be just as tasty as one left to fully mature on the vine. Picking tomatoes before they turn red reduces damage from birds.

If tomatoes are picked green or before they are fully mature, how should they be handled to insure proper ripening and full flavor?

Never refrigerate tomatoes when picked immature. Place them in a single layer at room temperature and allowed them to develop full color. When they are full ripe, place them in the refrigerator where they will store for several weeks. Those handled in this manner will be of high

quality and full flavor.

What is a husk tomato?

Husk tomato is Physallis, also called Ground Cherry. It is grown the same way as regular tomatoes and produces a fruit the size of a cherry tomato. The fruits are produced inside a paper-like husk which, when ripe, turns brown and the fruit drops from the plant. If left in the husk, the fruit will keep for several weeks. Like tomatoes, they are sensitive to cold weather and should be set out from plants after all danger of frost in the spring. Space the plants 1 1/2 feet apart in rows at least 3 feet apart. The ripened small fruit can be used in pies, jams or may be dried in sugar and used like raisins.

I have the best tomato crop I have ever had, but the large tomatoes are falling off the vines. Even the ones that stay on the vine are jarred off easily. What is the problem?

Cool fall temperatures cause the abscission zone, the area where the tomato is attached to the plant, to weaken and the heavy fruit subsequently falls. Gather fallen tomatoes as soon as possible, wipe them clean and store them in a warm place to ripen.

I have large translucent areas on my tomato fruit. What's going on?

This is an environmental problem. The translucent area is caused by sun scald. Heat from direct intense sunlight destroys the color pigments of the tomato. This damage does not make the tomato inedible, but it is unsightly.

Can I propagate tomatoes for the fall garden from existing vines?

If necessary, use suckers or layering (cover with soil until roots appear) of existing vine. Do this several weeks before the determined recommended transplanting date for fall tomatoes, and use early tomato varieties. This is not a generally recommended practice. This practice does not work well with indeterminate varieties.

How do you tell when a green tomato harvested early to prevent freeze damage will ever turn red and ripen?

This can simply be done with a sharp kitchen knife. Harvest a tomato typical of the majority of green tomatoes on your plants. Look at size but pay particular attention to fruit color. Slice through the center of the tomato. Closely examine the seed within the fruit. If the seeds are covered with a clear gell which cause them to move away from the knife, then that fruit will eventually turn red and ripen. If the seeds are cut by the knife then those fruit will never properly ripen. Compare the color and size of the tested fruit when harvesting tomatoes on your plants. Most similar fruit will eventually ripen and turn red.

Is a tomato a fruit or a vegetable?

The tomato is a legally-declared vegetable as determined by the Supreme Court of the United States. A vegetable is a herbaceous (non-woody) plant or plant part which can be eaten without processing and is usually consumed with the main meal. However, botanically it is the fruit of the plant.

The foliage on my tomatoes is infected by irregularly shaped spots which cause it to turn yellow and drop off. This occur in all seasons and is on the top as well as the bottom leaves.

Several types of leaf spots will attack tomatoes. Septoria leaf spot is seen quite often and can be controlled with a fungicide spray program. Begin the spray program early in the life of the plant.

The leaves on my tomato plants are distorted. Why?

This is caused tobacco mosaic virus. If the virus is severe, remove the plants to prevent spread to other plants. Working around the infected plants can spread the virus to nearby healthy plants. Many viruses are insect transmitted, so carry out a good insect control program on tomatoes. Cucumber mosaic virus causes symptoms similar to 2-4-D injury.

My tomato plants are stunted and have a pale yellow foliage. The root system has knots or swellings on the roots.

These are root knot nematodes. Some varieties such as Celebrity and Better Boy resist this problem. It is best to use only nematode resistant varieties. Nematode resistance is indicated by the letter N after the name. Example: Celebrity VFN.

My tomatoes were healthy during the spring and early summer, yet after a recent rain, they wilted and died very rapidly. I found a white fungal growth at the base of the plant.

This is southern blight. It is a soilborne fungus that lives on organic material in the soil. Deep burial of undecomposed organic material in the soil will reduce this problem. Control foliage diseases of tomato plants because the fallen leaves around the base of the plant will feed the fungus, and it will build up this area and cause damage later. Crop rotation will also reduce the incidence of southern blight.

My tomato plants wilted rapidly. When I cut the stem open, I found a brown ring around the inside.

This is Fusarium wilt caused by a soilborne fungus that attacks tomatoes and other crops. It is controlled only through the use of resistant varieties. Most commercial tomato varieties are resistant. Before you plant a variety, make sure it is resistant to Fusarium wilt. This resistance is denoted by the letter F after the name. Example: Celebrity VFN.

What do the letters "VFN" associated with particular tomato varieties indicate?

VFN indicates the tomato variety is resistant to three types of diseases: Verticilum wilt, Fusarium wilt and nematodes. Many of the new hybrid varieties are VFN types.

The lower foliage on my tomatoes is beginning to turn yellow and drop. The leaves have circular, dark brown to black spots.

This is Alternaria leaf spot or early blight, a common problem on tomatoes and causes defoliation, usually during periods of high rainfall. Plant tomatoes on a raised bed to improve water drainage and spaced them enough so air can move and dry the foliage and prevent diseases. Follow a spray program using a fungicide beginning when the fruit is set and continuing at 1 week intervals during the growing season until harvest.

My tomato fruits have small yellow specks on the surface. When the fruit are peeled, those yellow specks form a tough spot that must be cut off before eating the tomatoes. What's wrong?

The yellow speckling is caused by sucking insects such as stinkbugs or leaf-footed bugs. Early control of sucking insects that feed on the fruit is helpful in alleviating the problem.

We planted tomatoes in our small garden. They are loaded and are the best tomatoes we have ever had; however, there are some small holes near the stem end of the tomato. When we cut the tomato open, there is a small worm inside. What is it and what can we do?

Your fruits have been invaded by the tomato pinworm. They usually do not damage all fruit and can be controlled only by a preventive insecticide spray every 7 to 10 days. When the damage is evident, it is too late to do anything about it.

What causes my tomato leaves to turn yellowish and fall off?

Many conditions may cause these symptoms including spider mites, diseases and nutrient deficiencies. Examine the underside of the leaves for small red to greenish mites. If mites are found, treat with two to three applications of an insecticides at 5-day intervals.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- A Colour Atlas of Tomato Diseases : Observation, Identification and Control - by D. Blancard - Publication Date: May 1994 - List: $99.95
  The publisher, John Wiley & Sons :

This unique and comprehensive guide is designed to enable readers to diagnose and combat, through effective measures, both parasitic and non-parasitic diseases of the tomato plant and fruit. Using an easy-to-assimilate format, the text illustrates and describes the essential features of each disease. Considerable importance is placed on the symptoms of the roots and stems. Features over 300 magnificent color photographs to help users learn the processes and acquire the skills necessary for reliable diagnosis.

- Burpee Tomatoes - by Robert Hendrickson - Publication Date: March 1997 - List: $16.95
  Synopsis:
  For more than 100 years Burpee has specialized in tomato variety development. From the legendary "Big Boy" to lesser known varieties, Burpee tomatoes can be found in vegetable gardens all over the country. Written for beginning enthusiasts or experienced aficionados, there is something for everyone in Burpee Tomatoes. 75 color photos.

- Genetic Improvement of Tomato (Monographs on Theoretical and Applied Genetics, Vol 14) - by G. Kalloo (Editor) - Publication Date: February 1992 - List: $169.00

- Molecular Biology of Tomato : Fundamental Advances and Crop Improvement - by John I. Yoder (Editor) - Publication Date: June 1993 - List: $99.95

- In Praise of Tomatoes : A Year in the Life of a Home Tomato Grower - by Steven Shepherd - Publication Date: July 1996 - List: $22.00

- Compendium of Tomato Diseases (Aps Disease Compendium Series) - by J.B. Jones, John Paul Jones, R.E. Stall, T.A. Zitter (Editor) - Publication Date: June 1991 - List: $35.00
- Tomato Production, Processing & Technology - by Wilbur A. Gould - Publication Date: January 1992 - List: $93.00
- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan - Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed. Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable information. Original.*
- Collecting Processing and Germinating Seeds of Wildland Plants - by Cheryl Young, James A. Young - Publication Date: October 1, 1986 - List: $24.95
- Enduring Seeds : Native American Agriculture and Wild Plant Conservation - by Gary Paul Nabhan - Publication Date: April 1, 1991 - List: $14.00
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  Explores the intricate relationship between seeds and the plants which they produce.
- Kid's Gardening : A Kid's Guide to Messing Around in the Dirt/With Seeds - by Kevin Raftery, Kim Gilbert Raftery, Jim M'Guinness - Publication Date: May 1, 1989 - List: $13.95

Now young readers will know from whence those carrots came. This full-color extravaganza contains nearly a hundred pages of wipe-clean cardstock, hundreds of illustrations, dozens of growing activities, plus 15 varieties of vegetable, flower, and herb seeds.

- Principles of Seed Science and Technology - by Larry O. Copeland, Miller B. McDonald, Lawrence O. Copeland - Publication Date: March 1, 1995 - List: $74.95
- Saving Seeds : The Gardener's Guide to Growing and Storing Vegetable and Flower Seeds - by Marc Rogers, Polly Alexander (Illustrator) - Publication Date: March 1991 - List: $12.95
- Seed to Seed - by Suzanne Ashworth - Publication Date: January 1, 1995 - List: $20.00
- Seeds : The Definitive Guide to Growing, History, and Lore - by H. Peter Loewer, Peter Loewer - Publication Date: April 1, 1996 - List: $25.00
  Loewer examines the vast and often surprisingly complex world of seeds in an unparalleled thoroughness. In addition to the how-to of growing all kinds of plants and vegetables from seed, the book also considers the role of seeds in history, literature, and business. 100 line drawings.
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  A companion to Burpee Complete Gardener, this book focuses on all aspects of growing organic vegetables and edible herbs in the home garden. Planting techniques and tools, garden design, and more than 90 individual plant portraits are included. 300 full-color photos.
- Culinary Gardens : From Garden to Palate - by Susan McClure - Publication Date: September 1997 - List: $37.95

- Five Acres and Independence: A Handbook for Small Farm Management - by Maurice Grenville Kains, Maurice G. Kain - Publication Date: March 1978 - List: $7.95

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  Booknews, Inc. , 01/01/93:
  Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.

- Gardening Under Cover : A Northwest Guide to Solar Greenhouses, Cold Frames, and Cloches - by William Head - Publication Date: November 1989 - List: $10.95
  This is a complete guide to gardening with protective shelters that encourages both beginning and experienced gardeners to add months of gardening pleasure at small expense. With a little under-cover gardening know-how, Pacific Northwest gardeners can take advantage of our mild climate to produce flowers, herbs, and vegetables throughout the year.

- Grow It : The Beginner's Complete In-Harmony-With-Nature Small Farm Guide-From Vegetable and Grain Growing to Livestock Care - by Richard W. Langer, Susan McNeill (Illustrator) - Publication Date: January 1994 - List: $12.00
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- Growing Great Garlic : The Definitive Guide for Organic Gardeners and Small Farmers - by Ron L. Engeland - Publication Date: July 1995 - List: $14.95

- Heirloom Vegetable Gardening : A Master Gardener's Guide to Planting, Growing, Seed Saving, and Cultural History - by William Woys Weaver - Publication Date: June 1997 - List: $45.00
  Synopsis:
  Weaver focuses on 280 varieties of 37 vegetables in this encyclopedic guide to the history and cultivation of some of America's most treasured heirloom vegetables. 100+ color photos. 240 line drawings.

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- Growing Plants from Seed : A Comprehensive Beginners Handbook for Vegetables, Flowers, Herbs and More - by George Abraham, Katy Abraham, Doc Abraham - Publication Date: January 1992 - List: $13.95
  Synopsis:
  A guide for first-time seed growers addresses soil mixtures, lighting, types of seed, seed-starting kits, and more to help any gardener experience the rewarding feeling of growing flowers and vegetables from seed. Original.

- Peppers : The Domesticated Capsicums - by Jean Andrews - Publication Date: October 1995 - List: $65.00
  Booknews, Inc. , 04/01/96:
  An updated edition (first, 1984) of an elegantly produced, scholarly reference on peppers--their history and dispersion, biology, taxonomy, cultivation, and medicinal, economic, and gastronomic uses. Illustrated with the author's botanically accurate, aesthetically pleasing paintings that show the blossoms, buds, young peppers, and mature specimens of 34 cultivars. A review of the literature, a photo glossary, and an extensive bibliography add to the volume's reference value. 9x12" Annotation c. by Book News, Inc., Portland, Or.

- Peppers of the World : An Identification Guide - by Dave Dewitt, Paul W. Bosland - Publication Date: January 1997 - List: $19.95

- Plant Propagation : Principles and Practices - by Hudson Thomas Hartmann (Editor), Dale E. Kester, Fred T., Jr. Davies - Publication Date: January 1997 - List: $86.00
  The publisher, Prentice-Hall Career & Technology :
  Hallmarked as the most successful text of its kind, this remarkably thorough text covers all aspects of the propagation of plants - both sexual and asexual - with considerable attention given to human (vs natural) efforts to increase plant numbers.

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(Illustrator) - Publication Date: October 1995 - List: $24.95
Booknews, Inc. , 05/01/96:
This expansion of a now-classic guide originally published in 1989 is intended for the serious gardener or small-scale market farmer. It describes practical and sustainable ways of growing superb organic vegetables, with detailed coverage of scale and capital, marketing, livestock, the winter garden, soil fertility, weeds, and many other topics. Annotation c. by Book News, Inc., Portland, Or.

- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Composting

Frequently Asked Questions Other Information Sources Return to Garden Contents

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Why Make Compost?

Problems that home gardeners share are that of maintaining the organic matter content of the soil and that of disposing of waste organic materials that accumulate on home grounds. Composting converts organic wastes into a form that is useful as an amendment to soil, enabling a gardener to conserve and recycle plant nutrients and organic matter that would otherwise be wasted.

The organic matter supplied by compost is valuable in improving the fertility and structure of soil. Compost supplies energy and nutrients to soil microorganisms that recycle the nutrients held in the compost and eventually make them available to plants. The compost itself will improve the physical condition of soils, making heavy, clay soils easier to work and increasing the water holding capacity of sandy soils. Compost also has the characteristic of holding plant nutrients in a form available to plants.

Many soils in Massachusetts are very sandy, and nutrients are easily leached from the soil. These soils would certainly benefit from liberal applications of compost.

What materials can be composted?

Almost any organic material that accumulates in home gardens and on grounds can be composted. Leaves and needles, lawn clippings, weeds, garden residue, hedge trimmings, vegetable and fruit garbage, and even shredded paper and sawdust can be readily composted. Woody waste materials, such as tree branches, should not be included in a compost pile unless they are first shredded. If not shredded and not included with some green succulent material or added nitrogen, woody materials take too long to decompose. Branches larger than one inch in diameter should not be used. Chopping leaves with a lawn mower and adding

some nitrogen fertilizer will shorten the decomposition time considerably.

It is not advisable to include meat, bones, and fat in a compost heap since they attract dogs and vermin, thus creating a nuisance. Diseased plant material should be excluded.

Building the compost pile.

There is no special recipe for making compost. Procedures will vary according to the materials available and the needs of the individual. However, certain requirements must be met for the process to occur properly and within a practical period of time.

A forgotten heap of garden trash and leaves is not a compost pile, although this material would eventually rot. Ideally, the compost pile should be located in partial shade and near a supply of water. To ensure adequate bulk to sustain rapid decomposition, the pile should be at least 3' by 3' by 4'. It takes about 20 bushels of raw organic material to make a pile this size that will yield about 8 to 9 bushels of finished compost.

Start the pile with a 6" to 10" layer of loosely packed organic material, wet it thoroughly (do not saturate) and scatter about one cup of a complete (10-10-10, 5-10-10, 12-12-12, etc.) fertilizer over each 25 square feet of surface. Cover this with a 1" layer of soil. Continue making layers until a pile 4' to 6' tall has been built. For convenience, this height should not be exceeded, but the pile can be as long as necessary to accomodate the material at hand. The top of the pile should be concave to help catch water and to prevent runoff. It is not absolutely necessary to add fertilizer but the added nitrogen speeds up the process, and phosphorus gives the finished product a more balanced nutrient content.

Care of the pile.

The type of the material used, the season of the year, and the frequency of turning the pile will affect the time required to achieve a useful product. Anywhere from 3 months to a year can be necessary.

It is important to keep the pile well moistened throughout and to turn at least every 30 days to aerate it and ensure even decomposition of the material. When turning, attempt to take material from the outside and have it end up on the inside and vice versa. By monitoring the temperature of the interior of the pile, you can tell the optimum time for turning. The interior will get almost too hot to touch (140-160 F) if the process is occurring properly. When it cools to the outside temperature, it is time to turn the pile. At this time, inspect the material to see that it

is moist (not soggy) and add water if necessary. Do not pack the material down any more than needed to keep the pile standing.

The compost is finished when it turns almost black and most of the original materials are no longer recognizable or when fibrous material breaks up readily when moved.

Using compost

Compost is sometimes referred to as "synthetic material" and is an excellent substitute where animal manure is not available. It is not a substitute for mineral fertilizer for it is lacking in phosphorus. Compost is easily worked into the ground and can be applied before tilling the garden, or it can be raked in after soil preparation. A moderate rate of application is about 2 to 4 bushels per 100 square feet. At this rate the compost will add a significant amount of organic matter to the soil and, if prepared as suggested, will supply about a half pound each of the major fertilizer elements (nitrogen, phosophorus and potassium).

Compost can be used as a substitute for peat moss. It is a beneficial amendment when mixed with soil for use in potting mixes or when transplanting shrubs and trees.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

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- The On-Farm Composting Handbook from the Northeast Regional Agricultural Engineering Service, 152 Riley-Robb Hall, Cooperative Extension, Ithaca, NY 14853-5701. This costs $15 (I think). It has 11 chapters including process, materials, methods, management, environmental, uses, marketing, economics, etc. It is fairly good and readable.
- The Association for Vermont Recyclers, 64 Main Street, Montpeleir, VT publishes a great k-12 curriculum.

Periodicals:

- None identified.

This page was last updated on August 31, 2002

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Related web pages:

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Commercial suppliers:

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Electronic mailing lists:

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Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.

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- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95
- The On-Farm Composting Handbook from the Northeast Regional Agricultural Engineering Service, 152 Riley-Robb Hall, Cooperative Extension, Ithaca, NY 14853-5701. This costs $15 (I think). It has 11 chapters including process, materials, methods, management, environmental, uses, marketing, economics, etc. It is fairly good and readable.
- The Association for Vermont Recyclers, 64 Main Street, Montpeleir, VT publishes a great k-12 curriculum.

Periodicals:

- None identified.

This page was last updated on August 31, 2002

Frequently Asked Questions:

- Organic Fertilizers

Other Information Sources:

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- Suggested references
- Periodicals

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Organic Fertilizers

Organic or 'natural' materials such as manures and composts are more cumbersome and possibly more expensive than synthetic fertilizers, but nothing quite takes their place. In addition to providing some nutrient value, they improve soil structure and increase the ablility of the soil to hold air, nutrients and water.

Plants take up nutrients in specific forms regardless of whether the source is organic or synthetic. It is possible to supply all the nutrients needed by your plants by using only organic materials, but care and effort are needed to assure that sufficient amounts of nitrogen, phosphorus and potassium (the nutrients needed in greatest quantities by plants) are available to the plants throughout the season. Because the nutrients in organic materials are tied up in more complex molecules, it often takes longer for them to become available to the plants. This delay can result in temporary nutrient deficiencies, especially in the spring.

Organic materials which have not broken down sufficiently (fresh manures, manures with lots of wood shavings, fresh leaf piles, etc.) should be turned into the garden in the fall or a few weeks before planting or applied only in small quantities. An alternate method is to set them aside for the season, allowing them to decompose. Fresh manures can 'burn' plants; woody materials (wood chips, sawdust, leaf piles, etc.) can cause a temporary nitrogen deficiency until they are sufficiently decomposed. This deficiency can be counteracted somewhat by applying about 1 lb. nitrogen for every 100 lbs. of organic matter in the spring. A rule of thumb is that when the material starts to resemble soil, it is ready for the garden. (Note: manures and composts do not provide sufficient phosphorus for good yields of crops.)

One possible 'recipe' for a complete fertilizer is the following applied per 1,000 square feet:

1. 1,000 lbs. of compost or rotted, not dehydrated, manure (25 bushels) source of Nitrogen.
2. 20 lbs. of bone meal (10 quarts) - source of Phosphorus.
3. 30 lbs. of wood ash (15 quarts) - source of Potassium.

Work the materials into the top four inches of soil in early spring. This amount should supply your plants with sufficient nutrients throughout the growing season.

Common natural fertilizers and their nutritive value

Materials	Nitrogen	Phosphorus	Potassium	Availability	Comments

Dried Blood	12	0	0	high	
Bone Meal (steamed)	0	9	0	medium	
Rock Phosphate	0	13	0	low	must be ground to 200 mesh powder
Fish Emulsion	4	0.1	0	high	may attract pests
Fish Meal	10	4	0	high	may attract pests
Leaf Mold	1	0.4	1	medium	
Seaweed	1.5	0.7	5	medium	
Cottonseed Meal	7	2.5	2	high	may contain pesticide residues
Wood Ashes	0	2	5	high	hardwood preferred, liming effect.
Garden Compost	1	0.3	1	medium	varies with ingredients
Cow Manure	0.5	0.2	0.5	medium	rotted not dehydrated
Horse Manure	0.7	0.5	0.6	medium	rotted not dehydrated
Rabbit Manure	4	3	1	medium	rotted not dehydrated
Hen Manure	1.8	1	0.5	medium	rotted not dehydrated
Hog Manure	0.3	0.3	0.4	medium	rotted not dehydrated
Sheep Manure	1	0.35	0.5	medium	rotted not dehydrated
Sludge	4	2.5	0	medium	may contain toxic metals
Granite Dust	0	0	6		virtually insoluble
Limestone	-	-	-		used to raise pH

Dolomite Limestone	-	-	-		corrects magnesium deficiency and raises pH
Peat Moss	-	-	-		improves soil structure

NOTE: Materials with medium availability - double amounts; materials with low availability - use four times amount.

***Human, cat and dog feces should not be used due to the danger of disease.**

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Sheep Manure	1	0.35	0.5	medium	rotted not dehydrated
Sludge	4	2.5	0	medium	may contain toxic metals
Granite Dust	0	0	6		virtually insoluble
Limestone	-	-	-		used to raise pH
Dolomite Limestone	-	-	-		corrects magnesium deficiency and raises pH
Peat Moss	-	-	-		improves soil structure

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Harvesting &Storing Vegetables

Frequently Asked Questions Other Information Sources Return to Garden Contents

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Hydroponics

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Frequently Asked Questions:

- Is Hydroponics a viable means of producing food crops?

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Intensive Gardening Techniques

For some people, a small-sized garden is preferable to a larger one. Smaller gardens require less labor and expense than larger gardens. Decreasing garden size provides more yard space for other activities. The gardener can concentrate soil improvement efforts in a smaller area, and, with careful management, small gardens can produce sufficient vegetables for fresh eating during the growing season, and perhaps extra produce for preserving.

Considerations

For some gardeners a small garden is not practical. If you are interested in preserving, a smaller garden may not provide enough produce for winter use.

"Intensive" gardeners must pay close attention to scheduling plantings to ensure that no part of a smaller garden is left unoccupied. Nebraska's growing season (actually two short seasons interrupted by a heat spell) can complicate trying to stagger plantings.

Smaller gardens also require careful management. Growing plants closer together demands particular attention to pest control, fertilization and training of plants. To grow all the vegetables you want, you may have to use transplants instead of direct seeding, which will increase your costs.

To manage smaller gardens successfully, gardeners must use different growing techniques. These can include bed planting, vertical growing, interplanting, and succession planting.

Raised Beds

Raised beds are growing areas whose surface is "raised" above the surrounding area. Raised beds can be temporary or permanent. Once established, the garden traffic is confined to paths, which reduces soil compaction. Soil improvement efforts are focused on the beds alone,

not in the paths. Raised beds warm faster and dry earlier in the spring, allowing earlier spring planting. All these factors allow plants in raised beds to be spaced more closely than in normal growing areas.

Disadvantages of Raised Beds

Raised beds are not the answer for all gardeners lacking space. The initial labor and cost to establish the beds may be high. Once established, especially with permanent "sides," it may be difficult to use a standard size plow or tiller for cultivation. The tendency of the soil in raised beds to dry faster may increase the need for irrigation later in the season. Also, not all types of vegetables grow well in bed culture.

Types and Sizes

Raised beds can be free-standing or built with more permanent sides to help hold the soil in place. Freestanding beds can be formed by marking out a tilled area to indicate paths and beds. Make beds any convenient length, but not wider than five feet across for easy reaching from either side. Once marked, use a hoe or rake to move soil from paths up into beds. Make freestanding beds no higher than eight inches or they will dry too quickly or be washed easily by rains. Finish by smoothing the top of the bed with a rake.

The beds will settle somewhat through the growing season. To prevent excessive drying and washing of soil, mulch the sides of the beds with an organic mulch like straw, leaves or grass clippings.

Permanent raised beds have supported sides. A variety of materials including wood or concrete blocks can be used for the sides. Redwood or western redcedar of at least two-inch thickness are long-lasting, or you may use pressure-treated wood.

Certain wood preservatives can damage growing plants. Avoid materials which have been treated with creosote or penta (pentachlorophenol). Old railroad ties have been creosote-treated, and may contain enough residue to cause plant injury.

Safe preservatives include salts of copper, chromium and arsenic (indicated by combinations of initials like CCA or CAC) or by trade names like Osmose and Koppers. Woods treated with these materials are greenish in color.

The wood should be pressure-treated for the longest life. Use care when handling treated wood. Always handle it with gloves, and wear a mask while sawing it to avoid absorbing any of the preservative residues. Dispose of scraps and sawdust in a landfill. Do not burn scraps or use sawdust in the garden.

Make permanent raised beds for disabled gardeners somewhat higher for easy reaching. The gardener can sit on the edge of the bed to work.

Design wheelchair access growing beds to be three feet high and no more than two feet wide.

Once the sides are installed, fill beds with garden soil which has been amended with peat, shredded leaves, compost or other organic materials. Since these beds will be in place a number of years, enriching and loosening soil when first establishing beds is important. Properly amended raised beds will have soil loose and friable enough to be turned easily with a shovel. Old mulch, compost or other organic material can be turned under each year which will further enrich the soil.

You also can organize your garden into beds, but not make the beds raised. This is a good option in gardens with sandy soil that would dry too quickly if formed in raised beds. Beds are a more efficient way to organize the garden than rows, especially for small-sized vegetables. By establishing permanent paths and beds (even if not raised) you still will avoid compacting the soil in growing areas.

What to plant in raised beds

Most crops are adaptable to growing in beds, but small-sized vegetables like lettuce, greens, dwarf or bush varieties and cabbage perform the best. Root crops like beets and carrots also will thrive in the looser soils of beds.

Whether raised or not, the advantage of beds is that vegetable plants can be grown more closely together. Space plants by thinning or transplanting so they are evenly spaced in the beds. The spacing should be whatever the seed packet recommends for spacing between plants. For example, if the seed packet says to thin lettuce so plants stand six inches apart in rows two feet apart, ignore the row spacing, and thin all lettuce plants to stand six inches apart. Root crops like carrots and beets still can be sown in rows, but plant two or three rows the length of the growing bed.

Plants like lettuce and radishes can be sown by lightly sprinkling seed over the bed and gradually thinning young plants to their recommended final spacing.

Trellis and Vertical Growing

Most gardeners already use vertical growing to save space in the garden. Caging tomatoes and trellising peas are two familiar examples. Besides saving space, vegetables grown this way are easier to pick and may have less rot because the fruit does not contact the soil. Improved air circulation can reduce diseases. Growing plants vertically can mean higher yields per unit area. In addition, vegetable plants can be trained

on trellises to provide welcome summer shade or privacy screens, as well as to produce food for the table.

Trellising does have some disadvantages, however. Climbing supports must be sturdy, especially in windy sites. Building and installing trellises can involve time and expense. If plants are not naturally twining, they will have to be trained or secured to trellises, and heavy fruit will require additional support. Transpiration is higher in plants growing upright, so they may require extra water. Flowers will be more exposed to the wind, which may discourage pollinators like bees, or cause flower abortion.

Types and Installation

The type of vegetable determines what kind of trellis used. A wide variety of trellising materials is available. A good rule is to install the sturdiest trellis you can afford. If the trellis is part of your landscaping it should be aesthetically pleasing, too.

Posts or supports for trellises can be made from metal, wood or plastic like PVC pipe. Metal posts will last longer and are easier to install than wooden ones. Wooden posts should be treated with a preservative or they may last only one season.

Posts can be used to support plastic or string mesh, or chicken wire. Plastic and string meshes can be disposed of, plants and all, at clean-up time. Removing dead plants from chicken wire fencing may be frustrating and futile.

Longer poles made of bamboo can be arranged in teepees to support climbing vegetables like pole beans.

You can make a vertical frame of electrical conduit fastened with slip fittings, or 1/2 inch water pipe with threaded elbow couplings. Attach strings to support the plants. You can arrange vertical frames in a number of ways. Run them as a straight fence, in zigzag pattern, with space between the frames, or as an arbor.

All trellises or climbing supports should be installed while plants still are small. Orient trellises to run in an east-west direction, and locate them on the north side of the garden to avoid shading other plants.

Melons and squashes do not naturally twine and will have to be trained initially by weaving stem ends through mesh openings. Developing fruit can be supported with slings made from used stockings or rags. Insect protection is an extra benefit of using slings, especially if the entire fruit is wrapped.

Succession Planting

Vegetables for Succession Planting.

Vegetable	Plant Every:
Radishes	10 days
Lettuce	2 weeks
Summer Squash	3-4 weeks
Snap Beans	3 weeks
Sweet Corn	2-3 weeks

Most gardeners practice a simple succession planting in row gardens by following a lettuce planting in spring with a late crop of, say, beans, or by staggering plantings of beans or sweet corn to ensure a steady harvest. Staggered plantings also work well with lettuce, radishes and other fast-yielding crops. Succession planting demands careful attention to days-to-maturity for each vegetable you plant, and attention to soil fertility to keep the intensively planted vegetables growing well.

Schedule plantings so no area of the garden remains empty for long. Remember that later planted succession crops mature faster than earlier planted ones because growing conditions, especially temperature and light intensity, usually are more favorable. Remove plants once their initial flush of bearing is over.

Interplanting

Interplanting is planting different crops in adjoining areas to take advantage of differences in growing habits, light requirements or nutrient needs. A traditional example of this technique is growing beans and corn together. Making plants share space means the individual plants may yield less, but the total garden yield will be greater because the space is being used more efficiently.

The number of ways different vegetables can be combined is limited only by your creativity. For successful interplanting combinations, plan your garden around the largest, longest-growing vegetables like tomatoes or winter squash. Once you've decided their location, plant smaller, fast-growing vegetables around them.

In your design, consider the different growing habits of vegetable plants: for example, combine upright plants like caged tomatoes with a scattering of scallions, or grow melons around sweet corn. Interplant lettuce with pole beans; the lettuce will be slower to bolt when growing in the partial shade provided by the taller beans.

An interplanted garden does not resemble a traditional garden with all the vegetables planted in straight rows. Rather, interplanted gardens

have a mosaic effect with paths oriented around the interplanted areas. Plants can be arranged to take advantage of contrasts in texture and color, making a garden more visually interesting.

A common error in interplanting is crowding vegetable plants. Crowded plants yield poorly and are more subject to diseases. Consider the eventual harvest size of the vegetables you interplant, and space them so that at maturity they will just be touching each other. Make the interplanted area no wider than what you can easily reach across to keep from trampling plants.

You also can avoid crowding by interplanting fast growing vegetables with slow growing vegetables, for example, radishes or lettuce with tomatoes. By the time the tomato plants are bearing, the lettuce or radishes will be harvested. Or some of the lettuce can be removed in May to make room to sow seed of winter squash. Eventually the winter squash plants will cover the entire lettuce bed.

Similarly, vining squash or melons can be sown between trellised pea plants. The pea plants will be finished bearing about the time the melon or squash needs the trellis.

A method of interplanting which has received notice recently is known as "square foot gardening." This technique (based on a book of the same name by Mel Bartholomew) involves planting vegetables very intensively. The growing area is divided into square foot sections. In each section, plants or seeds are carefully spaced.

For example, in one square foot you can grow 16 radishes, nine beets or one cabbage plant. This technique may be useful for container growing or where space is extremely limited, but will demand correspondingly more attention by the gardener.

Follow the usual fertilization guidelines for each crop in the interplanting. Amend soil with compost or organic matter before planting, use a starter fertilizer for early spring plantings, and topdress vegetables at the proper stage of growth.

The closer spacing of interplanted vegetables will discourage some weeds. But the weeds that do grow must still be controlled, and rototillers will be too large for the job. Use small tools like onion hoes, or pull weeds by hand. Better yet, use mulches to control weeds; this also reduces watering needs.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

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herb seeds.

- Principles of Seed Science and Technology - by Larry O. Copeland, Miller B. McDonald, Lawrence O. Copeland - Publication Date: March 1, 1995 - List: $74.95
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- Burpee : The Complete Vegetable & Herb Gardener : A Guide to Growing Your Garden
  Organically - by Karan Davis Cutler, Cavagnarok David (Photographer), Barbara W. Ellis - Publication Date: November 1997 - List: $29.95
  Synopsis:
  A companion to Burpee Complete Gardener, this book focuses on

all aspects of growing organic vegetables and edible herbs in the home garden. Planting techniques and tools, garden design, and more than 90 individual plant portraits are included. 300 full-color photos.

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  Synopsis:
  Weaver focuses on 280 varieties of 37 vegetables in this encyclopedic guide to the history and cultivation of some of America's most treasured heirloom vegetables. 100+ color photos. 240 line drawings.

- A Dyer's Garden : From Plant to Pot Growing Dyes for Natural Fibers - by Rita Buchanan - Publication Date: August 1995 - List: $9.95

- A Produce Reference Guide to Fruits and Vegetables from Around the World : Nature's Harvest - by Donald D. Heaton - Publication Date: April 1997 - List: $29.95

- Growing Plants from Seed : A Comprehensive Beginners Handbook for Vegetables, Flowers, Herbs and More - by George Abraham, Katy Abraham, Doc Abraham - Publication Date: January 1992 - List: $13.95
  Synopsis:
  A guide for first-time seed growers addresses soil mixtures, lighting, types of seed, seed-starting kits, and more to help any gardener experience the rewarding feeling of growing flowers and vegetables from seed. Original.

- Peppers : The Domesticated Capsicums - by Jean Andrews - Publication Date: October 1995 - List: $65.00
  Booknews, Inc. , 04/01/96:
  An updated edition (first, 1984) of an elegantly produced, scholarly reference on peppers--their history and dispersion, biology, taxonomy, cultivation, and medicinal, economic, and gastronomic uses. Illustrated with the author's botanically accurate, aesthetically pleasing paintings that show the blossoms, buds, young peppers, and mature specimens of 34 cultivars. A review of the literature, a photo glossary, and an extensive bibliography add to the volume's reference value. 9x12" Annotation c. by Book News, Inc., Portland, Or.

- Peppers of the World : An Identification Guide - by Dave Dewitt, Paul W. Bosland - Publication Date: January 1997 - List: $19.95

- Plant Propagation : Principles and Practices - by Hudson Thomas Hartmann (Editor), Dale E. Kester, Fred T., Jr. Davies - Publication Date: January 1997 - List: $86.00
  The publisher, Prentice-Hall Career & Technology : Hallmarked as the most successful text of its kind, this remarkably thorough text covers all aspects of the propagation of plants - both sexual and asexual - with considerable attention given to human (vs natural) efforts to increase plant numbers.

- Forest Gardening : Cultivating an Edible Landscape - by Robert A. De J. Hart - Publication Date: September 1996 - List: $17.95

- Handbook of Organic Food Processing and Production - by Simon Wright (Editor) - Publication Date: October 1994 - List: $119.00

- Introduction to Permaculture - by Bill Mollison, Reny Mia Slay - Publication Date: November 1997 - List: $16.95

- Profitable Organic Farming - by Jon Newton - Publication Date: June 1995 - List: $36.95

- The New Organic Grower : A Master's Manual of Tools and Techniques for the Home and Market Gardener - by Eliot Coleman, Sheri Amsel (Illustrator), Molly Cook Field (Illustrator) - Publication Date: October 1995 - List: $24.95
  Booknews, Inc. , 05/01/96:
  This expansion of a now-classic guide originally published in 1989 is intended for the serious gardener or small-scale market farmer. It describes practical and sustainable ways of growing superb organic vegetables, with detailed coverage of scale and capital, marketing, livestock, the winter garden, soil fertility, weeds, and many other topics. Annotation c. by Book News, Inc., Portland, Or.

- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95

Periodicals:

- None identified.

This page was last updated on November 16, 2002

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The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Intensive Gardening Techniques

For some people, a small-sized garden is preferable to a larger one. Smaller gardens require less labor and expense than larger gardens. Decreasing garden size provides more yard space for other activities. The gardener can concentrate soil improvement efforts in a smaller area, and, with careful management, small gardens can produce sufficient vegetables for fresh eating during the growing season, and perhaps extra produce for preserving.

Considerations

For some gardeners a small garden is not practical. If you are interested in preserving, a smaller garden may not provide enough produce for winter use.

"Intensive" gardeners must pay close attention to scheduling plantings to ensure that no part of a smaller garden is left unoccupied. Nebraska's growing season (actually two short seasons interrupted by a heat spell) can complicate trying to stagger plantings.

Smaller gardens also require careful management. Growing plants closer together demands particular attention to pest control, fertilization and training of plants. To grow all the vegetables you want, you may have to use transplants instead of direct seeding, which will increase your costs.

To manage smaller gardens successfully, gardeners must use different growing techniques. These can include bed planting, vertical growing, interplanting, and succession planting.

Raised Beds

Raised beds are growing areas whose surface is "raised" above the surrounding area. Raised beds can be temporary or permanent. Once established, the garden traffic is confined to paths, which reduces soil compaction. Soil improvement efforts are focused on the beds alone, not in the paths. Raised beds warm faster and dry earlier in the spring, allowing earlier spring planting. All these factors allow plants in raised beds to be spaced more closely than in normal growing areas.

Disadvantages of Raised Beds

Raised beds are not the answer for all gardeners lacking space. The initial labor and cost to establish the beds may be high. Once established, especially with permanent "sides," it may be difficult to use a standard size plow or tiller for cultivation. The tendency of the soil in raised beds

to dry faster may increase the need for irrigation later in the season. Also, not all types of vegetables grow well in bed culture.

Types and Sizes

Raised beds can be free-standing or built with more permanent sides to help hold the soil in place. Freestanding beds can be formed by marking out a tilled area to indicate paths and beds. Make beds any convenient length, but not wider than five feet across for easy reaching from either side. Once marked, use a hoe or rake to move soil from paths up into beds. Make freestanding beds no higher than eight inches or they will dry too quickly or be washed easily by rains. Finish by smoothing the top of the bed with a rake.

The beds will settle somewhat through the growing season. To prevent excessive drying and washing of soil, mulch the sides of the beds with an organic mulch like straw, leaves or grass clippings.

Permanent raised beds have supported sides. A variety of materials including wood or concrete blocks can be used for the sides. Redwood or western redcedar of at least two-inch thickness are long-lasting, or you may use pressure-treated wood.

Certain wood preservatives can damage growing plants. Avoid materials which have been treated with creosote or penta (pentachlorophenol). Old railroad ties have been creosote-treated, and may contain enough residue to cause plant injury.

Safe preservatives include salts of copper, chromium and arsenic (indicated by combinations of initials like CCA or CAC) or by trade names like Osmose and Koppers. Woods treated with these materials are greenish in color.

The wood should be pressure-treated for the longest life. Use care when handling treated wood. Always handle it with gloves, and wear a mask while sawing it to avoid absorbing any of the preservative residues. Dispose of scraps and sawdust in a landfill. Do not burn scraps or use sawdust in the garden.

Make permanent raised beds for disabled gardeners somewhat higher for easy reaching. The gardener can sit on the edge of the bed to work. Design wheelchair access growing beds to be three feet high and no more than two feet wide.

Once the sides are installed, fill beds with garden soil which has been amended with peat, shredded leaves, compost or other organic materials. Since these beds will be in place a number of years, enriching and loosening soil when first establishing beds is important. Properly amended raised beds will have soil loose and friable enough to be turned easily with a shovel. Old mulch, compost or other organic material can be turned under each year which will further enrich the soil.

You also can organize your garden into beds, but not make the beds raised. This is a good option in gardens with sandy soil that would dry too quickly if formed in raised beds. Beds are a more efficient way to organize the garden than rows, especially for small-sized vegetables. By establishing permanent paths and beds (even if not raised) you still will avoid compacting the soil in growing areas.

What to plant in raised beds

Most crops are adaptable to growing in beds, but small-sized vegetables like lettuce, greens, dwarf or bush varieties and cabbage perform the best. Root crops like beets and carrots also will thrive in the looser soils of beds.

Whether raised or not, the advantage of beds is that vegetable plants can be grown more closely together. Space plants by thinning or transplanting so they are evenly spaced in the beds. The spacing should be whatever the seed packet recommends for spacing between plants. For example, if the seed packet says to thin lettuce so plants stand six inches apart in rows two feet apart, ignore the row spacing, and thin all lettuce plants to stand six inches apart. Root crops like carrots and beets still can be sown in rows, but plant two or three rows the length of the growing bed.

Plants like lettuce and radishes can be sown by lightly sprinkling seed over the bed and gradually thinning young plants to their recommended final spacing.

Trellis and Vertical Growing

Most gardeners already use vertical growing to save space in the garden. Caging tomatoes and trellising peas are two familiar examples. Besides saving space, vegetables grown this way are easier to pick and may have less rot because the fruit does not contact the soil. Improved air circulation can reduce diseases. Growing plants vertically can mean higher yields per unit area. In addition, vegetable plants can be trained on trellises to provide welcome summer shade or privacy screens, as well as to produce food for the table.

Trellising does have some disadvantages, however. Climbing supports must be sturdy, especially in windy sites. Building and installing trellises can involve time and expense. If plants are not naturally twining, they will have to be trained or secured to trellises, and heavy fruit will require additional support. Transpiration is higher in plants growing upright, so they may require extra water. Flowers will be more exposed to the wind, which may discourage pollinators like bees, or cause flower abortion.

Types and Installation

The type of vegetable determines what kind of trellis used. A wide variety of trellising materials is available. A good rule is to install the sturdiest trellis you can afford. If the trellis is part of your landscaping it should be aesthetically pleasing, too.

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- A Dyer's Garden : From Plant to Pot Growing Dyes for Natural Fibers - by Rita Buchanan - Publication Date: August 1995 - List: $9.95

- A Produce Reference Guide to Fruits and Vegetables from Around the World : Nature's Harvest - by Donald D. Heaton - Publication Date: April 1997 - List: $29.95

- Growing Plants from Seed : A Comprehensive Beginners Handbook for Vegetables, Flowers, Herbs and More - by George Abraham, Katy Abraham, Doc Abraham - Publication Date: January 1992 - List: $13.95
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  A guide for first-time seed growers addresses soil mixtures, lighting, types of seed, seed-starting kits, and more to help any gardener experience the rewarding feeling of

growing flowers and vegetables from seed. Original.

- Peppers : The Domesticated Capsicums - by Jean Andrews - Publication Date: October 1995 - List: $65.00
  Booknews, Inc. , 04/01/96:
  An updated edition (first, 1984) of an elegantly produced, scholarly reference on peppers--their history and dispersion, biology, taxonomy, cultivation, and medicinal, economic, and gastronomic uses. Illustrated with the author's botanically accurate, aesthetically pleasing paintings that show the blossoms, buds, young peppers, and mature specimens of 34 cultivars. A review of the literature, a photo glossary, and an extensive bibliography add to the volume's reference value. 9x12" Annotation c. by Book News, Inc., Portland, Or.

- Peppers of the World : An Identification Guide - by Dave Dewitt, Paul W. Bosland - Publication Date: January 1997 - List: $19.95

- Plant Propagation : Principles and Practices - by Hudson Thomas Hartmann (Editor), Dale E. Kester, Fred T., Jr. Davies - Publication Date: January 1997 - List: $86.00
  The publisher, Prentice-Hall Career & Technology :
  Hallmarked as the most successful text of its kind, this remarkably thorough text covers all aspects of the propagation of plants - both sexual and asexual - with considerable attention given to human (vs natural) efforts to increase plant numbers.

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Periodicals:

- None identified.

This page was last updated on November 16, 2002

Gardens - misc.

Frequently Asked Questions Other Information Sources Return to Garden Contents

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My garden has clay type soil. What is the best way to improve the soil?

- **Suggestion A:** Adding sand helps. Expensive sand won't be any better than cheap sand. Actually sandy top soil is better than clean sand. Organic matter will help a lot. Don't get too carried away with uncomposted material as it will tie up nitrogen and cause mildew problems.
- **Suggestion B:** Gypsum will do wonders for the workability of the soil. If you can't find a source rototill in old broken sheetrock from houses being remodeled or from broken sheets at the lumber yard. Use the kind with paper on both sides not the kind that has aluminum on one side.
- **Suggestion C:** You need an abundance of some form of organic material. I did beds on similar soil one year and used hardwood sawdust. The tilth improved beyond belief but the microbes at work consuming the sawdust nearly totally depleted the soil (temporarily) of nitrogen. Mass infusion of ammonium nitrate turned it around quickly, but a mild compost (like steer--not chicken) would be a better selection. Put it on 3 or more inches deep when the soil is workable. Unless you want to be organic, use Roundup herbicide to wipe out the grasses when they are lush and growing--just watch your plants!

One agriculture professor told me adding sand to clay is like putting beach balls into a room full of oatmeal for aeration. It only makes cement, unless you use an awful lot of sand.

What is a good way to control weeds in a garden?

- **Suggestion A:** I have had excellent results by getting the ground in shape laying a soaker hose out and covering the whole thing

with black plastic. Plant through the plastic and water as needed. You will not need as much water and your soil temperatures will be higher. I have never had a problem with the soil getting too hot down here in Oklahoma.

Why Garden Organically?

Since the "organic law" does not apply to home gardens, why would any gardener give up all synthetic fertilizers? And why not use synthetic pesticides, when just one application could eliminate even the most devastating ravages of a crop insect or disease? Why work so hard handling large quantities of organic soil amendments and manures, when synthetic fertilizers of every description and purpose are so quickly available and easy to use?

Early gardeners did it to preserve a way of life that reduced pollution and environmental decay, thus creating a more ecological society. Organic enthusiasts are extremely health-conscious, and hope that working vigorously outdoors and eating foods free from pesticides just might lead to better nutrition and health. Today's organic gardeners are even more ecologically aware due to the accelerated deterioration of the environment from all forms of man-made intrusions. They can see waste-disposal sites filling up due to an ever-increasing population and proliferation of technological litter. Organic wastes must go somewhere, and organic gardeners see the soil and its capacity to recycle as the best place for them.

Today's organic followers include not only purists but also individuals who see it as their small contribution to conserving resources and energy. It's their way of rebelling against the passage of the agrarian way of life and the arrival of chemical agriculture that is now necessary to feed a population increasing at alarming rates. Rather than ignoring this preference, the scientific community is increasing its efforts to reduce the need for chemicals.

Companion planting

Companion planting may be defined as the interplanting of two or more crops which benefit from being near each other. Some of the benefits of this technique are:

1. Control of insects
2. Improvement of soil structure
3. Control of weeds
4. Thinning of crops
5. Improvement of crop products.

Scientifically, very little is known about companion planting. Some gardeners testify that it works for them, but others view companion planting as unfounded and wishful thinking. Each of the benefits mentioned above has some substantiated scientific basis, however. The effectiveness of other plants, such as aromatic herbs, which are supposed to repulse insects with the aroma they release, is less certain.

Benefits

Insect Control. Insects may be repelled, attracted, or killed by some plants. For example, interplanting marigolds with crops may control nematodes in the soil. Catnip is reported to deter flea beetles. Mints, rosemary, sage, rue, and tomato are said to drive away white cabbage moths (looper adults). Garlic, by some accounts, repels Japanese beetles. You may want to use some trial-and-error approaches to determine the effectiveness of aromatic plants in repelling insects. Do not assume that the insect resistance of one plant will be imparted to another species growing nearby.

Some plants may attract predatory insects into the garden. Fennel may increase the population of wasps in the garden which control larval stages of insects, such as Mexican bean beetles, hornworms, and cabbage maggots, and supposedly some adult insects. Asters attract spiders which may feed on some garden pests. Diversity of planting may foil insects. Interplanting beans and potatoes is often suggested, but results have been varied.

Some plants may act as traps, attracting the insects to them rather than to the principal crop. Some examples which have been suggested are planting eggplants with potatoes to attract the Colorado potato beetle, planting tomatoes with corn to attract corn earworm (tomato fruit worm, tomato bud worm) or vice versa, and planting turnips, radish, or mustard to attract the Harlequin bug from other crops.

Improvement of Soil Structure. Some plants, such as alfalfa, parsnip, caraway, and tomato, are deep-rooted crops which penetrate the soil and may help break up compact subsoils and pans and help loosen and crumble the upper soil levels. Other crops do not benefit directly at the time a deep-rooted crop is growing in one site, but if you rotate crops, the next crop may benefit from the improved soil structure.

Control of Weeds. The science of controlling weeds by crops is in its infancy. Some plants have toxic effects on others. Walnut wilt is a disease of tomatoes growing underneath walnut trees. Walnuts exude a chemical which is toxic to many plants. Crop residues may release toxic residues which control weeds. The effectiveness of the control is usually limited. Marigold residue may be worth a try in weed control.

Improvement in Product. This factor is most noticeable in crops

harvested as forages (hay, silage) where the interplanted species are removed together. Grass-legume mixtures are common interplantings. The grass provides carbohydrates and fiber to the forage, and the legume provides protein to enrich its quality. Interplanting soybeans with corn is possible. Alfalfa/bromegrass mixtures are well-recommended. It is unlikely you can enhance the flavor of vegetables by planting them close to herbs.

Thinning of Crops. Interseeding a crop with one which matures sooner can give a properly thinned stand of the later-maturing crop. Carrots and beets or radish may be seeded together. When the radishes or beets, as greens, are harvested, it leaves the thinned carrot stand behind. On the other hand, carrots and leeks may be interseeded. The leeks occupy space so that the carrots are not too thick. The carrots are the first to be harvested.

Disadvantages

As with many practices, companion planting does not work for everyone or every time. Unsubstantiated testimonials are often the basis for companion planting. Caution is needed with claims such as "carrots dislike dill," "plant parsley with roses to repel beetles," "interplant asparagus with tomatoes and parsley for mutual benefit."

In addition, failure to recognize the true beneficial factor may lead to false impressions. People who state that the best melons or pumpkins come from the weediest parts of the patch are probably overlooking the fact that a very fertile soil is stimulating weed growth and crop growth relative to less fertile areas. The failure to control weeds in a garden normally leads to reduced yields relative to the full potential of the soil to produce a crop. It is more likely that better melons or pumpkins would have been harvested from those weedy spots if the weeds had been controlled. Weeds compete with crops for light, water, and nutrients and harbor diseases and insect pests.

Selecting Companion Plants

You should apply common sense and science to selecting crops for interplantings. Consider the relative competitive nature of the crops. Competition may be evened out by crop spacing, however. Be sure that a larger or more aggressive crop does not shade out a smaller crop. Deep-rooted crops may not be good companions for shallow-rooted crops as is often recommended. The deep-rooted crop may exhaust water from the lower strata of the soil leaving the shallow-rooted crop high and dry. Published articles, suggestions from other gardeners, and trial and error can lead to successful selection of interplantings. Scientifically-based knowledge about companion planting is scarce.

Designs for companion plantings

Plants in intercropped systems may be placed in several arrangements. Some designs may be best suited for certain crops. Each plan must be well-developed; otherwise, one or both crops may fail.

Interplanting in the Same Row. This design works well for plants of about the same size and with similar growth habits. They should grow at about the same rate, particularly until one of the crops may be harvested. Example: beets and radishes work well in this system.

Zig-zagged Rows. This arrangement allows for a group of plants to be tucked into another group of plants. Plants of dissimilar size and growth habit may be used. Example: beets and onions work well in this system.

Sections. Rows of crops may be planted between the rows of other crops. Variable spacing of rows may be used to allow light to reach each crop. Plants may be grouped together for a better appearing garden. Example: corn and pole beans work well in this system.

Borders. Borders may be used around other plantings for a variety of reasons. You may want to test the repulsive action of herbs on pests. Annual planting may be made with a perennial border or around a central planting of perennials. Attractive gardens may be made with borders. Try planting a rhubarb border around annual vegetables or have an asparagus bed surrounded by tomatoes or other annual vegetables.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- **GARDENS: Gardens & Gardening Mailing List**

  Subscription address: listserv@ukcc.uky.edu (two-part subscription, requires confirmation)

  Topics: Home gardening. Everyone is welcome to participate, especially the novice gardener. Topics will include vegetable gardens, herbs,flowers, ornamental gardening, container gardening, and so on. NOTE: This list generates heavy traffic.

Subscribe to GARDENS. Type "subscribe GARDENS Your Name" in the message body. (Not supported by all browsers.)

- **ORCHIDS: Orchid Growers Mailing List**

  Subscription address: mailserv@scuacc.scu.edu

  Topics: Share and discuss information and experiences of orchid growers. The discussions include, but not be restricted to: discussion of types grown; cultivation techniques of certain types; Orchid Society events; helpful orchid tips to assist growers; scientific, biological issues relating to orchid growth; seeding and propagating techniques; hybrids and hybridizing; anything that would be of interest to orchid growers.

  Subscribe to ORCHIDS. Type "subscribe ORCHIDS Your Name" in the message body. (Not supported by all browsers.)

- **HYDRO: Hydroponic Gardening Mailing List**

  Subscription address: majordomo@hawg.stanford.edu

  Topics: Discuss technical aspects of hydroponic gardening, including methods, systems, nutrients, plants, greenhouses, experiences, etc.

  Subscribe to HYDRO. Type "subscribe HYDRO Your Name" in the message&127 body. (Not supported by all browsers.)

- **MGARDEN: Master Garden Discussion Group**

  Subscription address: listserv@wsuvm1.csc.wsu.edu

  Topics: Home gardening issues and problems and to exchange gardening ideas.

  Subscribe to MGARDEN. Type "subscribe MGARDEN Your Name" in the message&127 body. (Not supported by all browsers.)

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan - Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed. Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable information. Original.*
- Collecting Processing and Germinating Seeds of Wildland Plants - by Cheryl Young, James A. Young - Publication Date: October 1, 1986 - List: $24.95
- Enduring Seeds : Native American Agriculture and Wild Plant Conservation - by Gary Paul Nabhan - Publication Date: April 1, 1991 - List: $14.00
- From Seed to Plant - by Gail Gibbons - Publication Date: March 1, 1991 - List: $15.95 *Explores the intricate relationship between seeds and the plants which they produce.*
- Kid's Gardening : A Kid's Guide to Messing Around in the Dirt/With Seeds - by Kevin Raftery, Kim Gilbert Raftery, Jim M'Guinness - Publication Date: May 1, 1989 - List: $13.95
  Now young readers will know from whence those carrots came. This full-color extravaganza contains nearly a hundred pages of wipe-clean cardstock, hundreds of illustrations, dozens of growing activities, plus 15 varieties of vegetable, flower, and herb seeds.
- Principles of Seed Science and Technology - by Larry O. Copeland, Miller B. McDonald, Lawrence O. Copeland - Publication Date: March 1, 1995 - List: $74.95
- Saving Seeds : The Gardener's Guide to Growing and Storing Vegetable and Flower Seeds - by Marc Rogers, Polly Alexander (Illustrator) - Publication Date: March 1991 - List: $12.95
- Seed to Seed - by Suzanne Ashworth - Publication Date: January 1, 1995 - List: $20.00
- Seeds : The Definitive Guide to Growing, History, and Lore - by H. Peter Loewer, Peter Loewer - Publication Date: April 1, 1996 - List: $25.00
  Loewer examines the vast and often surprisingly complex world of seeds in an unparalleled thoroughness. In addition to the how-to of growing all kinds of plants and vegetables from seed, the book also considers the role of seeds in history, literature, and business. 100 line drawings.
- Seeds and Propagation (Smith & Hawken--The Hands-On Gardener) - by Susan McClure, Jim Anderson (Illustrator) -

Publication Date: June 1, 1997 - List: $10.95

- The New Seed Starter's Handbook - by Nancy Bubel - Publication Date: April 1, 1988 - List: $15.95

- Gardening In Deer Country - by Vincent Drzewucki - Publication Date: January, 1998 - List: $9.95

- 200 Tips for Growing Vegetables in the Northeast - by Miranda Smith - Publication Date: February 1996 - List: $7.95

- 200 Tips for Growing Vegetables in the Pacific Northwest - by Maggie Stuckey - Publication Date: February 1996 - List: $7.95

- Building Your Own Greenhouse (Greenhouse Basics) - by Mark Freeman, Heather Bellanca (Illustrator) - Publication Date: April 1997 - List: $18.95

- Burpee : The Complete Vegetable & Herb Gardener : A Guide to Growing Your Garden
  Organically - by Karan Davis Cutler, Cavagnarok David (Photographer), Barbara W. Ellis - Publication Date: November 1997 - List: $29.95
  Synopsis:
  A companion to Burpee Complete Gardener, this book focuses on all aspects of growing organic vegetables and edible herbs in the home garden. Planting techniques and tools, garden design, and more than 90 individual plant portraits are included. 300 full-color photos.

- Culinary Gardens : From Garden to Palate - by Susan McClure - Publication Date: September 1997 - List: $37.95
- Five Acres and Independence: A Handbook for Small Farm Management - by Maurice Grenville Kains, Maurice G. Kain - Publication Date: March 1978 - List: $7.95

- Four-Season Harvest : How to Harvest Fresh Organic Vegetables from Your Home Garden All Year Long - by Eliot Coleman, Kathy Bary (Illustrator) - Publication Date: October 1992 - List: $19.95
  Booknews, Inc. , 01/01/93:
  Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round.
  Annotation copyright Book News, Inc. Portland, Or.

- Gardening Under Cover : A Northwest Guide to Solar Greenhouses, Cold Frames, and Cloches - by William Head - Publication Date: November 1989 - List: $10.95
  This is a complete guide to gardening with protective shelters that encourages both beginning and experienced gardeners to add months of gardening pleasure at small expense. With a little under-cover gardening know-how, Pacific Northwest gardeners can take advantage of our mild climate to produce flowers, herbs, and vegetables throughout the year.

- Grow It : The Beginner's Complete In-Harmony-With-Nature Small Farm Guide-From Vegetable and Grain Growing to Livestock Care - by Richard W. Langer, Susan McNeill (Illustrator) - Publication Date: January 1994 - List: $12.00
  Synopsis:
  An indispensable guide to small-scale organic farming that features advice on everything from building and stocking a pond to planting an orchard or making cheese. This extremely practical and easy-to-use guide, first published in 1972, is for full-time or part-time country dwellers/gardeners.

- Growing Great Garlic : The Definitive Guide for Organic Gardeners and Small Farmers - by Ron L. Engeland - Publication Date: July 1995 - List: $14.95

- Heirloom Vegetable Gardening : A Master Gardener's Guide to Planting, Growing, Seed Saving, and Cultural History - by William Woys Weaver - Publication Date: June 1997 - List: $45.00
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Interplanting in the Same Row. This design works well for plants of about the same size and with similar growth habits. They should grow at about the same rate, particularly until one of the crops may be harvested. Example: beets and radishes work well in this system.

Zig-zagged Rows. This arrangement allows for a group of plants to be tucked into another group of plants. Plants of dissimilar size and growth habit may be used. Example: beets and onions work well in this system.

Sections. Rows of crops may be planted between the rows of other crops. Variable spacing of rows may be used to allow light to reach each crop. Plants may be grouped together for a better appearing garden. Example: corn and pole beans work well in this system.

Borders. Borders may be used around other plantings for a variety of reasons. You may want to test the repulsive action of herbs on pests. Annual planting may be made with a perennial border or around a central planting of perennials. Attractive gardens may be made with borders. Try planting a rhubarb border around annual vegetables or have an asparagus bed surrounded by tomatoes or other annual vegetables.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- **GARDENS: Gardens & Gardening Mailing List**

  Subscription address: listserv@ukcc.uky.edu (two-part subscription, requires confirmation)

Topics: Home gardening. Everyone is welcome to participate, especially the novice gardener. Topics will include vegetable gardens, herbs,flowers, ornamental gardening, container gardening, and so on. NOTE: This list generates heavy traffic.

Subscribe to GARDENS. Type "subscribe GARDENS Your Name" in the message body. (Not supported by all browsers.)

- **ORCHIDS: Orchid Growers Mailing List**

  Subscription address: mailserv@scuacc.scu.edu

  Topics: Share and discuss information and experiences of orchid growers. The discussions include, but not be restricted to: discussion of types grown; cultivation techniques of certain types; Orchid Society events; helpful orchid tips to assist growers; scientific, biological issues relating to orchid growth; seeding and propagating techniques; hybrids and hybridizing; anything that would be of interest to orchid growers.

  Subscribe to ORCHIDS. Type "subscribe ORCHIDS Your Name" in the message body. (Not supported by all browsers.)

- **HYDRO: Hydroponic Gardening Mailing List**

  Subscription address: majordomo@hawg.stanford.edu

  Topics: Discuss technical aspects of hydroponic gardening, including methods, systems, nutrients, plants, greenhouses, experiences, etc.

  Subscribe to HYDRO. Type "subscribe HYDRO Your Name" in the message&127 body. (Not supported by all browsers.)

- **MGARDEN: Master Garden Discussion Group**

  Subscription address: listserv@wsuvm1.csc.wsu.edu

  Topics: Home gardening issues and problems and to exchange gardening ideas.

  Subscribe to MGARDEN. Type "subscribe MGARDEN Your Name" in the message&127 body. (Not supported by all browsers.)

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Burpee Seed Starter : A Guide to Growing Flower, Vegetable, and Herb Seeds Indoors and Outdoors - by Maureen Heffernan - Publication Date: January 1, 1997 - List: $19.95 *A complete, easy-to-use gardening manual covering the basics of starting plants from seed.*

Discusses indoor and outdoor cultivation, how to purchase seed, seed viability, gardening equipment, planting charts and light requirements, planting dates, and other valuable information. Original.

- Collecting Processing and Germinating Seeds of Wildland Plants - by Cheryl Young, James A. Young - Publication Date: October 1, 1986 - List: $24.95
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  Now young readers will know from whence those carrots came. This full-color extravaganza contains nearly a hundred pages of wipe-clean cardstock, hundreds of illustrations, dozens of growing activities, plus 15 varieties of vegetable, flower, and herb seeds.
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  Booknews, Inc. , 01/01/93:
  Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.

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  Booknews, Inc. , 04/01/96:
  An updated edition (first, 1984) of an elegantly produced, scholarly reference on peppers--their history and dispersion, biology, taxonomy, cultivation, and medicinal, economic, and gastronomic uses. Illustrated with the author's botanically accurate, aesthetically pleasing paintings that show the blossoms, buds, young peppers, and mature specimens of 34 cultivars. A review of the literature, a photo glossary, and an extensive bibliography add to the volume's reference value. 9x12" Annotation c. by Book News, Inc., Portland, Or.

- Peppers of the World : An Identification Guide - by Dave Dewitt, Paul W. Bosland - Publication Date: January 1997 - List: $19.95

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- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95

Periodicals:

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This page was last updated on August 31, 2002

Mulch

Frequently Asked Questions Other Information Sources Return to Garden Contents

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Other Information Sources:

Warning:

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Why Mulch?

Applying mulch to your garden is a good conservation practice. Thick mulches help prevent loss of top soil from wind and water erosion; reduce soil compaction, decrease water loss from the soil through evaporation; lessen soil temperature fluctuations and, as they decompose and become incorporated in the soil, improve soil tilth.

Mulching Materials

Weathered wood chips (nuggets or bark), sawdust, grass clippings, straw, pine needles or oak leaves, dehydrated or aged manures, chopped leaves, and compost are good mulching materials. A three-to six-inch layer will control most weed growth. Be sure not to bury any plant. Do not pile the mulch against plant bases, and always keep mulch away from plant crowns by a good three to four inches. Moist mulch laying against the plant's bark eventually results in trunk rot.

Clippings from a lawn which has not been treated with a broadleaf killer make a good mulch when mixed with another material such as peat. Clippings alone are inclined to pack down and interfere with water penetration of the soil.

Mulching for winter protection.

Winter mulching is of prime importance to transplants and of great benefit to all established plantings. Mulches for winter protection are applied after the soil has begun to harden. Too early applications provide "room and board" for small animals which move in and make their nests under the mulch in the fall. Protected by the mulch and a snow cover, they feed on bark and roots of thin-barked ornamentals and

of fruit trees, in particular, during the food-scarce weeks of winter.

Winter mulches are pulled away from garden plants in early spring to promote earlier warming of the soil by the sun. New mulches for the summer are laid down after the soil has warmed and fertilizer has been applied, usually by the first or second week of June in New England. If the old winter mulch seems to be in good condition, it may be raked or pushed back in place for another year.

Types of mulch

Aluminum foil or backed paper, will not decompose, apply one layer.

Advantages: Increases light around plants; aphids and other insects avoid. Reusable.

Disadvantages: Can tear if handled roughly. Expensive. Artificial looking.

Comments: Keeps ground very cool. Apply only after ground has warmed up.

Bark chips, bio-degradable, apply 2-3 inches.

Advantages: Attractive; good for permanent mulch. Reusable.

Disadvantages: May hinder water penetration.

Comments: Decomposes slowly unless composted first. Redwood decomposes slowest; may repel insects. Reusable.

Brick chips, will not decompose, apply 2-3 inches.

Advantages: Cheaper than stone mulch. Non-flammable.

Disadvantages: Not readily available; high moisture retention. No organic matter added.

Comments: Decorative; made from brick overburns.

Compost, bio-degradable, apply 1-2 inches.

Advantages: Contributes nutrients; turns quickly to humus.

Disadvantages: Needs heating period to kill off weed seeds and diseases; may have unpleasant odor.

Comments: Plan and start ahead so compost will be ready.

Corncobs and cornstalks, bio-degradable, apply 3-4 inches.

Advantages: Readily available in most areas. Good weed control.

Disadvantages: Water doesn't penetrate well; may generate heat.

Comments: Add nitrogen to aid decomposition. Avoid diseased stalks and cobs. Best chopped.

Cottonseed hulls, bio-degradable, apply 2-4 inches.

Advantages: Fertilizing value similar cottonseed meal.

Disadvantages: Very light, wind scatters.

Comments: Keeps down weeds between rows. Top layer of another mulch prevents scattering.

Grass clippings (dry), bio-degradable, apply 2-3 inches.

Advantages: Improves soil by adding organic matter.

Disadvantages: Absorbent; may carry weed seed.

Comments: Mix with other materials to prevent packing. Bottom layer decomposes rapidly; add more.

Hay, bio-degradable, apply 4-6 inches.

Advantages: Legume hays (alfalfa) add nitrogen.

Disadvantages: First cut hay full of weed seeds. Poor weed control.

Comments: Fewer weed seeds in 2nd or 3rd cut. Fluff up during season.

Leaves, bio-degradable, apply 2-3 inches.

Advantages: Contain many trace minerals; best food for earthworms.

Disadvantages: May become soggy and pack, hindering water penetration.

Comments: Chip or mix with another mulch to prevent matting.

Paper, bio-degradable, apply 5-6 pages or 4-6 inches, shredded.

Advantages: May add trace minerals. Decomposes readily. Newspaper or scrap paper.

Disadvantages: May pack and hinder water penetration. Scatters. Lead in colored pages; use black and white only.

Comments: Hold edges with rocks or dirt. Best shredded. Frost protection.

Peanut hulls, bio-degradable, apply 2-3 inches.

Advantages: Adds nitrogen, phosphorus and potassium; decomposes rapidly.

Disadvantages: Not readily available in North.

Comments: Attractive to rodents if not completely free of peanuts.

Peat moss, bio-degradable, apply 3-5 inches.

Advantages: Clean and free of weed seeds. Improves water retention when tilled into sandy soil.

Disadvantages: Extremely absorbent, water penetration hindered; expensive. Adds little or no nutrients.

Comments: Good soil conditioner to loosen heavy soils; acidic. Decomposes slowly.

Pine needles, bio-degradable, apply 3-4 inches.

Advantages: Light; usually free of weed seeds; absorbs little moisture. Does not pack. Reusable.

Disadvantages: Decomposes very slowly.

Comments: Add nitrogen for faster decomposition. Slightly acidic.

Polyethelene (black or clear), will not decompose, apply one layer.

Advantages: Retains but absorbs no moisture. Black is effective weed control.

Disadvantages: Weeds grow under clear plastic. Rain can't go through easily. Adds no nutrients.

Comments: Warms soil--effective with tropical crops (melons, tomatoes). Ground must be moist before applying.

Rock, crushed gravel or marble chips, will not decompose, apply 1-2 inches.

Advantages: Relatively inexpensive; not absorbent. Water penetrates, non-flammable.

Disadvantages: Poor weed control. Adds no organic matter to soil.

Comments: Should be considered permanent mulch.

Salt marsh hay, bio-degradable, apply 4-6 inches.

Advantages: Usually weed-free; available in marshy areas or along coast. Long lasting.

Disadvantages: Not available to everyone. Expensive if purchased.

Comments: Till under at end of season. Chopping may make more attractive.

Straw, bio-degradable, apply 4-6 inches.

Advantages: Adds nutrients; lightens soil when tilled under at end of season.

Disadvantages: Can be a fire hazard.

Comments: Add nitrogen to aid decomposition unless aged.

Vermiculite or perlite, will not decompose, apply 1-2 inches.

Advantages: Totally sterile, so will not carry disease. No weed seeds.

Disadvantages: Expensive; very light; scatters. Hinders water penetration.

Comments: Good for greenhouse use.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- MULCH-L: Mulch-based Agriculture Discussion GroupSubscription address: listproc@cornell.edu

  Topics: Sponsored by CIIFAD's Mulch-Based Agriculture Working Group at Cornell, this list has been set up for the interdisciplinary exchange of information on cover crops, green manures and other woody/non-woody mulch-based agricultural systems. The term "mulch" refers to a litter layer of vegetative biomass which is cut and left on (or partially incorporated into) the soil. Feel free to post questions or share information that may be relevant for others involved in research or extension of sustainable agriculture practices that include mulch as a component. Interest is primarily focused upon tropical farming systems (i.e. maize/mucuna rotation, "frijol tapado" and contour hedgerow mulch systems) that are relevant to resource-poor farmers, more general information that relates to the study of mulch-based agriculture is welcome.

Subscribe to MULCH-L. Type "subscribe MULCH-L Your Name" in the message&127 body. (Not supported by all browsers.)

Suggested references:

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Winter mulches are pulled away from garden plants in early spring to promote earlier warming of the soil by the sun. New mulches for the summer are laid down after the soil has warmed and fertilizer has been applied, usually by the first or second week of June in New England. If the old winter mulch seems to be in good condition, it may be raked or pushed back in place for another year.

Types of mulch

Aluminum foil or backed paper, will not decompose, apply one layer.

Advantages: Increases light around plants; aphids and other insects avoid. Reusable.

Disadvantages: Can tear if handled roughly. Expensive. Artificial looking.

Comments: Keeps ground very cool. Apply only after ground has warmed up.

Bark chips, bio-degradable, apply 2-3 inches.

Advantages: Attractive; good for permanent mulch. Reusable.

Disadvantages: May hinder water penetration.

Comments: Decomposes slowly unless composted first. Redwood decomposes slowest; may repel insects. Reusable.

Brick chips, will not decompose, apply 2-3 inches.

Advantages: Cheaper than stone mulch. Non-flammable.

Disadvantages: Not readily available; high moisture retention. No organic matter added.

Comments: Decorative; made from brick overburns.

Compost, bio-degradable, apply 1-2 inches.

Advantages: Contributes nutrients; turns quickly to humus.

Disadvantages: Needs heating period to kill off weed seeds and diseases; may have unpleasant odor.

Comments: Plan and start ahead so compost will be ready.

Corncobs and cornstalks, bio-degradable, apply 3-4 inches.

Advantages: Readily available in most areas. Good weed control.

Disadvantages: Water doesn't penetrate well; may generate heat.

Comments: Add nitrogen to aid decomposition. Avoid diseased stalks and cobs. Best chopped.

Cottonseed hulls, bio-degradable, apply 2-4 inches.

Advantages: Fertilizing value similar cottonseed meal.

Disadvantages: Very light, wind scatters.

Comments: Keeps down weeds between rows. Top layer of another mulch prevents scattering.

Grass clippings (dry), bio-degradable, apply 2-3 inches.

Advantages: Improves soil by adding organic matter.

Disadvantages: Absorbent; may carry weed seed.

Comments: Mix with other materials to prevent packing. Bottom layer decomposes rapidly; add

more.

Hay, bio-degradable, apply 4-6 inches.

Advantages: Legume hays (alfalfa) add nitrogen.

Disadvantages: First cut hay full of weed seeds. Poor weed control.

Comments: Fewer weed seeds in 2nd or 3rd cut. Fluff up during season.

Leaves, bio-degradable, apply 2-3 inches.

Advantages: Contain many trace minerals; best food for earthworms.

Disadvantages: May become soggy and pack, hindering water penetration.

Comments: Chip or mix with another mulch to prevent matting.

Paper, bio-degradable, apply 5-6 pages or 4-6 inches, shredded.

Advantages: May add trace minerals. Decomposes readily. Newspaper or scrap paper.

Disadvantages: May pack and hinder water penetration. Scatters. Lead in colored pages; use black and white only.

Comments: Hold edges with rocks or dirt. Best shredded. Frost protection.

Peanut hulls, bio-degradable, apply 2-3 inches.

Advantages: Adds nitrogen, phosphorus and potassium; decomposes rapidly.

Disadvantages: Not readily available in North.

Comments: Attractive to rodents if not completely free of peanuts.

Peat moss, bio-degradable, apply 3-5 inches.

Advantages: Clean and free of weed seeds. Improves water retention when tilled into sandy soil.

Disadvantages: Extremely absorbent, water penetration hindered; expensive. Adds little or no nutrients.

Comments: Good soil conditioner to loosen heavy soils; acidic. Decomposes slowly.

Pine needles, bio-degradable, apply 3-4 inches.

Advantages: Light; usually free of weed seeds; absorbs little moisture. Does not pack. Reusable.

Disadvantages: Decomposes very slowly.

Comments: Add nitrogen for faster decomposition. Slightly acidic.

Polyethelene (black or clear), will not decompose, apply one layer.

Advantages: Retains but absorbs no moisture. Black is effective weed control.

Disadvantages: Weeds grow under clear plastic. Rain can't go through easily. Adds no nutrients.

Comments: Warms soil--effective with tropical crops (melons, tomatoes). Ground must be moist before applying.

Rock, crushed gravel or marble chips, will not decompose, apply 1-2 inches.

Advantages: Relatively inexpensive; not absorbent. Water penetrates, non-flammable.

Disadvantages: Poor weed control. Adds no organic matter to soil.

Comments: Should be considered permanent mulch.

Salt marsh hay, bio-degradable, apply 4-6 inches.

Advantages: Usually weed-free; available in marshy areas or along coast. Long lasting.

Disadvantages: Not available to everyone. Expensive if purchased.

Comments: Till under at end of season. Chopping may make more attractive.

Straw, bio-degradable, apply 4-6 inches.

Advantages: Adds nutrients; lightens soil when tilled under at end of season.

Disadvantages: Can be a fire hazard.

Comments: Add nitrogen to aid decomposition unless aged.

Vermiculite or perlite, will not decompose, apply 1-2 inches.

Advantages: Totally sterile, so will not carry disease. No weed seeds.

Disadvantages: Expensive; very light; scatters. Hinders water penetration.

Comments: Good for greenhouse use.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- MULCH-L: Mulch-based Agriculture Discussion GroupSubscription address: listproc@cornell.edu

  Topics: Sponsored by CIIFAD's Mulch-Based Agriculture Working Group at Cornell, this list has been set up for the interdisciplinary exchange of information on cover crops, green manures and other woody/non-woody mulch-based agricultural systems. The term "mulch" refers to a litter layer of vegetative biomass which is cut and left on (or partially incorporated into) the soil. Feel free to post questions or share information that may be relevant for others involved in research or extension of sustainable agriculture practices that include mulch as a component. Interest is primarily focused upon tropical farming systems (i.e. maize/mucuna rotation, "frijol tapado" and contour hedgerow mulch systems) that are relevant to resource-poor farmers, more general information that relates to the study of mulch-based agriculture is welcome.

  Subscribe to MULCH-L. Type "subscribe MULCH-L Your Name" in the message&127 body. (Not supported by all browsers.)

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Periodicals:

- None identified.

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Organic Gardening

Frequently Asked Questions Other Information Sources Return to Garden Contents

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Soil Preparation

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Preparing the Soil

Regardless of the soil in your garden, it can be improved by adding organic matter. This is one of the keys to successful vegetable gardening.

If your soil is heavy clay, the addition of organic matter improves both drainage and aeration and also allows better root development. Liberal amounts of organic matter help sandy soil hold water and nutrients.

Where do you get organic matter? This magical stuff which improves soil and serves as a food source for soil fungi and bacteria comes in the form of peat moss, compost, hay, grass clippings, barnyard fertilizer, shredded bark, leaves or even shredded newspapers.

When adding organic matter to soil, supply enough to physically change the soil structure. Ideally, at least one-third of the final soil mix should be some type of organic material. To accomplish this, spread a 2- to 4- inch layer of organic material over the garden surface and till it to a depth of at least 6 to 10 inches. Apply the recommended rate of fertilizer over the garden surface at the same time, and till it in along with the organic material.

Tilling the Soil

Some gardeners prefer a shovel or spading fork to the rototiller for working garden soil, but many look for an easier way to handle this chore. For gardeners with rototillers or those who are considering renting or buying one, here are some tips to make the tilling job much easier.

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- Kid's Gardening : A Kid's Guide to Messing Around in the Dirt/With Seeds - by Kevin Raftery, Kim Gilbert Raftery, Jim M'Guinness - Publication Date: May 1, 1989 - List: $13.95
  Now young readers will know from whence those carrots came. This full-color extravaganza contains nearly a hundred pages of wipe-clean cardstock, hundreds of illustrations, dozens of growing activities, plus 15 varieties of vegetable, flower, and herb seeds.
- Principles of Seed Science and Technology - by Larry O. Copeland, Miller B. McDonald, Lawrence O. Copeland - Publication Date: March 1, 1995 - List: $74.95
- Saving Seeds : The Gardener's Guide to Growing and Storing Vegetable and Flower Seeds - by Marc Rogers, Polly Alexander (Illustrator) - Publication Date: March 1991 - List: $12.95

- Seed to Seed - by Suzanne Ashworth - Publication Date: January 1, 1995 - List: $20.00
- Seeds : The Definitive Guide to Growing, History, and Lore - by H. Peter Loewer, Peter Loewer - Publication Date: April 1, 1996 - List: $25.00
  Loewer examines the vast and often surprisingly complex world of seeds in an unparalleled thoroughness. In addition to the how-to of growing all kinds of plants and vegetables from seed, the book also considers the role of seeds in history, literature, and business. 100 line drawings.
- Seeds and Propagation (Smith & Hawken--The Hands-On Gardener) - by Susan McClure, Jim Anderson (Illustrator) - Publication Date: June 1, 1997 - List: $10.95
- The New Seed Starter's Handbook - by Nancy Bubel - Publication Date: April 1, 1988 - List: $15.95
- Gardening In Deer Country - by Vincent Drzewucki - Publication Date: January, 1998 - List: $9.95
- 200 Tips for Growing Vegetables in the Northeast - by Miranda Smith - Publication Date: February 1996 - List: $7.95
- 200 Tips for Growing Vegetables in the Pacific Northwest - by Maggie Stuckey - Publication Date: February 1996 - List: $7.95
- Building Your Own Greenhouse (Greenhouse Basics) - by Mark Freeman, Heather Bellanca (Illustrator) - Publication Date: April 1997 - List: $18.95
- Burpee : The Complete Vegetable & Herb Gardener : A Guide to Growing Your Garden Organically - by Karan Davis Cutler, Cavagnarok David (Photographer), Barbara W. Ellis - Publication Date: November 1997 - List: $29.95
  Synopsis:
  A companion to Burpee Complete Gardener, this book focuses on all aspects of growing organic vegetables and edible herbs in the home garden. Planting techniques and tools, garden design, and more than 90 individual plant portraits are included. 300 full-color photos.
- Culinary Gardens : From Garden to Palate - by Susan McClure - Publication Date: September 1997 - List: $37.95
- Five Acres and Independence: A Handbook for Small Farm Management - by Maurice Grenville Kains, Maurice G. Kain - Publication Date: March 1978 - List: $7.95
- Four-Season Harvest : How to Harvest Fresh Organic Vegetables from Your Home Garden All Year Long - by Eliot Coleman, Kathy Bary (Illustrator) - Publication Date: October 1992 - List: $19.95
  Booknews, Inc. , 01/01/93:

Everyone who grows vegetables must know Coleman. He's the organic methods expert--the one who knows how to maximize both garden yield and gardening pleasure, year round. Annotation copyright Book News, Inc. Portland, Or.

- Gardening Under Cover : A Northwest Guide to Solar Greenhouses, Cold Frames, and Cloches - by William Head - Publication Date: November 1989 - List: $10.95
  This is a complete guide to gardening with protective shelters that encourages both beginning and experienced gardeners to add months of gardening pleasure at small expense. With a little under-cover gardening know-how, Pacific Northwest gardeners can take advantage of our mild climate to produce flowers, herbs, and vegetables throughout the year.

- Grow It : The Beginner's Complete In-Harmony-With-Nature Small Farm Guide-From Vegetable and Grain Growing to Livestock Care - by Richard W. Langer, Susan McNeill (Illustrator) - Publication Date: January 1994 - List: $12.00
  Synopsis:
  An indispensable guide to small-scale organic farming that features advice on everything from building and stocking a pond to planting an orchard or making cheese. This extremely practical and easy-to-use guide, first published in 1972, is for full-time or part-time country dwellers/gardeners.

- Growing Great Garlic : The Definitive Guide for Organic Gardeners and Small Farmers - by Ron L. Engeland - Publication Date: July 1995 - List: $14.95

- Heirloom Vegetable Gardening : A Master Gardener's Guide to Planting, Growing, Seed Saving, and Cultural History - by William Woys Weaver - Publication Date: June 1997 - List: $45.00
  Synopsis:
  Weaver focuses on 280 varieties of 37 vegetables in this encyclopedic guide to the history and cultivation of some of America's most treasured heirloom vegetables. 100+ color photos. 240 line drawings.

- A Dyer's Garden : From Plant to Pot Growing Dyes for Natural Fibers - by Rita Buchanan - Publication Date: August 1995 - List: $9.95

- A Produce Reference Guide to Fruits and Vegetables from Around the World : Nature's Harvest - by Donald D. Heaton - Publication Date: April 1997 - List: $29.95

- Growing Plants from Seed : A Comprehensive Beginners Handbook for Vegetables, Flowers, Herbs and More - by George Abraham, Katy Abraham, Doc Abraham - Publication Date: January 1992 - List: $13.95
  Synopsis:
  A guide for first-time seed growers addresses soil mixtures, lighting, types of seed, seed-starting kits, and more to help any gardener experience the rewarding feeling of

growing flowers and vegetables from seed. Original.

- Peppers : The Domesticated Capsicums - by Jean Andrews - Publication Date: October 1995 - List: $65.00
  Booknews, Inc. , 04/01/96:
  An updated edition (first, 1984) of an elegantly produced, scholarly reference on peppers--their history and dispersion, biology, taxonomy, cultivation, and medicinal, economic, and gastronomic uses. Illustrated with the author's botanically accurate, aesthetically pleasing paintings that show the blossoms, buds, young peppers, and mature specimens of 34 cultivars. A review of the literature, a photo glossary, and an extensive bibliography add to the volume's reference value. 9x12" Annotation c. by Book News, Inc., Portland, Or.

- Peppers of the World : An Identification Guide - by Dave Dewitt, Paul W. Bosland - Publication Date: January 1997 - List: $19.95

- Plant Propagation : Principles and Practices - by Hudson Thomas Hartmann (Editor), Dale E. Kester, Fred T., Jr. Davies - Publication Date: January 1997 - List: $86.00
  The publisher, Prentice-Hall Career & Technology :
  Hallmarked as the most successful text of its kind, this remarkably thorough text covers all aspects of the propagation of plants - both sexual and asexual - with considerable attention given to human (vs natural) efforts to increase plant numbers.

- Forest Gardening : Cultivating an Edible Landscape - by Robert A. De J. Hart - Publication Date: September 1996 - List: $17.95

- Handbook of Organic Food Processing and Production - by Simon Wright (Editor) - Publication Date: October 1994 - List: $119.00

- Introduction to Permaculture - by Bill Mollison, Reny Mia Slay - Publication Date: November 1997 - List: $16.95

- Profitable Organic Farming - by Jon Newton - Publication Date: June 1995 - List: $36.95

- The New Organic Grower : A Master's Manual of Tools and Techniques for the Home and Market Gardener - by Eliot Coleman, Sheri Amsel (Illustrator), Molly Cook Field (Illustrator) - Publication Date: October 1995 - List: $24.95
  Booknews, Inc. , 05/01/96:
  This expansion of a now-classic guide originally published in 1989 is intended for the serious gardener or small-scale market farmer. It describes practical and sustainable ways of growing superb organic vegetables, with detailed coverage of scale and capital, marketing, livestock, the winter garden, soil fertility, weeds, and many other topics. Annotation c. by Book News, Inc., Portland, Or.

- The Art of the Kitchen Garden - by Jan Gertley, Michael Gertley - Publication Date: January 1999 - List Price: $34.95

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Exotic Livestock Index

Return to the Small Farm Resource

- Buffalo
- Earthworms
- Elk
- Emu
- Llama
- Ostrich

If you have a question, we will post the question in the appropriate contents page to get suggestions from our site visitors.

Questions and suggestions can be sent to us via our Feedback form.

Visitor Questions:

Go to Livestock Page

Livestock related links and mailing lists

Raising Buffalo

Frequently Asked Questions Other Information Sources Return to Exotic Livestock

Frequently Asked Questions:

- What kind of fencing is required to hold buffalo?

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

Warning:

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What kind of fencing is required to hold buffalo?

- **Suggestion A:** What a guy in our area found (by trial and error, which meant going on buffalo roundups at odd hours of the day and night) was that it takes a VERY stout fence to contain buffalo. What he ended up with was an 8' chain link fence on 8x8" posts, with a 4-strand electric fence 4' inside it. A couple years later, he gave up and sold out, to the relief of the neighbors. From what I've read, most successful buffalo ranches count their area in *sections*, not acres.... Buffalo are programmed to roam.
- *Note: According to the Executive Director of the National Bison Association, most bison owners use cattle fencing with maybe a strand of electric wire at the top. If you have a cornfield on one side of your pasture, you may need a more substantial fence but you would with beef cattle also. Bison are not "programmed to roam". Happy, well-fed bison will not get out.*

Related web pages:

- The National Bison Association web site can be visited at www.nbabison.org.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 15, 2002

Frequently Asked Questions:

- What kind of fencing is required to hold buffalo?

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- The National Bison Association web site can be visited at www.nbabison.org.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 15, 2002

Raising Elk

Frequently Asked Questions Other Information Sources Return to the Small Farm Resource

Frequently Asked Questions:

- What is question 1?

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

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What is Question One?

I don't know but the answer would go here.

Related web pages:

- The North American Elk Breeders Association.
- The Colorado Elk and Game Breaders Association.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 15, 2002

Frequently Asked Questions:

- What is question 1?

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

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- The Colorado Elk and Game Breaders Association.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 15, 2002

Raising Emu

Frequently Asked Questions Other Information Sources Return to Exotic Livestock

Frequently Asked Questions:

Other Information Sources:

Warning:

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What is all this Emu hype about?

One of the most recent investments to attract attention in the United States today is Emu Ranching. The Emu is a large, flightless bird (a member of the ratite family) with a wonderful personality and a real market future. They originate from Australia and have always been an important part of Aboriginal life in the Australian outback. The U.S. is presently building a breeder base of emus with the goal of sufficient production to satisfy the consumer market before the next decade. Products derived from the emu include meat, oil, leather and feathers. The meat is a red meat much like beef. It is superior to other red meat because of its low cholesterol, low fat, and high protein value. The oil is an excellent moisturizer and joint rub. It's recommended for arthritis pain, and is very effective on burns.

Are these a worthwhile investment?

One person writes: Emus are NOT A GREAT ALTERNATIVE:

- They require a substantial investment in facilities and stock.10K-50K.for HQ.
- They cost a lot to maintain. $200-300/year not including medical.
- There is only a rapidly declining breeders market. Prices have plummeted in the past year. The meat will never be in demand, even at $1/lb., and the oil is mostly exaggerated claims, with plenty of cheaper substitutes.
- This subject has been well researched, and is clearly a market for dreamers, rainbow chasers, or suckers, with very few exceptions.Ostriches or other ratites are no better.

Related web pages:

- The Idaho Emu Association.
- The Kansas Emu Association.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- **Ratite Discussion List**

  To subscribe, email <Majordomo@uidaho.edu>.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Ratite Management, Medicine, and Surgery - by Thomas N. Tully, Jr.(Editor), Simon M. Shane (Editor) - Publication Date: August 1996 - List: $59.00
  Booknews, Inc. , 12/01/96:
  Compiles the knowledge and experience of veterinary educators and practitioners involved in the commercial production of ostriches, emus, and their near kin in southern Africa. The topics include clinical anatomy, hatchery management, hematology and chemistry, restraint and handling, nutrition, disease control, reproduction, anesthesiology, surgical conditions, parasites, examination and health certification, and jurisprudence. Includes several pages of color plates in addition to many monochrome photographs. Annotation c. by Book News, Inc., Portland, Or.

Periodicals:

- None identified.

This page was last updated on August 31, 2002

Frequently Asked Questions:

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Periodicals:

- None identified.

This page was last updated on August 31, 2002

Raising Llamas

Frequently Asked Questions Other Information Sources Return to Exotic Livestock

Frequently Asked Questions:

Other Information Sources:

Warning:

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What are Llamas?

Llamas, pronounced 'yamuz', are members of the camelid family. The first ancestors of all camels lived in North America more than 40 million years ago. About 2 million years ago, some types of camels left North America and went to Asia. These were the North American Camel, which is now extinct, but all dromedaries and bactrian camels living today descended from these animals. Other types of camels left North America and went to South America. The two types of wild camels living in S. America today are the vicuna (vye-coon-yuh) and the guanaco (whah-knock-o). People used the guanaco to breed two domestic breeds of camel, the alpacas (al-pack-as) and the llamas (ya-muz).

What can Llamas be used for?

They are used for packing into the mountains, well known for their sure footedness and ability to carry up to 1/3 of their body weight. A large male llama can weigh up to 400 pounds with the average being around 350 pounds. They are also valued by hand spinners for their hair that is spun into fine soft fiber. If a llama has been trained for guarding other livestock, they can be of great value to sheep and goat farmers. Many are used today as sheep and goat guardians.

Llamas are very intelligent and curious. They can be trained easily and remember their training forever. They are a great addition to most small farm situations as they are very easy keepers. The maintenance cost is small compared to other large farm animals. They need their toenails trimmed much the same way as a goat, they also need annual vaccinations and need to be wormed on a regular basis. The manure is excellent for gardens, having very similar characteristics to sheep manure.

Do Llamas spit?

Yes, they do spit. However they are most usually aiming at fellow llamas not humans. Unfortunately the most exposure most people get to a llama is in a zoo. These llamas have been given to the zoo because they have been mistreated in some way or another, giving them a definite attitude problem. Female llamas spit at stud llamas after being bred, this is like saying "back off Jack!" Once they spit them off, it's a good sign that they are bred.

Can a Llama be kept by itself?

Llamas are herd animals, which means they must always have a companion animal with them. It doesn't have to be another llama, it can be a goat, sheep, pig, horse, or dog but they are usually happier with one of their own kind.

Related web pages:

- Llama Owners of Washington State

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- A Guide to Raising Llamas : Care, Showing, Breeding, Packing, Profiting (Storey Animal Handbook) - by Gale Birutta - Publication date: May 1, 1997 - List $14.95
  Synopsis:
  A comprehensive handbook on raising llamas, covering

behavior, training, facilities, showing, health care, first aid, breeding, and birthing. Also explains building a herd, fleece harvesting and marketing, pasture management, developing and selling organic fertilizer, and using llamas as guard and expedition animals. Includes source list and glossary. Line drawings.
Card catalog description
Easy to raise, manageable, and increasingly affordable, llamas have become the best new choice for backyard livestock. Uses for these versatile animals include packing, protecting other livestock, and producing fleece and organic fertilizer. Written for both the novice and experienced owner, this definitive handbook includes buying your first llama; building a herd; breeding, birthing, and herd management; feeding and facilities; health care and first aid; llama behavior and training; using llamas as guardian and expedition animals; and trade secrets and marketing tips.

- Llamas on the Trail : A Packer's Guide - by David Harmon, Amy S. Rubin, Nancy Diane Russell (Illustrator) - Publication Date: January 1, 1993 - List: $15.00
  Booknews, Inc. , 08/01/93:
  A charming book--because llamas are that--with abundant advice for the beginner on history, gaits, care and feeding, training, packing. (It is still advisable to make a trip or two with an experienced handler.) Annotation copyright Book News, Inc. Portland, Or.
- The Flocks of the Wamani : A Study of Llama Herders on the Punas of Ayacucho, Peru
  by Kent V. Flannery, Joyce Marcus, Robert G. Reynolds - Publication Date: April 1989 - List: $44.50

Periodicals:

- None identified.

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Periodicals:

- None identified.

This page was last updated on November 15, 2002

Raising Ostriches

Frequently Asked Questions Other Information Sources Return to Exotic Livestock

Frequently Asked Questions:

Other Information Sources:

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General Information:

Although their range was once much broader, today ostrich are found naturally only in the Savannah areas of Africa. There is only one true species of ostrich (Struthio camelus) although several subspecies are recognized.

Ostrich are primarily grazing animals, existing on a variety of plant and brush material. In many instances, succulent plants and fruits also make up a large portion of their diet as do small insects and lizards. Ostrich travel vast distances to obtain sufficient food and water.

Ostrich are equipped with many advantageous features including excellent eye sight, large external ear canals, and powerful legs which allow speeds of up to 40 mph. Because of these features, mortalities in adult ostrich are not thought to be common. By comparison, mortalities in chicks, usually related to predation, are thought to be as high as 90%.

Ostrich reach an adult height of over 7 feet by 16 to 18 months of age. They continue to increase in weight after this time with adult males reaching over 300 pounds. Ostrich may become sexually mature at 2 years of age although males often mature later than females. It is not uncommon for hens to begin laying at 2 to 3 years of age while males may take as long as 4 to 5 years to be functionally mature. In captivity, females may lay as many as 100 egg in a season, although 20 to 40 are more common. Eggs are whitish in color, weigh about 3 pounds (1000 to 1500 grams) and are generally laid every other day. Eggs are typically laid in late afternoon. Although mating may occur numerous time during the day, it is believed that a single mating may be effective for up to a week.

Adult male ostrich are solid black in color with white wing tips while the smaller females are brownish gray. Male ostrich of East Africa have

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

pink or red skin and are often referred to a "red necks", while the more southern ostrich has blue skin and is refereed to as "blue necks". The color of the neck is dependent on the presence of the male hormone testosterone. The color of the feathers is dependent on the presence or absence of the female hormone estrogen. Thus, castrated males will have normal feather color but not the skin color and immature or spayed females will have black feathers.

In North America, the breeding season is from February to October. The mating behavior of the male is quite elaborate with the male sitting on his hocks, moving his wings up and down while throwing his head from side to side. During this time the male will usually makes a thumping sound and will inflate his neck area and create a loud booming noise. The receptive female walks with her head down, popping her beak and shaking her wings ("clucking"). When approached, the female will sit, allowing the male to mount from the back.

The male digs a depression in the ground by sitting and digging with his legs, pushing dirt backwards, forming the nest . Eggs are laid in these nests and the male usually sits on the eggs at night while the female incubates during the day. Wild clutches usually range from 8 to 14 eggs. Both parents are involved with the rearing of the young.

Ranching:

Ostrich have been noted by mankind since the earliest recorded histories. Numerous references and notations exist throughout the bible and ostrich have played various roles in man's history. As early as medieval times, the wearing of ostrich plumes often represented the status of nobility. This trend continued with European nobility through the late 1800's. Feathers were obtained, in most instances, from birds killed in Northern Africa.

Beginning in the mid to late 1800's, ostrich farming in southern Africa emerged and developed into one of the largest businesses in South Africa by the turn of the century. Production in these areas was primarily related to feather marketing and a captive, cross-bred bird was developed that was smaller and more easily handled and produced excellent feather quality. This bird is often referred to as the South African "black" ostrich, a term coined by U.S. ostrich farmers.

The first ostrich were brought into the United States in 1882 and were taken to Southern California. Shortly afterwards, ranching became notable in Arizona, Florida, and Georgia. Production was for feathers for use in the European fashion markets and the decline in the demand for feathers that occurred at the turn of the century ended ostrich farming in North America. Ostrich farming in Southern Africa also

suffered severely with the end of the feather trade. Presently, between 50,000 and 70,000 birds are slaughtered annually throughout South Africa, Israel, Zimbabwe, Namibia, Tanzania, and Kenya primarily for the meat and leather products. Exact figures for the numbers of animals in North America are not available, although ostrich farming has become one of the fastest growing alternative or supplemental agricultural ventures available.

Anatomy:

Ostrich, like all ratites, are flightless, although they do possess wings. The ostrich has a large breast plate that covers the thoracic area and protects the heart and liver. There is no keel and thus, no location for the attachment of flight muscles. The heart, lungs and liver are in the thoracic cavity. The ostrich does not have a gall bladder or crop but instead has a glandular stomach called a proventricculus. This stomach empties into a muscular stomach called the ventriculus. The ventriculus contains grit, rocks and other material that helps break down food and allows it to pass into the small intestine. Because the intestine of the ostrich is abnormally long, the amount of time necessary for food to pass thorough it is also long (36 hours). As in most birds, ostrich posses a cloaca which is a common site for excretion by the urinary tract and the digestive tract.

The respiratory system of ostrich as with all birds, consists of lungs, and a system of air sacs that originate in the thorax and extend into the hollow bones. Not all bones are hollow and some, including the lower leg, have a thick cortex. Ostrich can use the air sac system to reduce body heat by panting. The normal respiratory rate of an ostrich is between 7 and 12 breaths/minute.

The reproductive tract of the male ostrich consists of two testicles. The male phallus or penis is located in the ventral cloaca but unlike mammals, does not contain the urethra. The female reproductive tract consists of a single ovary and reproductive tract with a small clitoris located on the ventral cloaca.

Ostrich have two toes (emu and rhea have 3). The larger clawed toe is actually the third digit while the smaller clawless toe is the fourth digit.

The nostrils of ostrich are located forward on the beak, rather than at the base of the beak as in most birds. The trachea or wind pipe is large and located in the lower part of the mouth. The esophagus is above the tracheal opening and extends down the right side of the neck. There is one large jugular vein that runs down the right side of the neck.

Facilities:

Chicks:

Young chicks can be maintained in a variety of suitable facilities. A small portable pen, 12 feet long, 4 feet wide and 2 foot high can be adequate for a number of chicks. The pen is placed on short cut grass and moved daily. Chicks are brought out to the pen after the temperature reaches above 60 F and the sun is shining. Birds can be maintained in this type of facility until the temperature drops or until weather is prohibitive. Include some type of shade and wind break as young birds are sensitive to extreme sun and wind.

Young birds should be brought indoors in the evening and maintained in a heated environment until at least 2 to 3 months of age. Temperature in indoor shelters should be maintained at least 65 F and enough room to allow the birds to exercise should be provided. In areas where weather is more severe, this period may need to be extended.

Do not provide feed at night but available water is acceptable. Feed the young birds as outlined in CARE OF YOUNG BIRDS section, prior to turning them out in the morning.

Juveniles:

Juvenile birds between 3 and 10 months of age can be maintained in a similar, but larger facility as young birds. For convenience, access to the indoor facility should be available directly from the outdoor pens. However, shelter is not needed except in extremely cold areas. The amount of space per bird, for both indoor and outdoor facilities should be increased for this age bird as compared to that available for younger chicks. Outdoor pens can be of any type of substrate but ground cover such as grass, clover, or alfalfa is ideal. Grass should be kept at a closely mowed level, especially when grass begins to dry out or turn to seed, as impactions are more common at this time. Daily mowing may be necessary during some periods of the year.

Adults:

Pens and facilities for adults vary considerably. Most ranchers maintain adult pairs or trios in facilities that range from five thousand square feet to an acre or more. In general, the more room that can be provided, the better the situation. Common fences and line of sight access to neighboring pairs is often desirable but may not be practicable with overly aggressive males.

Housing or shade is usually provided although not always utilized. If birds are accustomed to being fed and watered in a shed they will be more easily confined when necessary and may build the nest and lay indoors. Alley-ways for movement of birds from pen to pen, access for haling, and provisions for confinement for veterinary care should be

considered at the time of construction. Although suprising, most ratites do not require indoor shelter once over 6 months of age and often refuse to use such structures, independent of weather.

Fencing is dependent on personal preference and economics. Chain link is good but may result in problems related to leg and foot injures and is not easily climbed if escape from the pen by egg gatherers is necessary. Tubular "cattle" type fence is suitable and offer some benefits and others types of woven wire fencing are routinely used.

Many ranchers are now utilizing group pens consisting of several males and numerous females in larger acreage. This appears to provide some benefits and is more nearly similar to a natural situation. Early results indicate that increased fertility, more egg numbers, and extended laying periods can be expected in this type of set up. Several acres of enclosed pasture are needed for this type of operation. Difficulties with a group breeding situation include the inability to determine exactly the resultant chicks parentage.

Eggs:

Ostrich generally lay eggs every other day. Studies have shown that storing eggs for a period of from 7 to 10 days generally results in better hatchability and egg storage is recommended. Eggs can be gathered daily, placed either on their side or upright, and maintained at between 65 and 70 F. Eggs should be turned several times a day.

Collection of eggs and proper handling is important to successful hatching. Many producers use disposable gloves to handle and gather eggs. Others use a similar idea employing disposable plastic bags while still others simply wash and clean their hands thoroughly before handling eggs. Which ever the case, the idea is to prevent unnecessary contamination of the egg.

Many products are available for cleaning and sanitizing eggs once collected. A variety of dips, sprays, and similar products are marketed and used widely. While the use of such agents is heavily debated, should contamination problems occur, the use of cleaners and sanitation products can be effective. If dips, sprays, or washes are used, read the directions carefully and follow the recommended procedures outlined by the manufacturer.

Eggs laid in wet weather are the most likely to become contaminated. This is usually the result of soil bacteria being taken into the egg while the egg is sitting in water or mud. Occasionally, reproductive tract infections in the hen can also result in bacterial contamination of the egg. A complete bacteriologic examination by a veterinary diagnostic laboratory can provide insight into these problems and is strongly

recommended when an abnormally large number of eggs are contaminated.

Many new products which sterilize the egg shell, the air or the working area in the incubator room now available to producers. These products all have merit when attempting to correct a diagnosed contamination problem. The use of these products as a eans of preventing potential contamination can be considered in any operation's biosecurity plan.

Incubation:

Often, the facilities in which the incubation equipment is kept is as critical as the equipment itself. Although there are no strict requirements that will insure successful incubation, there are several factors that should be considered.

1. Facilities should be capable of being maintained at 65 to 70F.
2. Outside fresh air exchange should be at least 20%.
3. Humidity should not exceed 45%
4. Traffic and personnel should be maintained at a minimum with as few people as possible entering the facility.
5. Floors and walls should be of such a construction to allow daily cleaning and washing.
6. Additional air movement within the room should be supplied by portable fans or some similar mechanism.

The hatching process in ostrich, as in all birds, begins when the egg cell is expelled from the ovary of the hen. When the ovum passes into the oviduct of the female, it begins to mature and if spermatozoa are present, fertilization occurs. As the egg continues down the oviduct, the viscous albumin (egg white) , papery shell membrane and hard outer shell are progressively secreted by the lining of the duct. Even before the egg is laid, the formation of a visible embryo has begun and appears as a whitish disk on the surface of the yolk. Additional development does not occur until incubation at the proper temperature. The egg is fully formed and ready to be laid about 24 hours after it is discharged from the ovary.

Hatching:

Eggs should be allowed to hatch on their own or help should be given only under duress and the help should be minimal. What ever the circumstances, it is important to allow the chicks to exit the shell on their own. At the time of internal pipping, the bird has not yet internalized all of the yolk material and the blood vessels that are attached to the inside membranes of the shell have not dried up

sufficiently to allow the bird to hatch normally. The final process of exiting the shell may take many hours to several days, depending on the vigor of the bird. It may be necessary to remove pieces of sharp shell or to remove dried membranes to assist the chick in this process. Birds taken out of the shell prematurely (right; rhea) often have incompletely internalized yolk sacs and are often subject to umbilical and yolk sac infections.

Once the bird has completely exited the shell, treat the umbilical area with liberal amounts of 7% Iodine. This will help disinfect the area, prevent bleeding, and minimize bacterial contamination.

After Hatching:

The newly hatched chicks can be placed into a brooder as soon as they are dry or as soon as several birds in any batch have hatched and are ready to be removed from the hatcher. The brooder may be kept in the same room as the hatcher.

Numbered leg bands are placed on the birds and they are weighed at the time they are placed into the brooder. No food or water is provided until they are 6 to 8 days of age. This allows the birds to absorb any fluid that is in the tissues and requires that the bird begin to utilize the yolk material. Birds that have excessive water in the tissues ("wet" chicks") (see above picture) are held for longer periods without food or water. Chicks have been kept up to 10 days with no notable problems. All birds are taken out and placed on grass or dirt, as soon as weather permits to further stimulate water absorption and to encourage activity.

Often wet chicks have difficulty placing their legs under them at this stage and a condition called "spraddle leg" develops. Most birds can be treated by hobbling the legs together in a normal position with tape, tubing, or Vetrap until the chick is able to stand on its own (usually one to two days). Treatment is almost always successful if the condition is detected early. Care must be taken when hobbling birds in the brooder as they may turn onto their back and will be unable to right themselves.

Our brooder box is constructed of stainless steel so that it can be sanitized easily. It is 4 feet long, 2 1/2 feet wide, with 3 foot sides. The temperature in the hatching -brooder room is 75-78 F. Additional heat is provided for the brooded chicks with a single heat lamp directed in one corner of the brooder box. A washable mat (Nomad entrance carpet, 3M Inc) is used on the floor of the brooder. This type of flooring is ideal since it is easily cleaned, can't be eaten, and provides support for the chicks during the first few days while still allowing a clean dry surface.

Chick Care:

After the chicks are removed from the brooder, they are placed on grass in a portable pen for as long as weather permits. The grass in the pen area is cut short and the pen is moved daily. Birds are brought back indoors nightly and maintained as described for brooding during the first week. Only water is provided at night.

Before birds are placed out in the morning, feed is provided for a one hour period. Birds are then placed in the portable pen. Supplemental feeding of cut alfalfa or clover is provided several times daily. Birds are provided pelleted feed 3 times per day for 1 hour time periods. The availability of pelleted food is limited for this age bird because we feel it helps to stimulate the use of the yolk material by the birds and reduces the incidence of bacterial enteritis that often results from continuous feeding. Using this feeding schedule, birds loose about 0.25 to 0.50 pounds of their hatching weight during the first week, then they return to or slightly exceed their hatching weight by the second week, gain about 0.50 pound by the third week and double their birth weight by one month. After this, gains of nearly 0.5 pounds per day are not uncommon with a 3 month old bird weighing 30 pounds.

When chicks are 6 to 7 days of age, reexamine the umbelical area to determine if further treatment is needed. At this time, a small "knot" or bump can often be detected at the umbelicus. This is usually what remains of the umbelical vessels and can be the source of bacterial infection that may result in umbelical and yolk sac infections. To treat this condition, simply feel the umbelical area and remove the scab that has formed on the umbelicus (below left). Apply pressure with your fingers from the belly outward, and the potential infected material will be easily expressed (below, right). Retreat this area with 7% iodine and return the bird to its original facility. No further treatment is usually needed.

Nutrition:

The area of nutrition for ostrich has been a major concern for producers since the beginning of ostrich ranching. Few detailed studies have been performed and much is still unknown about optimum diets. This may perhaps be due to the fact that ostrich prefer a varied and diverse diet, consisting primarily of plant material. This type of diet may be difficult to duplicate in a pelleted form.

Animals do not utilize feed as such but rather the nutrients contained in the feed. However, not all animals require the same nutrients. Nutrients that are required include:

1. Carbohydrates

2. Proteins or amino acids
3. Vitamins
4. Minerals
5. Fats and oils
6. Water

The concentrations of these nutrients vary considerably in different plants and it is for this reason that commercially prepared feed mix various sources of ingredients in order to meet differing nutritional requirements.

Research findings have shown that chicks up to six month of age do well on the pelleted diet that is produce at O.S.U. The general composition and formulation of this feed is similar to that produced by several feed companies with the exception that this diet is a 18% protein and 16% fiber. The protein component is sufficient to provide good growth without producing leg or bone development problems and the high fiber content has proven to be of value in maintaining good fecal consistency and reduces bacterial enteritis while still allowing adequate consumption for good growth rates.

Growth Rates:

Age in weeks	Average gain in pounds
2-3	1.3
3-4	2.8
4-5	2.4
5-6	3.3
6-7	3.3
7-8	4.4

With the limited feeding program outlined in the Care Of Newly Hatched Chick section and the supplimentation of birds with available green forage such as alfalfa, grass, clover, etc., growth and development should not be a problem. Care must be taken that feed is stored properly to prevent mold or other contamination problems and that it is fresh enough that all vitamin and supplementations are still available.

Birds that are provided forage such as alfalfa or grass, should also be provided access to grit and gravel. The size of the gravel can be varied with the size of the bird but access to it is necessary for both breakdown of the feed and normal function of the proventriculus. Oyster shell should not be used as grit as it breaks down rapidly and may change the calcium/phosphorus balance that was provided by the diet being fed.

Diets for adult birds can be similar to that used for chicks with the

exception that laying birds should have a calcium/phosphorus ratio sufficient to compensate for egg production. Consult your Veterinarian and/or feed company representative for specifics on available feeds.

It is beneficial to maintain production age birds on a maintenance diet during the non-laying period that differs from that used during the laying period. This maintenance diet should allow the bird to maintain but not gain weight and perhaps even loose (not more than 5-10% body weight) during the non-laying period. Beginning about 2 months before the laying period, the higher protein, more balanced laying diet can again be given to boost the birds prior to laying and breeding.

Identification:

There are numerous options available to producers for identifying ostrich. The most common method of identifying young birds is by the use of plastic numbered leg bands. These bands can be placed on the birds at hatching and will be useful for several weeks. Larger bands are available for juvenile and adult birds that can be adjusted to the size of the lag as the birds grow.

Many producers use microchip identification as a method of identifying birds. Birds can be microchipped at hatching by implanting the small chip under the skin (often placed in the pipping muscle of the neck at this time). This method is useful in both identifying birds on the ranch and also for locating and identifying lost or stolen birds. Many insurance companies require microchip identification. Microchip birds at one month of age. Locations for implanting the microchip include the hip muscle, the muscle on the back just above the tail and the area between the wings. Several companies produce both microchips and readers. Unfortunately, different products are not totally compatible. Consequently, different readers are required for different chips.

There are also now companies that provide DNA fingerprint identification. This procedure involves analysis of blood from your bird that is used to identify that bird from all other birds.

Sexing:

Because different plumage of male and female ostrich is not apparent until the birds are nearly two years of age, sexing young birds by visual examination of the phallus (present in both sexes) is necessary. Sexing ostrich can be done at any age but we have found that examination at 1 to 2 months is best. Examination of birds younger than this is often more difficult, and examining older birds usually involves both restraint and internal examination.

The birds can be examined while standing or while held by a second person. The examiner simply pulls up on the tail of the bird and with the other hand applies pressure on the cloaca area. By gently applying pressure from the bird outward, the cloaca will be inverted and the phallus (which rests on the floor of the cloaca) will be expressed. The male phallus is larger, curved and more cartilaginous than that of the female. In order to become proficient at this type of examination, do several birds and compare the difference. After a little practice, this procedure will become easily mastered and more than 95% of the birds of this age can be accurately sexed. In some instances, the difference will not be as notable and these birds should be reexamined at a later time to confirm your earlier decision.

There are also companies that provide a recombinant DNA sex determination for ostrich.

Diseases:

The Following is a listing of all diseases and disease agents that have been positively identified and reported in the scientific literature. Because of the relative newness of this industry, this list will surely increase as more information is gathered. At the present time, tentative, but not confirmed, reports exist of other potential diseases that could effect ostrich. You should work closely with your Veterinarian and a state or federal diagnostic laboratory when ever you suspect disease problems or are concerned about the introduction of agents onto your ranch.

Nematode:

- Paronchocerca struthionus. A filariad nematode recovered from the lungs of an ostrich in West Africa. An incidental finding in a bird that died of other causes. Pathogenicity unknown.
- Struthiofilaria megalocephala. Several reports of nematodes from body cavity of ostrich. Pathogenicity unknown but possible.
- Lipostrongylus douglassi. Intestinal nematode of ostrich. Reported susceptible to antihelminthic treatment with fenbendazole.

Cestode:

- Houttuynia struthionis. Intestinal tapeworm of ostrich. Reporting of efficacy of fenbendazole.

Trematode:

- Philophthalmus gralli (eye fluke) reported to cause severe eye irritation and discharge in captive ostrich in Florida.

Protozoa:

- Hexamitiasis. Reported identifications of intestinal infections with possible pathogenicity in young ranched ostrich in North America.

Arthropods:

- Struthiolipeurus nandu (Mallophagan louse) infestation in ostrich causing feather loss.
- Unidentified feather mite belonging to family Pterolichidae infesting ostrich in North America causing feather loss. Successfully treated with Ivermectin.
- Numerous ticks of various life stages reported to infest ostrich.

Viral diseases:

- Newcastle disease virus in ostrich reported in ranched ostrich in Israel. High mortality reported with viral isolation from brain.
- Pox virus recovered from skin lesion in Israel.
- Spongyform encephalopathy in a ranched ostrich.
- Crimean-Congo Haemmorrhagic Fever Virus. Report of virus isolation from human thought to have acquired infection from handling slaughter ostrich or ticks off the ostrich in South Africa.

Bacterial Diseases:

- Staphylococcus hyicus in an ostrich causing conjunctivitis.
- Colobacillosis responsible for mortalities in young ranched ostrich.
- Tuberculosis in ostrich and other ratites.
- Pasteurella multocida infections in ostrich in Nigeria resulting in generalized and pulmonary infections.

Fungal infections:

- Aspergillus infections reported in Ostrich.

Nutritional and metabolic diseases:

- Vitamin E and selenium deficiencies in ostrich from South Africa.
- Parsley-induced photosensitivity in captive ostrich.
- Anasarca and myopathy in ostrich chicks.
- Nutritional muscular dystrophy in ostrich chicks.

Medical Management:

Antibiotics:

There are no antibiotics that are available today that have been tested

sufficiently on ostrich. As a result, the use of specific antibiotics should be the decision of your Veterinarian and should be based on a complete understanding of the problem, bacterial isolation attempts and antibiotic sensitivity testing. The following are a listing of some commonly used antibiotics that have been reported to be effective in some instances:

- Amoxicillin (Smith Kline Beecham) 5mg/lb
- Amikacin Sulfate (Aveco) 5 mg/lb
- Batryl (Miles, Inc) 1.13mg/lb
- Gentamicin (Schering-Plough) 2 mg/lb
- Sulfadimethoxine (Burns Vet Supply) 12.5 to 25 mg/lb
- Tetracycline 7.5 mg/lb
- Tribrissen (Cooper Animal Health Inc) 2ml/kg
- Trimethoprim
- Sulfadiazine 48% (Pittman Moore) 20 mg/lb

Anthelmintics:

A complete parasite evaluation should be performed on all birds on a routine basis. Anthelminthic treatment should only be conducted when specific parasites are identified and not used on a prophylactic basis. Complete examination for ectoparasites should include visual and microscopic evaluation for lice, mites, and ticks while both simple smears and concentration procedures (flotation) should be performed on feces for intestinal helminths.

As was the case with antibiotics, there are no anthelminthics that are approved for ostrich. Several have been evaluated in trials and shown to be effective:

- Fenbebdazole (Panacur 2.5%, Hoechst) 15 mg/kg . Efficacy against nematodes and perhaps cestodes.
- Ivermectin (Ivomec, MSD/Agvet) 200 mglkg . Efficacy against nematodes and some ectoparasites.
- Carbaryl dust (5%) (Security %% Garden Dust, Security Products Co,) Efficacy against lice.

Clinical Pathology:

The use of hematology in determining the health status of birds is becoming a more routine practice as data is becoming available. Many insurance companies are requiring some type of testing prior to insuring birds and many Veterinarians are using a series of tests to identify both clinical and subclinically ill animals.

There are two groups of tests that are routinely used; 1) complete blood counts (total white blood cell, total red blood cell, hematocrit or packed

cell volume, hemoglobin, and differential white blood cell counts and 2) clinical chemistries (Glucose, blood urea nitrogen, cholesterol, triglicerides, ...). Complete blood cell counts are often useful in identifying ongoing infections, problems related to anemia and dehydration while serum chemistries are useful determining problems with specific organ functions, electrolyte imbalances, and to evaluate treatment effects.

Under most circumstances, the drawing of blood for these tests is not overly stressful for the birds and with good facilities and experience, little or no adverse effects will be noted as a result. The proper handling of the samples and the interpretation of the results are essential, however, for an accurate evaluation of the status of the bird.

Table 1 Provides normal complete blood values for adult ostrich while Table 2 lists normal serum chemistry values.

Although the interpretation of the information provided by these tests should be conducted by your veterinarian, several general rules should be noted.

Complete cell counts:

- White blood cell counts (WBC) over 14,000 are a general indication of ongoing acute or chronic infection. Counts over 20,000 may be the result of excitement during the handling process.
- The packed cell volume (PCV) for adult ostrich (30-40 %) is generally lower than that seen in most other birds. Juvenile birds will have a lower PCV than adults.
- Total Red Blood Cell Counts (RBC) for ostrich are slightly below the average for other birds.
- Hemoglobin and hematocrit values for adult ostrich are higher than that seen in juvenile birds.

Clinical Chemistry:

- Juvenile ostrich have lower calcium and magnesium values than that seen in adult birds.
- Immature birds have higher total protein, uric acid, and potassium levels than do adult birds.
- Immature ostrich have higher uric acid levels than do adults.
- Obese birds have trigliceride values in excess of 400.
- Calcium levels in laying hens should be greater than 14.

Table 1. Hematologic values (Complete blood counts) for clinically normal adult ostrich:

Parameter	Mean	Value

White blood cells	(103/ul)	5.5 to
Total red blood cell	(106/ul)	1.5
Hematocrit	(%)	30-40
Hemoglobin	(mg/dl)	12-15
Triglicerides	(106/ul)	1.7

Table 2. Mean Serum Chemistry Values For Clinically Normal Adult Ostrich:

Parameter	Mean	Value
Albumin	(g/dl)	1.3 - 2.5
Billirubin	(umol/L)	6.0
BUN	(mg/dl)	1.2-1.8
Cholesterol	(mg/dl)	82-97
Glucose	(mg/dl)	215-245
Phosphorus	(mg/dl)	4.4-5.2
Calcium	(mg/dl)	9.5-13
Total Protein	(g/dl)	3.7-4.7
Triglycerides	(mg/dl)	90-130
Urea	(umol/L)	0.4
Uric acid	(umol/L)	460-490

Toe and Leg Problems:

Rolled toes:

This is a condition usually seen in birds under 2 weeks of age where the toe itself is rolled to one side. In this instance, the toe nail points to one side. This condition is usually the result poor substrate during brooding, Improper incubation conditions, or occasionally, improper nutrition in the hen.

Treatment is easy and usually 100% effective is delt with early. See the section on Correcting Rolled Toes for details on treatment.

Deviated toes:

This condition is one seen in growing birds that is usually the result of some form of trauma to the toe. Generally the bird can walk on the pad of the foot but the toe projects to one side at the joint.

This condition can usually be treated with good success by surgical manipulation. If diagnosed early, and if the break can be treated and

cast so that the bird can walk, correction is usually successful. Early treatment is essential for success.

Turned or crooked legs:

This problem involves the twisting of the entire bone resulting in the foot pointing outward. The appearance of this problem can often be quite rapid with notable rotation occurring within a few days. Although there are not good studies to document the actual cause of all cases, based on similar problems in other animals, it appears that the primary causes are related to nutrition, exercise, and growth rate.

There does not appear to be any good treatments available at this time. Surgical intervention has not proven useful and other efforts are equally unsuccessful. The prevention of the condition appears to be the best opportunity for the rancher. Limited feeding, feed with protein levels below 20%, a balanced feed suitable for proper bone growth, and proper activity levels for young chicks are all essential in preventing this problem.

Slipped tendons:

The two most commonly seen tendon problems are with the heel and hock tendons. The problem arises when the tendon that runs down the back the leg, the back of the heel and to the tow (heel tendon) or the tendon that runs down the groove in the rear of the hock (hock tendon) slips out of the groove that hold them in place. The most common cause of this condition is some form of trauma, poor flooring or footing, or improper exercise.

Most cases can be treated successfully with surgery. Care must be taken to minimize the damage to the tendons after they have slipped out of their normal position. Wrapping the bird, minimizing the use of the legs, and early treatment will increase the chances of success.

Bowed legs:

This condition is one in which the toes of the chick point in the correct direction but the leg bones bow either inward or outward. The condition us generally caused by improper diet especially excess vitamin supplimentation and perhaps too rapid of an early growth rate.

There is no suitable treatment other than to improve the diet and change the feeding program.

Correcting Rolled Toes:

The toes of ostrich occasionally roll to one side. This is often the result of either incubation conditions or less than ideal flooring for the young birds during brooding. Although this is not a life threatening situation, it

is not desirable and will often influence the price and value of the birds. The situation can be easily corrected.

We wait until he birds are at least 2 weeks old before attempting to correct these rolled toes. At this age the birds are usually active, eating, and mobile enough to attempt to correct this situation while younger birds may become more easily stressed.

Place the toe that is rolled on a flat wooden stick (tongue depressor) and position it so that is it correctly aligned. Wrap the toe in this position with non-sticky tape (VetRap) being sure that it is aligned correctly. Place a second stick at the front of the first one forming a "T" and fasten the two sticks together with tape. The bird can now be placed back with other similar aged birds and allowed to walk on this "T" for one or two days. This is usually sufficient to correct most situations. Try to keep the bandage dry and free of fecal material. If additional correction is still needed, repeat the procedure, never allowing the wrap to be on for more than a few days. Do only one toe at a time on birds with multiple problems.

Digestive Problems:

Impactions:

Impactions are one of the most frequently seen problems in growing chicks up to adult hood. There are two types of impaction problems. One being acute or newly acquired impactions and the other being chronic or long standing impactions.

Acute impactions are generally those that result from a bird eating too much unusable material vary rapidly. This type of impaction can occur on sand, dirt, rocks, gravel, grass, etc. Death in these instances is often quick due to the overextended and non-functional condition of the proventriculus.

Chronic impactions usually result from the bird having a partially impacted proventriculus which allows some material to pass through normally. This can result from consumption of material like grass, rocks, sand, etc. or some larger foreign body that would partially block the proventriculus. These birds do not gain weight normally, are often eat excess non-food material such as sand, dirt, etc. and often appear malnourished.

Many birds develop this type of problem when confronted with new situations. Moving into new pens, changing diets, excess stress including movement, feed changes, or diseases may initiate the abnormal eating habits and contribute to the problem.

Early treatment with some form of oral lubricant such as mineral oil,

etc. can often help to breakdown some of this material and get the bird back to a normal diet. More commonly, surgical intervention is necessary to remove the impacted material. If diagnosed early, surgical intervention can be vary successful.

Foreign body ingestion:

Much like impactions, birds of all ages will often eat almost any type of object. In many of these cases, the objects are non-digestible and can sit in the proventriculus and impair normal food movement. Objects such as nails, plastic, knives, tools, etc. are eaten by curious birds. In most cases, as long as the object does not damage the intestine wall or puncture the proventriculus, the foreign object may be eventually digested and passed through the digestive tract. If it is too large and blocks the normal activity of the proventriculus, a chronic impaction may result.

Surgical intervention is usually successful in correcting this problem. Again, early diagnosis and surgery is essential.

Surgery generally requires a pre-anesthetic followed by gas anesthetics. After surgical preparation including clipping all feathers along the midline of the xiphoid (breast bone) cartilage, an incision is made along the midline starting at the xiphlid cartilage. The proventriculus, located on the left side, is pulled through the incision. The proventriculus in opened and the contents completely cleaned out. The contents of the ventriculus can also be removed by manual manipulation and pressure at this time. Care should be taken not to contaminate the abdominal cavity during the initial incision and the air sac during cleaning of the ventriculus and proventriculus.

Surgical gut (2 layers) are recommended to close the proventriculus and the abdominal wall while non-absorbable sutures are used on the skin.

Supportive treatment including oral fluids are helpful for the first several hours after surgery along with antibiotic therapy.

Prolapses:

Young birds often develop prolapses of the rectum. This can be a serious problem and requires immediate attention. The condition often occurs in birds with diarrhea and results from straining during defecation. The prolapse can easily be replaced and sutured in place. Early diagnosis and treatment are essential but with them, good results can be anticipated.

Occasionally, older males will develop a prolapsed phallus. In this instance, the phallus will not be retracted into the cloaca and mechanical damage, exposure to cold, etc. can result.

Treatment usually consists of confinement, cleaning and lubrication of

the phallus. Surgery is usually not required and may be contraindicated.

Yolk Sac Infections:

Umbilical infections are often one of the most common causes of moralities in chicks up to 2 weeks of age. Many of these infections result from over ambitious handling of hatching chicks, poor sanitation in the hatcher, or contamination of the umbilical area after hatching. Proper treatment of newly hatched chicks and proper hatching procedures can reduce losses due to these type of infections. See section on CARE OF NEWLY HATCHED CHICKS for procedures to deal with prevention of umbilical infections.

Yolk sac infections are generally due to the same problems as are umbilical infections. Many times the yolk sac becomes infected as a result of the umbilical area being infected. Proper care and handling of newly hatched chicks can minimize these infections.

Yolk sac removal:

The removal of the yolk sac in young chicks involves a surgical procedure that totally removes both the yolk sac and the umbilical stump. Although this procedure has been widely used to eliminate yolk sac infections in the past, it is not a common practice now and the overall results of this type of surgery may not be good.

The yolk sac of young chicks may not be absorbed during the proper time period and this can create a problem with the developing chick. Normally, the yolk sac is completely absorbed in ostrich by 18 to 20 days after hatching. If it is not, death may result. The condition is most notable around 10 day to 2 weeks after hatching when the chick appears distended, acts weak, and is less active than others.

The removal of the yolk sac should be a last effort since the yolk material is necessary for providing both nutrition and antibody to the young bird. The prevention of this problem by stimulating the chick to use this material is the most beneficial treatment. Consult with your veterinarian on how to manage young birds to insure better yolk absorption and to help diagnose those birds with yolk sac retention and infections.

Surgical procedure usually involves anesthetizing the bird with Isofluorane, Halothane or Metofane. The feathers on the entire abdomen are clipped and the area is surgically prepped. An incision of about 2 inches is made completely around the navel, completely removing it (Note that it is still attached to the yolk sac and care should be taken not to rupture the yolk sac). The yolk sac is then tied off next to the intestine and the yolk sac removed. The abdomen is sutured with

gut and the skin with non-absorbable suture. Flushing the abdominal cavity with warm saline (PBS) is usually helpful in maintaining temperature and antibiotic therapy is recommended.

Chicks can be returned to their familiar surroundings as soon as recovered from the anesthesia.

Respiratory Diseases:

Respiratory diseases are most common in juvenile and young adult birds. Vary often, respiratory problems are seen in birds recently moved, new introductions, or birds under other stresses.

Nasal discharge, ocular discharge, or swelling below the eye are all good indications of a developing respiratory problem. Diagnosis, testing and treatment should be considered at this point to prevent further development that might include more serious air sac infections or pneumonia. More severely infected birds will show signs of labored breathing (even at rest), increased respiratory rate, and ruffled feathers.

Both developing and severe respiratory infections are difficult to diagnose until late in the infection. Fungal infections (Aspergillus) and bacterial (Pasteurella, E. coli) and/or Mycoplasma infections are usually what are diagnosed either by laboratory culture or at post mortum examination.

Treatment including the use of systemic antibiotics that have been shown to be sensitive to the agent involved, vitamin and nutritional supplimentation, and supportive care are often successful if a diagnosis is made early.

Aspiration pneumonia is occasionally seen as a result of forcing fluids or the regurgitation of fluids into the trachea and lungs. This may happen as a result of improper administration of oral fluids or medication. Consult your veterinarian for proper administration of any fluids to any age bird.

Anesthetics and Tranquilizers:

Inhalation anesthetics used during surgery include Isoflurane (3-4%) or Halothane. Young birds can be masked down or intubated without a preanesthetic. Larger birds usually require preanesthetics before intubation.

Injectible anesthetics include Telazol (1mg/lb IV), Rompon (Haver) (3mg/kg)/Ketamine HCl (Fort Dodge), or Rompon (0.5 mg/lb)/Telazol (1.5mg/lb).

Vaccinations:

At present, there are no recommended vaccination programs for ostrich. Vaccination for Eastern and Western Encephalomyelitis and Clostridium perfringens Types C and D may be useful but not thoroughly tested. Both require a initial inoculation, a booster in 2 weeks and annual boosters. Consult your veterinarian for specifics.

Handling and Transporting Birds:

Young birds up to two months of age can generally be picked up while supporting the chest with one hand and placing the other hand on the back, leaving the feet to dangle below. This age bird can also be easily handled and transported by wrapping them in a large towel. The wrapped bird can often be handled for various treatment purposes and transportation more safely than allowing it to try to stand and walk in a moving vehicle.

Juvenile birds (4 to 8 months) are generally too large to pick up but can be walked and guided by one person by grasping the tail with one hand a wing with the other. Do not lift the birds by the wings, however. More effectively, two people can maneuver this size bird by one person getting behind the bird and lifting on the rump while holding the wing(s) while the other holds the neck and/or beak and directs the bird from the front. Adult birds can also be moved this way, once hooded, and generally require little more effort than the juvenile bird.

Care of Ostrich Hide at Slaughter:

If attempting to save an ostrich hide from a bird that has been slaughtered or died on the ranch, the following procedures should be followed:

1. Do not pluck the feathers from the bird but cut them off with heavy pruners or clippers.
2. To remove the skin, make the first incision on the inside of one leg, cutting up the leg, across the chest and down the inside of the other leg. Cut around the leg at the small portion of the leg at the end of each incision.
3. Cut around the chest plate beginning your incision at the plate continuing to the rectum. Cut around the rectum.
4. Going back to the chest plate, cut up the neck. Now cut around the neck at the end of the cut.
5. Beginning at the rectum, pull the skin off. When you get to the wings, cut a circular incision around each wing and pull the skin

over the wing (leaving a whole where the wing was.) Many people prefer to use a air compressor, inserting a hose into one leg thorough a small hole in the skin. By holding a hand around the incision, creating an air tight effect allow air pressure to built up to 100 pounds psi. The skin will soon pop up from the carcus.

6. Place skin in brine solution made by using 40 gallons of water with 1 1/2 gallon of chlorax bleach, 10 pounds table salt, and 2 cups of Borax. Leave skin in solution 3 to 5 days then scrape off excess fat, meat, etc with a large spoon. An alternative method would be to simply apply salt to the hide and scrape off excess meat, fat, etc. as it dries out.
7. Air dry the skin for 24 hours and cover skin with salt. Leave salt on for 2 days and remove excess when all water is gone.
8. Hide can now be sent after rolling. Do not freeze hide after salting.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Ratite Management, Medicine, and Surgery - by Thomas N. Tully, Jr. (Editor), Simon M. Shane (Editor) - Publication Date: August 1996 - List: $59.00
  Booknews, Inc. , 12/01/96:
  Compiles the knowledge and experience of veterinary educators and practitioners involved in the commercial production of ostriches, emus, and their near kin in southern Africa. The topics include clinical anatomy, hatchery management, hematology and

chemistry, restraint and handling, nutrition, disease control, reproduction, anesthesiology, surgical conditions, parasites, examination and health certification, and jurisprudence. Includes several pages of color plates in addition to many monochrome photographs. Annotation c. by Book News, Inc., Portland, Or.

Periodicals:

- None identified.

This page was last updated on November 15, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

General Information:

Although their range was once much broader, today ostrich are found naturally only in the Savannah areas of Africa. There is only one true species of ostrich (Struthio camelus) although several subspecies are recognized.

Ostrich are primarily grazing animals, existing on a variety of plant and brush material. In many instances, succulent plants and fruits also make up a large portion of their diet as do small insects and lizards. Ostrich travel vast distances to obtain sufficient food and water.

Ostrich are equipped with many advantageous features including excellent eye sight, large external ear canals, and powerful legs which allow speeds of up to 40 mph. Because of these features, mortalities in adult ostrich are not thought to be common. By comparison, mortalities in chicks, usually related to predation, are thought to be as high as 90%.

Ostrich reach an adult height of over 7 feet by 16 to 18 months of age. They continue to increase in weight after this time with adult males reaching over 300 pounds. Ostrich may become sexually mature at 2 years of age although males often mature later than females. It is not uncommon for hens to begin laying at 2 to 3 years of age while males may take as long as 4 to 5 years to be functionally mature. In captivity, females may lay as many as 100 egg in a season, although 20 to 40 are more common. Eggs are whitish in color, weigh about 3 pounds (1000 to 1500 grams) and are generally laid every other day. Eggs are typically laid in late afternoon. Although mating may occur numerous time during the day, it is believed that a single mating may be effective for up to a week.

Adult male ostrich are solid black in color with white wing tips while the smaller females are brownish gray. Male ostrich of East Africa have pink or red skin and are often referred to a "red necks", while the more southern ostrich has blue skin and is refereed to as "blue necks". The color of the neck is dependent on the presence of the male hormone testosterone. The color of the feathers is dependent on the presence or absence of the female hormone estrogen. Thus, castrated males will have normal feather color but not the skin color and immature or spayed females will have black feathers.

In North America, the breeding season is from February to October. The mating behavior of the male is quite elaborate with the male sitting on his hocks, moving his wings up and down while throwing his head from side to side. During this time the male will usually makes a thumping sound and will inflate his neck area and create a loud booming noise. The receptive female walks with her head down, popping her beak and shaking her wings ("clucking"). When approached, the female will sit, allowing the male to mount from the back.

The male digs a depression in the ground by sitting and digging with his legs, pushing dirt backwards, forming the nest . Eggs are laid in these nests and the male usually sits on the eggs at night while the female incubates during the day. Wild clutches usually range from 8 to 14 eggs. Both parents are involved with the rearing of the young.

Ranching:

Ostrich have been noted by mankind since the earliest recorded histories. Numerous references and notations exist throughout the bible and ostrich have played various roles in man's history. As early as medieval times, the wearing of ostrich plumes often represented the status of nobility. This trend continued with European nobility through the late 1800's. Feathers were obtained, in most instances, from birds killed in Northern Africa.

Beginning in the mid to late 1800's, ostrich farming in southern Africa emerged and developed into one of the largest businesses in South Africa by the turn of the century. Production in these areas was primarily related to feather marketing and a captive, cross-bred bird was developed that was smaller and more easily handled and produced excellent feather quality. This bird is often referred to as the South African "black" ostrich, a term coined by U.S. ostrich farmers.

The first ostrich were brought into the United States in 1882 and were taken to Southern California. Shortly afterwards, ranching became notable in Arizona, Florida, and Georgia. Production was for feathers for use in the European fashion markets and the decline in the demand for feathers that occurred at the turn of the century ended ostrich farming in North America. Ostrich farming in Southern Africa also suffered severely with the end of the feather trade. Presently, between 50,000 and 70,000 birds are slaughtered annually throughout South Africa, Israel, Zimbabwe, Namibia, Tanzania, and Kenya primarily for the meat and leather products. Exact figures for the numbers of animals in North America are not available, although ostrich farming has become one of the fastest growing alternative or supplemental agricultural ventures available.

Anatomy:

Ostrich, like all ratites, are flightless, although they do possess wings. The ostrich has a large breast plate that covers the thoracic area and protects the heart and liver. There is no keel and thus, no location for the attachment of flight muscles. The heart, lungs and liver are in the thoracic cavity. The ostrich does not have a gall bladder or crop but instead has a glandular stomach called a proventricculus. This stomach empties into a muscular stomach called the ventriculus. The ventriculus contains grit, rocks and other material that helps break down food and allows it to pass into the small intestine. Because the intestine of the ostrich is abnormally long, the amount of time necessary for food to pass thorough it is also long (36 hours). As in most birds, ostrich posses a cloaca which is a common site for excretion by the urinary tract and the digestive tract.

The respiratory system of ostrich as with all birds, consists of lungs, and a system of air sacs that originate in the thorax and extend into the hollow bones. Not all bones are hollow and some, including the lower leg, have a thick cortex. Ostrich can use the air sac system to reduce body heat

by panting. The normal respiratory rate of an ostrich is between 7 and 12 breaths/minute.

The reproductive tract of the male ostrich consists of two testicles. The male phallus or penis is located in the ventral cloaca but unlike mammals, does not contain the urethra. The female reproductive tract consists of a single ovary and reproductive tract with a small clitoris located on the ventral cloaca.

Ostrich have two toes (emu and rhea have 3). The larger clawed toe is actually the third digit while the smaller clawless toe is the fourth digit.

The nostrils of ostrich are located forward on the beak, rather than at the base of the beak as in most birds. The trachea or wind pipe is large and located in the lower part of the mouth. The esophagus is above the tracheal opening and extends down the right side of the neck. There is one large jugular vein that runs down the right side of the neck.

Facilities:

Chicks:

Young chicks can be maintained in a variety of suitable facilities. A small portable pen, 12 feet long, 4 feet wide and 2 foot high can be adequate for a number of chicks. The pen is placed on short cut grass and moved daily. Chicks are brought out to the pen after the temperature reaches above 60 F and the sun is shining. Birds can be maintained in this type of facility until the temperature drops or until weather is prohibitive. Include some type of shade and wind break as young birds are sensitive to extreme sun and wind.

Young birds should be brought indoors in the evening and maintained in a heated environment until at least 2 to 3 months of age. Temperature in indoor shelters should be maintained at least 65 F and enough room to allow the birds to exercise should be provided. In areas where weather is more severe, this period may need to be extended.

Do not provide feed at night but available water is acceptable. Feed the young birds as outlined in CARE OF YOUNG BIRDS section, prior to turning them out in the morning.

Juveniles:

Juvenile birds between 3 and 10 months of age can be maintained in a similar, but larger facility as young birds. For convenience, access to the indoor facility should be available directly from the outdoor pens. However, shelter is not needed except in extremely cold areas. The amount of space per bird, for both indoor and outdoor facilities should be increased for this age bird as compared to that available for younger chicks. Outdoor pens can be of any type of substrate but ground cover such as grass, clover, or alfalfa is ideal. Grass should be kept at a closely mowed level, especially when grass begins to dry out or turn to seed, as impactions are more common at this time. Daily mowing may be necessary during some periods of the year.

Adults:

Pens and facilities for adults vary considerably. Most ranchers maintain adult pairs or trios in facilities that range from five thousand square feet to an acre or more. In general, the more room

that can be provided, the better the situation. Common fences and line of sight access to neighboring pairs is often desirable but may not be practicable with overly aggressive males.

Housing or shade is usually provided although not always utilized. If birds are accustomed to being fed and watered in a shed they will be more easily confined when necessary and may build the nest and lay indoors. Alley-ways for movement of birds from pen to pen, access for haling, and provisions for confinement for veterinary care should be considered at the time of construction. Although suprising, most ratites do not require indoor shelter once over 6 months of age and often refuse to use such structures, independent of weather.

Fencing is dependent on personal preference and economics. Chain link is good but may result in problems related to leg and foot injures and is not easily climbed if escape from the pen by egg gatherers is necessary. Tubular "cattle" type fence is suitable and offer some benefits and others types of woven wire fencing are routinely used.

Many ranchers are now utilizing group pens consisting of several males and numerous females in larger acreage. This appears to provide some benefits and is more nearly similar to a natural situation. Early results indicate that increased fertility, more egg numbers, and extended laying periods can be expected in this type of set up. Several acres of enclosed pasture are needed for this type of operation. Difficulties with a group breeding situation include the inability to determine exactly the resultant chicks parentage.

Eggs:

Ostrich generally lay eggs every other day. Studies have shown that storing eggs for a period of from 7 to 10 days generally results in better hatchability and egg storage is recommended. Eggs can be gathered daily, placed either on their side or upright, and maintained at between 65 and 70 F. Eggs should be turned several times a day.

Collection of eggs and proper handling is important to successful hatching. Many producers use disposable gloves to handle and gather eggs. Others use a similar idea employing disposable plastic bags while still others simply wash and clean their hands thoroughly before handling eggs. Which ever the case, the idea is to prevent unnecessary contamination of the egg.

Many products are available for cleaning and sanitizing eggs once collected. A variety of dips, sprays, and similar products are marketed and used widely. While the use of such agents is heavily debated, should contamination problems occur, the use of cleaners and sanitation products can be effective. If dips, sprays, or washes are used, read the directions carefully and follow the recommended procedures outlined by the manufacturer.

Eggs laid in wet weather are the most likely to become contaminated. This is usually the result of soil bacteria being taken into the egg while the egg is sitting in water or mud. Occasionally, reproductive tract infections in the hen can also result in bacterial contamination of the egg. A complete bacteriologic examination by a veterinary diagnostic laboratory can provide insight into these problems and is strongly recommended when an abnormally large number of eggs are contaminated.

Many new products which sterilize the egg shell, the air or the working area in the incubator room

now available to producers. These products all have merit when attempting to correct a diagnosed contamination problem. The use of these products as a eans of preventing potential contamination can be considered in any operation's biosecurity plan.

Incubation:

Often, the facilities in which the incubation equipment is kept is as critical as the equipment itself. Although there are no strict requirements that will insure successful incubation, there are several factors that should be considered.

1. Facilities should be capable of being maintained at 65 to 70F.
2. Outside fresh air exchange should be at least 20%.
3. Humidity should not exceed 45%
4. Traffic and personnel should be maintained at a minimum with as few people as possible entering the facility.
5. Floors and walls should be of such a construction to allow daily cleaning and washing.
6. Additional air movement within the room should be supplied by portable fans or some similar mechanism.

The hatching process in ostrich, as in all birds, begins when the egg cell is expelled from the ovary of the hen. When the ovum passes into the oviduct of the female, it begins to mature and if spermatozoa are present, fertilization occurs. As the egg continues down the oviduct, the viscous albumin (egg white) , papery shell membrane and hard outer shell are progressively secreted by the lining of the duct. Even before the egg is laid, the formation of a visible embryo has begun and appears as a whitish disk on the surface of the yolk. Additional development does not occur until incubation at the proper temperature. The egg is fully formed and ready to be laid about 24 hours after it is discharged from the ovary.

Hatching:

Eggs should be allowed to hatch on their own or help should be given only under duress and the help should be minimal. What ever the circumstances, it is important to allow the chicks to exit the shell on their own. At the time of internal pipping, the bird has not yet internalized all of the yolk material and the blood vessels that are attached to the inside membranes of the shell have not dried up sufficiently to allow the bird to hatch normally. The final process of exiting the shell may take many hours to several days, depending on the vigor of the bird. It may be necessary to remove pieces of sharp shell or to remove dried membranes to assist the chick in this process. Birds taken out of the shell prematurely (right; rhea) often have incompletely internalized yolk sacs and are often subject to umbilical and yolk sac infections.

Once the bird has completely exited the shell, treat the umbilical area with liberal amounts of 7% Iodine. This will help disinfect the area, prevent bleeding, and minimize bacterial contamination.

After Hatching:

The newly hatched chicks can be placed into a brooder as soon as they are dry or as soon as several birds in any batch have hatched and are ready to be removed from the hatcher. The brooder may be kept in the same room as the hatcher.

Numbered leg bands are placed on the birds and they are weighed at the time they are placed into the brooder. No food or water is provided until they are 6 to 8 days of age. This allows the birds to absorb any fluid that is in the tissues and requires that the bird begin to utilize the yolk material. Birds that have excessive water in the tissues ("wet" chicks") (see above picture) are held for longer periods without food or water. Chicks have been kept up to 10 days with no notable problems. All birds are taken out and placed on grass or dirt, as soon as weather permits to further stimulate water absorption and to encourage activity.

Often wet chicks have difficulty placing their legs under them at this stage and a condition called "spraddle leg" develops. Most birds can be treated by hobbling the legs together in a normal position with tape, tubing, or Vetrap until the chick is able to stand on its own (usually one to two days). Treatment is almost always successful if the condition is detected early. Care must be taken when hobbling birds in the brooder as they may turn onto their back and will be unable to right themselves.

Our brooder box is constructed of stainless steel so that it can be sanitized easily. It is 4 feet long, 2 1/2 feet wide, with 3 foot sides. The temperature in the hatching -brooder room is 75-78 F. Additional heat is provided for the brooded chicks with a single heat lamp directed in one corner of the brooder box. A washable mat (Nomad entrance carpet, 3M Inc) is used on the floor of the brooder. This type of flooring is ideal since it is easily cleaned, can't be eaten, and provides support for the chicks during the first few days while still allowing a clean dry surface.

Chick Care:

After the chicks are removed from the brooder, they are placed on grass in a portable pen for as long as weather permits. The grass in the pen area is cut short and the pen is moved daily. Birds are brought back indoors nightly and maintained as described for brooding during the first week. Only water is provided at night.

Before birds are placed out in the morning, feed is provided for a one hour period. Birds are then placed in the portable pen. Supplemental feeding of cut alfalfa or clover is provided several times daily. Birds are provided pelleted feed 3 times per day for 1 hour time periods. The availability of pelleted food is limited for this age bird because we feel it helps to stimulate the use of the yolk material by the birds and reduces the incidence of bacterial enteritis that often results from continuous feeding. Using this feeding schedule, birds loose about 0.25 to 0.50 pounds of their hatching weight during the first week, then they return to or slightly exceed their hatching weight by the second week, gain about 0.50 pound by the third week and double their birth weight by one month. After this, gains of nearly 0.5 pounds per day are not uncommon with a 3 month old bird weighing 30 pounds.

When chicks are 6 to 7 days of age, reexamine the umbelical area to determine if further treatment is needed. At this time, a small "knot" or bump can often be detected at the umbelicus. This is

usually what remains of the umbelical vessels and can be the source of bacterial infection that may result in umbelical and yolk sac infections. To treat this condition, simply feel the umbelical area and remove the scab that has formed on the umbelicus (below left). Apply pressure with your fingers from the belly outward, and the potential infected material will be easily expressed (below, right). Retreat this area with 7% iodine and return the bird to its original facility. No further treatment is usually needed.

Nutrition:

The area of nutrition for ostrich has been a major concern for producers since the beginning of ostrich ranching. Few detailed studies have been performed and much is still unknown about optimum diets. This may perhaps be due to the fact that ostrich prefer a varied and diverse diet, consisting primarily of plant material. This type of diet may be difficult to duplicate in a pelleted form.

Animals do not utilize feed as such but rather the nutrients contained in the feed. However, not all animals require the same nutrients. Nutrients that are required include:

1. Carbohydrates
2. Proteins or amino acids
3. Vitamins
4. Minerals
5. Fats and oils
6. Water

The concentrations of these nutrients vary considerably in different plants and it is for this reason that commercially prepared feed mix various sources of ingredients in order to meet differing nutritional requirements.

Research findings have shown that chicks up to six month of age do well on the pelleted diet that is produce at O.S.U. The general composition and formulation of this feed is similar to that produced by several feed companies with the exception that this diet is a 18% protein and 16% fiber. The protein component is sufficient to provide good growth without producing leg or bone development problems and the high fiber content has proven to be of value in maintaining good fecal consistency and reduces bacterial enteritis while still allowing adequate consumption for good growth rates.

Growth Rates:

Age in weeks	Average gain in pounds
2-3	1.3
3-4	2.8
4-5	2.4
5-6	3.3
6-7	3.3

7-8	4.4

With the limited feeding program outlined in the Care Of Newly Hatched Chick section and the supplimentation of birds with available green forage such as alfalfa, grass, clover, etc., growth and development should not be a problem. Care must be taken that feed is stored properly to prevent mold or other contamination problems and that it is fresh enough that all vitamin and supplementations are still available.

Birds that are provided forage such as alfalfa or grass, should also be provided access to grit and gravel. The size of the gravel can be varied with the size of the bird but access to it is necessary for both breakdown of the feed and normal function of the proventriculus. Oyster shell should not be used as grit as it breaks down rapidly and may change the calcium/phosphorus balance that was provided by the diet being fed.

Diets for adult birds can be similar to that used for chicks with the exception that laying birds should have a calcium/phosphorus ratio sufficient to compensate for egg production. Consult your Veterinarian and/or feed company representative for specifics on available feeds.

It is beneficial to maintain production age birds on a maintenance diet during the non-laying period that differs from that used during the laying period. This maintenance diet should allow the bird to maintain but not gain weight and perhaps even loose (not more than 5-10% body weight) during the non-laying period. Beginning about 2 months before the laying period, the higher protein, more balanced laying diet can again be given to boost the birds prior to laying and breeding.

Identification:

There are numerous options available to producers for identifying ostrich. The most common method of identifying young birds is by the use of plastic numbered leg bands. These bands can be placed on the birds at hatching and will be useful for several weeks. Larger bands are available for juvenile and adult birds that can be adjusted to the size of the lag as the birds grow.

Many producers use microchip identification as a method of identifying birds. Birds can be microchipped at hatching by implanting the small chip under the skin (often placed in the pipping muscle of the neck at this time). This method is useful in both identifying birds on the ranch and also for locating and identifying lost or stolen birds. Many insurance companies require microchip identification. Microchip birds at one month of age. Locations for implanting the microchip include the hip muscle, the muscle on the back just above the tail and the area between the wings. Several companies produce both microchips and readers. Unfortunately, different products are not totally compatible. Consequently, different readers are required for different chips.

There are also now companies that provide DNA fingerprint identification. This procedure involves analysis of blood from your bird that is used to identify that bird from all other birds.

Sexing:

Because different plumage of male and female ostrich is not apparent until the birds are nearly two

years of age, sexing young birds by visual examination of the phallus (present in both sexes) is necessary. Sexing ostrich can be done at any age but we have found that examination at 1 to 2 months is best. Examination of birds younger than this is often more difficult, and examining older birds usually involves both restraint and internal examination.

The birds can be examined while standing or while held by a second person. The examiner simply pulls up on the tail of the bird and with the other hand applies pressure on the cloaca area. By gently applying pressure from the bird outward, the cloaca will be inverted and the phallus (which rests on the floor of the cloaca) will be expressed. The male phallus is larger, curved and more cartilaginous than that of the female. In order to become proficient at this type of examination, do several birds and compare the difference. After a little practice, this procedure will become easily mastered and more than 95% of the birds of this age can be accurately sexed. In some instances, the difference will not be as notable and these birds should be reexamined at a later time to confirm your earlier decision.

There are also companies that provide a recombinant DNA sex determination for ostrich.

Diseases:

The Following is a listing of all diseases and disease agents that have been positively identified and reported in the scientific literature. Because of the relative newness of this industry, this list will surely increase as more information is gathered. At the present time, tentative, but not confirmed, reports exist of other potential diseases that could effect ostrich. You should work closely with your Veterinarian and a state or federal diagnostic laboratory when ever you suspect disease problems or are concerned about the introduction of agents onto your ranch.

Nematode:

- Paronchocerca struthionus. A filariad nematode recovered from the lungs of an ostrich in West Africa. An incidental finding in a bird that died of other causes. Pathogenicity unknown.
- Struthiofilaria megalocephala. Several reports of nematodes from body cavity of ostrich. Pathogenicity unknown but possible.
- Lipostrongylus douglassi. Intestinal nematode of ostrich. Reported susceptible to antihelminthic treatment with fenbendazole.

Cestode:

- Houttuynia struthionis. Intestinal tapeworm of ostrich. Reporting of efficacy of fenbendazole.

Trematode:

- Philophthalmus gralli (eye fluke) reported to cause severe eye irritation and discharge in captive ostrich in Florida.

Protozoa:

- Hexamitiasis. Reported identifications of intestinal infections with possible pathogenicity in young ranched ostrich in North America.

Arthropods:

- Struthiolipeurus nandu (Mallophagan louse) infestation in ostrich causing feather loss.
- Unidentified feather mite belonging to family Pterolichidae infesting ostrich in North America causing feather loss. Successfully treated with Ivermectin.
- Numerous ticks of various life stages reported to infest ostrich.

Viral diseases:

- Newcastle disease virus in ostrich reported in ranched ostrich in Israel. High mortality reported with viral isolation from brain.
- Pox virus recovered from skin lesion in Israel.
- Spongyform encephalopathy in a ranched ostrich.
- Crimean-Congo Haemmorrhagic Fever Virus. Report of virus isolation from human thought to have acquired infection from handling slaughter ostrich or ticks off the ostrich in South Africa.

Bacterial Diseases:

- Staphylococcus hyicus in an ostrich causing conjunctivitis.
- Colobacillosis responsible for mortalities in young ranched ostrich.
- Tuberculosis in ostrich and other ratites.
- Pasteurella multocida infections in ostrich in Nigeria resulting in generalized and pulmonary infections.

Fungal infections:

- Aspergillus infections reported in Ostrich.

Nutritional and metabolic diseases:

- Vitamin E and selenium deficiencies in ostrich from South Africa.
- Parsley-induced photosensitivity in captive ostrich.
- Anasarca and myopathy in ostrich chicks.
- Nutritional muscular dystrophy in ostrich chicks.

Medical Management:

Antibiotics:

There are no antibiotics that are available today that have been tested sufficiently on ostrich. As a result, the use of specific antibiotics should be the decision of your Veterinarian and should be based on a complete understanding of the problem, bacterial isolation attempts and antibiotic sensitivity testing. The following are a listing of some commonly used antibiotics that have been reported to be effective in some instances:

- Amoxicillin (Smith Kline Beecham) 5mg/lb
- Amikacin Sulfate (Aveco) 5 mg/lb

- Batryl (Miles, Inc) 1.13mg/lb
- Gentamicin (Schering-Plough) 2 mg/lb
- Sulfadimethoxine (Burns Vet Supply) 12.5 to 25 mg/lb
- Tetracycline 7.5 mg/lb
- Tribrissen (Cooper Animal Health Inc) 2ml/kg
- Trimethoprim
- Sulfadiazine 48% (Pittman Moore) 20 mg/lb

Anthelmintics:

A complete parasite evaluation should be performed on all birds on a routine basis. Anthelminthic treatment should only be conducted when specific parasites are identified and not used on a prophylactic basis. Complete examination for ectoparasites should include visual and microscopic evaluation for lice, mites, and ticks while both simple smears and concentration procedures (flotation) should be performed on feces for intestinal helminths.

As was the case with antibiotics, there are no anthelminthics that are approved for ostrich. Several have been evaluated in trials and shown to be effective:

- Fenbebdazole (Panacur 2.5%, Hoechst) 15 mg/kg . Efficacy against nematodes and perhaps cestodes.
- Ivermectin (Ivomec, MSD/Agvet) 200 mglkg . Efficacy against nematodes and some ectoparasites.
- Carbaryl dust (5%) (Security %% Garden Dust, Security Products Co,) Efficacy against lice.

Clinical Pathology:

The use of hematology in determining the health status of birds is becoming a more routine practice as data is becoming available. Many insurance companies are requiring some type of testing prior to insuring birds and many Veterinarians are using a series of tests to identify both clinical and subclinically ill animals.

There are two groups of tests that are routinely used; 1) complete blood counts (total white blood cell, total red blood cell, hematocrit or packed cell volume, hemoglobin, and differential white blood cell counts and 2) clinical chemistries (Glucose, blood urea nitrogen, cholesterol, triglicerides, ...). Complete blood cell counts are often useful in identifying ongoing infections, problems related to anemia and dehydration while serum chemistries are useful determining problems with specific organ functions, electrolyte imbalances, and to evaluate treatment effects.

Under most circumstances, the drawing of blood for these tests is not overly stressful for the birds and with good facilities and experience, little or no adverse effects will be noted as a result. The proper handling of the samples and the interpretation of the results are essential, however, for an accurate evaluation of the status of the bird.

Table 1 Provides normal complete blood values for adult ostrich while Table 2 lists normal serum chemistry values.

Although the interpretation of the information provided by these tests should be conducted by your veterinarian, several general rules should be noted.

Complete cell counts:

- White blood cell counts (WBC) over 14,000 are a general indication of ongoing acute or chronic infection. Counts over 20,000 may be the result of excitement during the handling process.
- The packed cell volume (PCV) for adult ostrich (30-40 %) is generally lower than that seen in most other birds. Juvenile birds will have a lower PCV than adults.
- Total Red Blood Cell Counts (RBC) for ostrich are slightly below the average for other birds.
- Hemoglobin and hematocrit values for adult ostrich are higher than that seen in juvenile birds.

Clinical Chemistry:

- Juvenile ostrich have lower calcium and magnesium values than that seen in adult birds.
- Immature birds have higher total protein, uric acid, and potassium levels than do adult birds.
- Immature ostrich have higher uric acid levels than do adults.
- Obese birds have trigliceride values in excess of 400.
- Calcium levels in laying hens should be greater than 14.

Table 1. Hematologic values (Complete blood counts) for clinically normal adult ostrich:

Parameter	Mean	Value
White blood cells	(103/ul)	5.5 to
Total red blood cell	(106/ul)	1.5
Hematocrit	(%)	30-40
Hemoglobin	(mg/dl)	12-15
Triglicerides	(106/ul)	1.7

Table 2. Mean Serum Chemistry Values For Clinically Normal Adult Ostrich:

Parameter	Mean	Value
Albumin	(g/dl)	1.3 - 2.5
Billirubin	(umol/L)	6.0
BUN	(mg/dl)	1.2-1.8
Cholesterol	(mg/dl)	82-97
Glucose	(mg/dl)	215-245
Phosphorus	(mg/dl)	4.4-5.2
Calcium	(mg/dl)	9.5-13
Total Protein	(g/dl)	3.7-4.7

Triglycerides	(mg/dl)	90-130
Urea	(umol/L)	0.4
Uric acid	(umol/L)	460-490

Toe and Leg Problems:

Rolled toes:

This is a condition usually seen in birds under 2 weeks of age where the toe itself is rolled to one side. In this instance, the toe nail points to one side. This condition is usually the result poor substrate during brooding, Improper incubation conditions, or occasionally, improper nutrition in the hen.

Treatment is easy and usually 100% effective is delt with early. See the section on Correcting Rolled Toes for details on treatment.

Deviated toes:

This condition is one seen in growing birds that is usually the result of some form of trauma to the toe. Generally the bird can walk on the pad of the foot but the toe projects to one side at the joint.

This condition can usually be treated with good success by surgical manipulation. If diagnosed early, and if the break can be treated and cast so that the bird can walk, correction is usually successful. Early treatment is essential for success.

Turned or crooked legs:

This problem involves the twisting of the entire bone resulting in the foot pointing outward. The appearance of this problem can often be quite rapid with notable rotation occurring within a few days. Although there are not good studies to document the actual cause of all cases, based on similar problems in other animals, it appears that the primary causes are related to nutrition, exercise, and growth rate.

There does not appear to be any good treatments available at this time. Surgical intervention has not proven useful and other efforts are equally unsuccessful. The prevention of the condition appears to be the best opportunity for the rancher. Limited feeding, feed with protein levels below 20%, a balanced feed suitable for proper bone growth, and proper activity levels for young chicks are all essential in preventing this problem.

Slipped tendons:

The two most commonly seen tendon problems are with the heel and hock tendons. The problem arises when the tendon that runs down the back the leg, the back of the heel and to the tow (heel tendon) or the tendon that runs down the groove in the rear of the hock (hock tendon) slips out of the groove that hold them in place. The most common cause of this condition is some form of trauma, poor flooring or footing, or improper exercise.

Most cases can be treated successfully with surgery. Care must be taken to minimize the damage

to the tendons after they have slipped out of their normal position. Wrapping the bird, minimizing the use of the legs, and early treatment will increase the chances of success.

Bowed legs:

This condition is one in which the toes of the chick point in the correct direction but the leg bones bow either inward or outward. The condition us generally caused by improper diet especially excess vitamin supplimentation and perhaps too rapid of an early growth rate.

There is no suitable treatment other than to improve the diet and change the feeding program.

Correcting Rolled Toes:

The toes of ostrich occasionally roll to one side. This is often the result of either incubation conditions or less than ideal flooring for the young birds during brooding. Although this is not a life threatening situation, it is not desirable and will often influence the price and value of the birds. The situation can be easily corrected.

We wait until he birds are at least 2 weeks old before attempting to correct these rolled toes. At this age the birds are usually active, eating, and mobile enough to attempt to correct this situation while younger birds may become more easily stressed.

Place the toe that is rolled on a flat wooden stick (tongue depressor) and position it so that is it correctly aligned. Wrap the toe in this position with non-sticky tape (VetRap) being sure that it is aligned correctly. Place a second stick at the front of the first one forming a "T" and fasten the two sticks together with tape. The bird can now be placed back with other similar aged birds and allowed to walk on this "T" for one or two days. This is usually sufficient to correct most situations. Try to keep the bandage dry and free of fecal material. If additional correction is still needed, repeat the procedure, never allowing the wrap to be on for more than a few days. Do only one toe at a time on birds with multiple problems.

Digestive Problems:

Impactions:

Impactions are one of the most frequently seen problems in growing chicks up to adult hood. There are two types of impaction problems. One being acute or newly acquired impactions and the other being chronic or long standing impactions.

Acute impactions are generally those that result from a bird eating too much unusable material vary rapidly. This type of impaction can occur on sand, dirt, rocks, gravel, grass, etc. Death in these instances is often quick due to the overextended and non-functional condition of the proventriculus.

Chronic impactions usually result from the bird having a partially impacted proventriculus which allows some material to pass through normally. This can result from consumption of material like grass, rocks, sand, etc. or some larger foreign body that would partially block the proventriculus.

These birds do not gain weight normally, are often eat excess non-food material such as sand, dirt, etc. and often appear malnourished.

Many birds develop this type of problem when confronted with new situations. Moving into new pens, changing diets, excess stress including movement, feed changes, or diseases may initiate the abnormal eating habits and contribute to the problem.

Early treatment with some form of oral lubricant such as mineral oil, etc. can often help to breakdown some of this material and get the bird back to a normal diet. More commonly, surgical intervention is necessary to remove the impacted material. If diagnosed early, surgical intervention can be vary successful.

Foreign body ingestion:

Much like impactions, birds of all ages will often eat almost any type of object. In many of these cases, the objects are non-digestible and can sit in the proventriculus and impair normal food movement. Objects such as nails, plastic, knives, tools, etc. are eaten by curious birds. In most cases, as long as the object does not damage the intestine wall or puncture the proventriculus, the foreign object may be eventually digested and passed through the digestive tract. If it is too large and blocks the normal activity of the proventriculus, a chronic impaction may result.

Surgical intervention is usually successful in correcting this problem. Again, early diagnosis and surgery is essential.

Surgery generally requires a pre-anesthetic followed by gas anesthetics. After surgical preparation including clipping all feathers along the midline of the xiphoid (breast bone) cartilage, an incision is made along the midline starting at the xiphlid cartilage. The proventriculus, located on the left side, is pulled through the incision. The proventriculus in opened and the contents completely cleaned out. The contents of the ventriculus can also be removed by manual manipulation and pressure at this time. Care should be taken not to contaminate the abdominal cavity during the initial incision and the air sac during cleaning of the ventriculus and proventriculus.

Surgical gut (2 layers) are recommended to close the proventriculus and the abdominal wall while non-absorbable sutures are used on the skin.

Supportive treatment including oral fluids are helpful for the first several hours after surgery along with antibiotic therapy.

Prolapses:

Young birds often develop prolapses of the rectum. This can be a serious problem and requires immediate attention. The condition often occurs in birds with diarrhea and results from straining during defecation. The prolapse can easily be replaced and sutured in place. Early diagnosis and treatment are essential but with them, good results can be anticipated.

Occasionally, older males will develop a prolapsed phallus. In this instance, the phallus will not be retracted into the cloaca and mechanical damage, exposure to cold, etc. can result.

Treatment usually consists of confinement, cleaning and lubrication of the phallus. Surgery is usually not required and may be contraindicated.

Yolk Sac Infections:

Umbilical infections are often one of the most common causes of moralities in chicks up to 2 weeks of age. Many of these infections result from over ambitious handling of hatching chicks, poor sanitation in the hatcher, or contamination of the umbilical area after hatching. Proper treatment of newly hatched chicks and proper hatching procedures can reduce losses due to these type of infections. See section on CARE OF NEWLY HATCHED CHICKS for procedures to deal with prevention of umbilical infections.

Yolk sac infections are generally due to the same problems as are umbilical infections. Many times the yolk sac becomes infected as a result of the umbilical area being infected. Proper care and handling of newly hatched chicks can minimize these infections.

Yolk sac removal:

The removal of the yolk sac in young chicks involves a surgical procedure that totally removes both the yolk sac and the umbilical stump. Although this procedure has been widely used to eliminate yolk sac infections in the past, it is not a common practice now and the overall results of this type of surgery may not be good.

The yolk sac of young chicks may not be absorbed during the proper time period and this can create a problem with the developing chick. Normally, the yolk sac is completely absorbed in ostrich by 18 to 20 days after hatching. If it is not, death may result. The condition is most notable around 10 day to 2 weeks after hatching when the chick appears distended, acts weak, and is less active than others.

The removal of the yolk sac should be a last effort since the yolk material is necessary for providing both nutrition and antibody to the young bird. The prevention of this problem by stimulating the chick to use this material is the most beneficial treatment. Consult with your veterinarian on how to manage young birds to insure better yolk absorption and to help diagnose those birds with yolk sac retention and infections.

Surgical procedure usually involves anesthetizing the bird with Isofluorane, Halothane or Metofane. The feathers on the entire abdomen are clipped and the area is surgically prepped. An incision of about 2 inches is made completely around the navel, completely removing it (Note that it is still attached to the yolk sac and care should be taken not to rupture the yolk sac). The yolk sac is then tied off next to the intestine and the yolk sac removed. The abdomen is sutured with gut and the skin with non-absorbable suture. Flushing the abdominal cavity with warm saline (PBS) is usually helpful in maintaining temperature and antibiotic therapy is recommended.

Chicks can be returned to their familiar surroundings as soon as recovered from the anesthesia.

Respiratory Diseases:

Respiratory diseases are most common in juvenile and young adult birds. Vary often, respiratory problems are seen in birds recently moved, new introductions, or birds under other stresses.

Nasal discharge, ocular discharge, or swelling below the eye are all good indications of a developing respiratory problem. Diagnosis, testing and treatment should be considered at this point to prevent further development that might include more serious air sac infections or pneumonia. More severely infected birds will show signs of labored breathing (even at rest), increased respiratory rate, and ruffled feathers.

Both developing and severe respiratory infections are difficult to diagnose until late in the infection. Fungal infections (Aspergillus) and bacterial (Pasteurella, E. coli) and/or Mycoplasma infections are usually what are diagnosed either by laboratory culture or at post mortum examination.

Treatment including the use of systemic antibiotics that have been shown to be sensitive to the agent involved, vitamin and nutritional supplimentation, and supportive care are often successful if a diagnosis is made early.

Aspiration pneumonia is occasionally seen as a result of forcing fluids or the regurgitation of fluids into the trachea and lungs. This may happen as a result of improper administration of oral fluids or medication. Consult your veterinarian for proper administration of any fluids to any age bird.

Anesthetics and Tranquilizers:

Inhalation anesthetics used during surgery include Isoflurane (3-4%) or Halothane. Young birds can be masked down or intubated without a preanesthetic. Larger birds usually require preanesthetics before intubation.

Injectible anesthetics include Telazol (1mg/lb IV), Rompon (Haver) (3mg/kg)/Ketamine HCl (Fort Dodge), or Rompon (0.5 mg/lb)/Telazol (1.5mg/lb).

Vaccinations:

At present, there are no recommended vaccination programs for ostrich. Vaccination for Eastern and Western Encephalomyelitis and Clostridium perfringens Types C and D may be useful but not thoroughly tested. Both require a initial inoculation, a booster in 2 weeks and annual boosters. Consult your veterinarian for specifics.

Handling and Transporting Birds:

Young birds up to two months of age can generally be picked up while supporting the chest with one hand and placing the other hand on the back, leaving the feet to dangle below. This age bird can also be easily handled and transported by wrapping them in a large towel. The wrapped bird can often be handled for various treatment purposes and transportation more safely than allowing it to try to stand and walk in a moving vehicle.

Juvenile birds (4 to 8 months) are generally too large to pick up but can be walked and guided by one person by grasping the tail with one hand a wing with the other. Do not lift the birds by the wings, however. More effectively, two people can maneuver this size bird by one person getting

behind the bird and lifting on the rump while holding the wing(s) while the other holds the neck and/or beak and directs the bird from the front. Adult birds can also be moved this way, once hooded, and generally require little more effort than the juvenile bird.

Care of Ostrich Hide at Slaughter:

If attempting to save an ostrich hide from a bird that has been slaughtered or died on the ranch, the following procedures should be followed:

1. Do not pluck the feathers from the bird but cut them off with heavy pruners or clippers.
2. To remove the skin, make the first incision on the inside of one leg, cutting up the leg, across the chest and down the inside of the other leg. Cut around the leg at the small portion of the leg at the end of each incision.
3. Cut around the chest plate beginning your incision at the plate continuing to the rectum. Cut around the rectum.
4. Going back to the chest plate, cut up the neck. Now cut around the neck at the end of the cut.
5. Beginning at the rectum, pull the skin off. When you get to the wings, cut a circular incision around each wing and pull the skin over the wing (leaving a whole where the wing was.) Many people prefer to use a air compressor, inserting a hose into one leg thorough a small hole in the skin. By holding a hand around the incision, creating an air tight effect allow air pressure to built up to 100 pounds psi. The skin will soon pop up from the carcus.
6. Place skin in brine solution made by using 40 gallons of water with 1 1/2 gallon of chlorax bleach, 10 pounds table salt, and 2 cups of Borax. Leave skin in solution 3 to 5 days then scrape off excess fat, meat, etc with a large spoon. An alternative method would be to simply apply salt to the hide and scrape off excess meat, fat, etc. as it dries out.
7. Air dry the skin for 24 hours and cover skin with salt. Leave salt on for 2 days and remove excess when all water is gone.
8. Hide can now be sent after rolling. Do not freeze hide after salting.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Ratite Management, Medicine, and Surgery - by Thomas N. Tully, Jr. (Editor), Simon M. Shane (Editor) - Publication Date: August 1996 - List: $59.00
  Booknews, Inc. , 12/01/96:
  Compiles the knowledge and experience of veterinary educators and practitioners involved in the commercial production of ostriches, emus, and their near kin in southern Africa. The topics include clinical anatomy, hatchery management, hematology and chemistry, restraint and handling, nutrition, disease control, reproduction, anesthesiology, surgical conditions, parasites, examination and health certification, and jurisprudence. Includes several pages of color plates in addition to many monochrome photographs. Annotation c. by Book News, Inc., Portland, Or.

Periodicals:

- None identified.

This page was last updated on November 15, 2002

Livestock related links and mailing lists

Related Web Sites:

Related Mailing Lists:

EXT-MEAT: Meat Specialists Extension Group Discussion

Subscription address: listserv@vm1.spcs.umn.edu

Topics: Meat specialists extension

Subscribe to EXT-MEAT. Type "subscribe EXT-MEAT Your Name" in the message body. (Not supported by all browsers.)

FOODLINK: Food Safety Discussion List

Subscription address: listproc@listproc.wsu.edu

Subscribe to FOODLINK. Type "subscribe FOODLINK Your Name" in the message body. (Not supported by all browsers.)

Return to The Small Farm Resource

This page was last updated on August 02, 2002

Property Management

Return to the Small Farm Resource

If you have a question, we will post the question in the appropriate contents page to get suggestions from our site visitors.

Questions and suggestions can be sent to us via our Feedback form.

Visitor Questions:

Rural Alarm Systems

Frequently Asked Questions Other Information Sources Return to Property Management

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Are there commercially available driveway alarms that work?

Suggestion A: I installed a driveway alarm at the entrance to our house, which sets a half-mile off the main road. This works great. It gives someone a notice that there is a vehicle coming to the house. I buried the magnetic sensor at the entrance and and ran the cable to the house. The cable run can be up to 5,000 feet. From the panel in the house you can turn on lights, ring bells, or whatever you want to add. We've had this about six years now and it was well worth the effort. No false alarms from rain, snow, or little animals.

What is a good way to protect outbuildings?

Suggestion A: Use motion detectors. The only problem with these are any little critters that frequent your outbuildings will set off the alarm.

Related web pages:

- Communicating for Agriculture is a nonprofit organization dedicated to the needs of America's farmers and ranchers. They can be contacted at: http://www.cainc.org

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Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

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Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Barns

Frequently Asked Questions Other Information Sources Return to Property Management

Frequently Asked Questions:

- What kind of siding is best for barns?

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

What kind of siding is best for barns?

- **Suggestion A:** If you use T1-11 siding, get 5/8" not 3/8".

Related web pages:

- Communicating for Agriculture is a nonprofit organization dedicated to the needs of America's farmers and ranchers. They can be contacted at: http://www.cainc.org

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Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Roofs and Rails : How to Plan and Build Your Ideal Horse Facility/a Western Horseman Book - by Gavin Ehringer, Gary Vorhes - List: $14.95 - Publication Date: May 1, 1995
- 6th International Conference on the Conservation of Earthen

Architecture : Abode 90 Preprints - by Grimstad - Publication Date: March 1991 - List $100.00

- Adobe and Rammed Earth Buildings : Design and Construction - by Paul Graham McHenry - Publication Date: October 1, 1989 - List: $27.50
  Booknews, Inc. , 06/01/90:
  An unrevised reprint of the Wiley editions of 1984. It presents both engineering information and detailed technical data for adobe and rammed earth building. Annotation copyright Book News, Inc. Portland, Or.
- American Barns : A Pictorial History - by Jill Caravan - Publication Date: September 1995 - List: $12.98
  Synopsis:
  A lavishly illustrated volume records traditional American barns in their classic regional styles, including the red barns of Vermont, round Shaker barns, Kentucky horse barns, and prairie barns from colonial to modern times.
- Barn : The Art of a Working Building - by Elric Endersby, Alexander Greenwood, David Larkin, Paul Rocheleau - Publication Date: November 1, 1992 - List: $60.00.
  Synopsis:
  A celebration of an ancient symbol of shelter and harvest, with more than 200 full-color photographs and an informed text by two expert practitioners of the art and craft of barn restoration. Here is the barn as history, architecture, heritage, and, finally, as living space, an example of preserving authentic structures to fulfill present needs.
- Barns, Sheds & Outbuildings : Placement, Design and Construction - by Byron D. Halstead (Editor) - Publication Date: January 1, 1995 - List: $12.95
  From the Publisher :
  Although it dates from a time before power tools, electricity, and gasoline, this book abounds in simple ideas that rural householders and farmers find useful today. Barns, poultry houses, piggeries, corn cribs, ice houses, spring houses, granaries, smoke houses, root cellars and even kennels and birdhouses are includes in this fascinating compendium from days gone by.
- Building a Multi-Use Barn : For Garage, Animals, Workshop, Studio - by John D. Wagner - Publication Date: July 1994 - List: $14.95
- Buildings of Earth and Straw : Structural Design for Rammed Earth and Straw Bale Architecture - by Bruce King - Publication Date: April 1, 1997 - List: $25.00

How-To Editor's Recommended Book, 11/01/97:
Chelsea Green's The Rammed Earth House and The Straw Bale House chronicle the possibilities and realities of straw bale and rammed earth construction. Buildings of Earth and Straw fills in the gaps for professional builders, contractors, engineers, inspectors, lenders, and architectural students. It includes special construction requirements of earth and straw, design capabilities and limitations of these materials, and documentation of testing data for use in addressing the concerns of officials. This book offers the nuts and bolts of rammed earth and straw bale building techniques, and why they are so spectacular, durable, and earth-friendly.

- East Tennessee Cantilever Barns - by Marian Moffett, Lawrence Wodehouse - Publication Date: August 1993 - List: $29.95
Booknews, Inc. , 08/01/94:
Two historians of architecture (U. of Tennessee) let their enthusiasm for vernacular architecture get out of hand and grow into a systematic survey of cantilevered barns in their parts. In all they found 316, which they locate, describe, and often illustrate, while discussing their structure and origins, who built them, regional factors, and their place in vernacular architecture. Annotation copyright Book News, Inc. Portland, Or.
- Field Guide to New England Barns and Farm Buildings (Library of New England) - by Thomas Durant Visser - Publication Date: June 1997 - List: $19.95
Synopsis:
A recognized authority on historic barn preservation, Visser has combed the New England area for the representative barns and outbuildings featured in this collection. Two hundred of Visser's photographs accompany the text, which includes accounts from 18th- and 19th-century observers, describes key architectural characteristics, historic uses, and special features such as timbers and frames, sheathings, doors, and cupolas.
- How to Build Small Barns & Outbuildings - by Monte Burch - Publication Date: August 1, 1992 - List: $18.95
- Silent Spaces : The Last of the Great Aisled Barns - by Malcolm Kirk - Publication Date: November 1, 1994 - List: $50.00
Card catalog description
Silent Spaces: The Last of the Great Aisled Barns is a striking pictorial celebration of standing examples of these distinctive buildings found in Europe and America by one photographer in his obsessive search for the origins of aisled barns.
- Building Small Barns, Sheds and Shelters - by Monte Burch - Publication Date: December 1, 1982 - List: $14.95
- Complete Plans for Building Horse Barns Big and Small - by

Nancy W. Ambrosiano, Mary F. Harcourt - Publication Date: December 1, 1989

The author, Nancy W. Ambrosiano , 01/18/97:
"Barns" is designed to help horsemen solve housing problems. We have worked with horsemen from around the country, from back yard innovators to Olympic Team members, to find good solutions to common and uncommon horsekeeping challenges. From clever watering systems to low-cost horse housing, we've found people with good ideas they are willing to share. And with our backgrounds as equestrian management professionals, we've been able to review each idea with an eye to safety, economy and the reality of the average horse owner.

Periodicals:

- None identified.

This page was last updated on August 31, 2002

Frequently Asked Questions:

- What kind of siding is best for barns?

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

Warning:

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What kind of siding is best for barns?

- **Suggestion A:** If you use T1-11 siding, get 5/8" not 3/8".

Related web pages:

- Communicating for Agriculture is a nonprofit organization dedicated to the needs of America's farmers and ranchers. They can be contacted at: http://www.cainc.org

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Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Roofs and Rails : How to Plan and Build Your Ideal Horse Facility/a Western Horseman Book - by Gavin Ehringer, Gary Vorhes - List: $14.95 - Publication Date: May 1, 1995
- 6th International Conference on the Conservation of Earthen Architecture : Abode 90 Preprints - by Grimstad - Publication Date: March 1991 - List $100.00
- Adobe and Rammed Earth Buildings : Design and Construction - by Paul Graham McHenry - Publication Date: October 1, 1989 - List: $27.50
  Booknews, Inc. , 06/01/90:
  An unrevised reprint of the Wiley editions of 1984. It presents both engineering information and detailed technical data for adobe and rammed earth building. Annotation copyright Book News, Inc. Portland, Or.

- American Barns : A Pictorial History - by Jill Caravan - Publication Date: September 1995 - List: $12.98
  Synopsis:
  A lavishly illustrated volume records traditional American barns in their classic regional styles, including the red barns of Vermont, round Shaker barns, Kentucky horse barns, and prairie barns from colonial to modern times.
- Barn : The Art of a Working Building - by Elric Endersby, Alexander Greenwood, David Larkin, Paul Rocheleau - Publication Date: November 1, 1992 - List: $60.00.
  Synopsis:
  A celebration of an ancient symbol of shelter and harvest, with more than 200 full-color photographs and an informed text by two expert practitioners of the art and craft of barn restoration. Here is the barn as history, architecture, heritage, and, finally, as living space, an example of preserving authentic structures to fulfill present needs.
- Barns, Sheds & Outbuildings : Placement, Design and Construction - by Byron D. Halstead (Editor) - Publication Date: January 1, 1995 - List: $12.95
  From the Publisher :
  Although it dates from a time before power tools, electricity, and gasoline, this book abounds in simple ideas that rural householders and farmers find useful today. Barns, poultry houses, piggeries, corn cribs, ice houses, spring houses, granaries, smoke houses, root cellars and even kennels and birdhouses are includes in this fascinating compendium from days gone by.
- Building a Multi-Use Barn : For Garage, Animals, Workshop, Studio - by John D. Wagner - Publication Date: July 1994 - List: $14.95
- Buildings of Earth and Straw : Structural Design for Rammed Earth and Straw Bale Architecture - by Bruce King - Publication Date: April 1, 1997 - List: $25.00
  How-To Editor's Recommended Book, 11/01/97:
  Chelsea Green's The Rammed Earth House and The Straw Bale House chronicle the possibilities and realities of straw bale and rammed earth construction. Buildings of Earth and Straw fills in the gaps for professional builders, contractors, engineers, inspectors, lenders, and architectural students. It includes special construction requirements of earth and straw, design capabilities and limitations of these materials, and documentation of testing data for use in addressing the concerns of officials. This book offers the nuts and bolts of rammed earth and straw bale building techniques, and why they are so spectacular, durable, and earth-friendly.
- East Tennessee Cantilever Barns - by Marian Moffett, Lawrence Wodehouse - Publication Date: August 1993 - List: $29.95
  Booknews, Inc. , 08/01/94:
  Two historians of architecture (U. of Tennessee) let their enthusiasm for vernacular architecture get out of hand and grow into a systematic survey of cantilevered barns in their parts. In all they found 316, which they locate, describe, and often illustrate, while discussing their structure and origins, who built them, regional factors, and their place in vernacular architecture. Annotation copyright Book News, Inc. Portland, Or.
- Field Guide to New England Barns and Farm Buildings (Library of New England) - by

Thomas Durant Visser - Publication Date: June 1997 - List: $19.95
Synopsis:
A recognized authority on historic barn preservation, Visser has combed the New England area for the representative barns and outbuildings featured in this collection. Two hundred of Visser's photographs accompany the text, which includes accounts from 18th- and 19th-century observers, describes key architectural characteristics, historic uses, and special features such as timbers and frames, sheathings, doors, and cupolas.

- How to Build Small Barns & Outbuildings - by Monte Burch - Publication Date: August 1, 1992 - List: $18.95
- Silent Spaces : The Last of the Great Aisled Barns - by Malcolm Kirk - Publication Date: November 1, 1994 - List: $50.00
  Card catalog description
  Silent Spaces: The Last of the Great Aisled Barns is a striking pictorial celebration of standing examples of these distinctive buildings found in Europe and America by one photographer in his obsessive search for the origins of aisled barns.
- Building Small Barns, Sheds and Shelters - by Monte Burch - Publication Date: December 1, 1982 - List: $14.95
- Complete Plans for Building Horse Barns Big and Small - by Nancy W. Ambrosiano, Mary F. Harcourt - Publication Date: December 1, 1989
  The author, Nancy W. Ambrosiano , 01/18/97:
  "Barns" is designed to help horsemen solve housing problems. We have worked with horsemen from around the country, from back yard innovators to Olympic Team members, to find good solutions to common and uncommon horsekeeping challenges. From clever watering systems to low-cost horse housing, we've found people with good ideas they are willing to share. And with our backgrounds as equestrian management professionals, we've been able to review each idea with an eye to safety, economy and the reality of the average horse owner.

Periodicals:

- None identified.

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Erosion Control

Frequently Asked Questions Other Information Sources Return to Property Management

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Erosion

Soil erosion is a gradual process that occurs when the actions of water, wind, and other factors eat away and wear down the land, causing the soil to deteriorate or disappear completely. The main agents of soil erosion are wind, water, and tillage. Maintaining a continuous vegetative cover on the soil is usually the best way to control erosion. Soil deterioration and low quality of water due to erosion and run off has often become a severe problem around the world. Many times the problems become so severe that the land can no longer be cultivated and is abandoned. The key to minimizing soil erosion and saving the farm lands is the farmer himself. Ultimately, he is the one who must reduce the level at which erosion sediments are dislodged from his cropland.

Studies in water quality relating to agriculture have shown that, of the four to five billion tons of sediment being deposited in the country's streams each year, over half is coming from croplands. The deposited soil, which contains pesticides, farm chemicals, and nutrients vital to the crops but damaging to ground water, gets there mainly as a result of runoff due to rainstorms and sheet erosion.

Runoff occurs when the rainfall rate exceeds the soil's infiltration capacity. On sloping areas, runoff is a concern since it can carry soil particles, nutrients, and other chemicals with it.

Geological erosion occurs where soil is in its natural environment surrounded by its natural vegetation. This has been taking place naturally for millions of years and has helped create balance in uncultivated soil that enables plant growth. A classical example of the results of geological erosion is the Grand Canyon.

Accelerated erosion can be caused by man's activities, such as

agriculture and construction, which alter the natural state of the environment.

Wind Erosion

Wind erosion, or "soil drifting" is caused by the action of wind on exposed soil, especially smooth, unprotected surfaces. Wind picks up finer soil particles and deposits them downwind. Improper tillage practices, low soil moisture, poor soil cover or any combinations thereof can increase the risk of wind erosion.

Drip irrigation is a successful, economical way to water new windbreaks.

- **Windbreaks** of trees and shrubs in a subdivision in North Dakota make an interesting pattern on the land.
- **A living snowfence** in Colorado beautifies the landscape and will stop blowing snow, keeping snow on the fields where moisture is needed.
- **Wind barriers** of grass and legume crops are rotated with row crops in Iowa.
- **Wheat residues** are left on the soil surface to protect an Oklahoma crop field.
- **Buffer strips** of weeping lovegrass protect a cottonfield in Texas.
- **Perennial grass** barriers protect cucumbers growing in South Carolina.
- **A combination** of wind barriers and ground cover protects soil.
- **Well-managed rangeland** protects highly erosive soil in Wyoming.

The second most common erosion control practice in Canada is the use of windbreaks or shelterbelts, which are lines of trees or bushes planted at the borders of or within fields, normally at right angles to the prevailing winds (maintaining natural vegetation along fencelines has the same effect). This technique is most commonly used in the Prairies (29 to 37 percent of farms), where the flat terrain, minimal natural brush protection, large fields, and frequency of high winds make cultivated land especially vulnerable to wind erosion. Ontario farms also report substantial use of windbreaks (21 percent of farms).

Water Erosion

Water erosion occurs when rain, spring run-off, or floodwater carry soil particles away. This can occur through sheet erosion, where soil

materials are removed relatively uniformly, or rill erosion where flowing water creates small channels in the soil, called rills, and larger channels, called gullies. The extent of water erosion depends on the amount of soil cover, soil texture, the length and grade of the field slope, the amount and timing of heavy rainfall, and the tillage and cropping practices used. Raindrops can be a major problem for farmers when they strike bare soil. With an impact of up to 30 mph, rain washes out seed and splashes soil into the air. If the fields are on a slope the soil is splashed downhill which causes deterioration of soil structure. Soil that has been detached by raindrops is more easily moved than soil that has not been detached.

Sheet erosion is caused by raindrops. Sheet erosion is defined as the uniform removal of soil in thin layers from sloping land. This, of course, is nearly impossible; in reality the loose soil merely runs off with the rain.

Rill erosion is the most common form of erosion. Although its effects can be easily removed by tillage, it is the most often overlooked. It occurs when soil is removed by water from little streamlets that run through land with poor surface draining. Rills can often be found in between crop rows.

Gullies are larger than rills and cannot be fixed by tillage. Gully erosion is an advanced stage of rill erosion, just as rills are often the result of sheet erosion.

Tillage

Tillage erosion happens when the action of tilling drags soil downhill. The extent of tillage erosion depends on the shape and gradient of the slope, the type of equipment, depth of tillage, the speed at which tillage equipment is used, and the number of tillage operations.

Tillage and planting practices that reduce erosion include contour cultivation and strip-cropping. Contour cultivation is cultivation that follows the contours of a field, producing furrows that run perpendicular or at angles to the slope-line of a field. This creates an irregular surface that breaks up the downslope movement of water and thus reduces water erosion of the soil. This cultivation technique is practiced in Canada in the Prairies (11 to 18 percent of farms) and Prince Edward Island (10 percent of farms). Strip-cropping, a technique that involves alternating strips (50 to 200 metres wide) of crop and summerfallow or of two crops across a field, is less commonly used in Canada.

Tillage practices are used for wind erosion control by producing a rough, cloddy surface that maintains surface residue and conserves soil

moisture. When used along with crop residues, also known as stubble mulch tillage, reduced tillage, or conservation tillage, it reduces wind velocity and traps eroding soil.

An implement used for emergency wind erosion control should gently lift the soil, creating as many and as large of clods as possible. Disks and harrow-type implements with several ranks of closely spaced tines generally will not be effective, and should not be used.

In fine or medium textured soils, most types of chisel, lister, or broad shovel points create a ridge and bring clods to the surface. The shank and/or point should produce a gentle lifting action to bring clods to the surface and to avoid breaking them. An angled, wide point which lifts the soil usually creates larger clods and a larger ridge than a point that has a straight, narrow, vertical shape.

Narrow points 2 to 4 inches wide require a shank spacing of about 24 inches for best results. Wider shovels or lister bottoms that create a larger ridge can be spaced 36 to 48 inches apart. Tillage depth to produce maximum roughness generally varies between 4 and 12 inches, depending on soil conditions.

Moist or heavy soils often provide good ridges and clods with tillage depths of 4 to 8 inches. Dry or sandy soils generally require deeper tillage.

Field speed for emergency tillage depends on the implement, soil conditions, and depth of tillage. In general, slow speeds produce more clods while faster speeds provide more ridging effect. Speeds of 3 to 4 mph usually result in the most effective surface. For best results, vary both implement depth and field speed to determine the combination producing maximum overall roughness.

It often is difficult to obtain effective clods and roughness in sandy soils, and the roughness is often short-lived. Wide shovels or lister bottoms spaced 40 to 50 inches apart usually provide the best combination of clods and ridges in sandy soil.

If more than one emergency tillage operation is anticipated, use a shallow depth (4 to 6 inches) the first time. Follow with a deeper tillage the second time, with new furrows spaced between the original furrows. Vary the face angle of the tillage tool, depth of operation, and field speed to obtain the best combination.

In sandy soils it usually is best to anticipate emergency tillage will be required, and time the operation to obtain the best roughness. Some operators obtain best results soon after a rainfall when the soil is moist and the implement shanks follow tractor tire tracks. Clods readily form in sandy soil when the soil surface is moist and has been lightly compacted.

Other operators prefer a soil ripper to bring up large, dry clods when subsurface soil is dry. Still others attempt to time the operation when the top two inches of soil is frozen, to bring up frozen clods. One danger is that the soil may freeze too fast or too deep before the operation is completed.

Emergency tillage can be used in a field planted to winter wheat. If wind erosion occurs, it is better to control the damage early using emergency tillage, rather than risk losing the entire crop. Use narrow chisel points spaced 4 to 6 feet apart, 4 to 6 inches deep. Tillage direction should be perpendicular or at an angle to the wheat row to minimize plant injury.

Data from a five year study at two sites in Kansas suggests this type of emergency tillage has minimal effect on potential yield, but can reduce the damage to growing wheat and can reduce soil loss in moderate erosion situations. This study found emergency tillage caused the most damage to wheat yields when the wheat had just emerged. The least yield reduction was found when the tillage was done in fields with wheat plants already tillered. Emergency tillage is not effective if clods cannot be brought to the surface, and is not possible after the soil has frozen more than 2 inches deep.

Row crops just planted or just emerged often are vulnerable to wind erosion, and can be protected by emergency tillage. Growers often equip their planters with narrow, flat running sweeps to pull clods to the surface during planting. This is especially important between crop rows where tractor or planter tires leave smooth surfaces with no clods.

After planting, rotary hoes, strippers (implements with several rotary hoe type wheels between each crop row) and cultivators are used to create clods on the soil surface. These operations are carried out both in anticipation of wind erosion, and after erosion begins. The most effective time is often after a rain. A heavy rain will melt any clods present and create a soil surface that blows easily.

Effective clods can be created at the soil surface if emergency tillage is done soon after the rain when there is considerable moisture in the top 2 inches of soil. Although emergency tillage can be effective in row crop situations after the soil begins to erode, tillage in moist soil conditions in anticipation of erosion almost always will be better.

Tillage is also very effective in controlling rill and sheet erosion. The rough surface along with crop residues prevents rain water from carrying of soil particles and other organic matter.

Management Practices

Erosion control methods include maintaining a cover on the soil, particularly at times of the year when soil is most vulnerable to erosion. Winter cover crops, such as fall rye and winter wheat, can be planted after fall harvest so that soil is not left exposed over the normally barren and highly erosive fall and spring months. Ontario farms report using winter cover crops at double the figure for all of Canada (20 percent versus 10 percent). Grassed waterways, which are grassy strips in run-off depressions that provide a route for excess water, are generally used more in western Canada and Ontario than in the east.

There are several accepted Best Management Practices (BMP) that are used frequently in controlling erosion factors of both wind and water. They range from better utilization of the natural environment to the construction of artificial devices, but all can be effective in minimizing potential damage. Some of these BMPs include the following:

Crop rotation improves the overall efficiency of nitrogen uptake and utilization in the soil. If certain cover crops are planted in the winter, erosion and runoff is prevented when the ground thaws, and nutrients are trapped in the soil and released to the spring crops. Growing forages in rotations is the most common erosion control practice in Canada; 42 percent of farms report this practice. In general, the semi-arid regions of the Prairies have little opportunity to use forages for erosion control due to inadequate soil moisture during the growing season; in contrast, the important practice of "stubble mulch cropping" is commonly employed in these areas for erosion control.

There are many reasons why crop rotation is an effective way to make farmlands more productive.

1. The yield advantages of crops being rotated has been proven by data to be much higher than that of continuous crops.
2. There is evidence that conservation tillage systems which leave much of the prior crop residues on the soil surface are much better adapted to crop rotations than to that of continuous crops.
3. Rotating crops provides greater yield advantages when using some form of conservation tillage.
4. Residues from sod crops, corn, and soybeans influence certain soil physical properties that, in turn, influence soil drainage and aeration.
5. Rotating crops can reduce the potential for serious insect and disease infestations associated with specific residues. This is especially important if continuous corn or soybeans is produced under conservation tillage, since residues are left on the surface year 'round harbor insects and disease.

Contour Cultivation. On gently sloping land, contour cultivation, a special tillage practice carried out on the contour of the field, can

reduce the velocity of overland flow. Contour cultivation should not be carried out on steep slopes though, because it will merely make the erosion situation worse.

Strip Cropping. Strip cropping is a technique in which alternate strips of different crops are planted in the same field. There are three main types of this BMP: contour strip cropping, field strip cropping, and buffer strip cropping. This BMP is used to control both wind and water erosion. If the strips are planted along the contour, water damage can be minimized; in dry regions, if the strips are planted crosswise to the contour, wind damage is also minimized.

- In contour strip cropping there is a layout in which the crops follow a definite rotational sequence, and tillage is held closely to the exact contour of the field.
- When using the field strip cropping practice, strips of a uniform width are placed across the general slope of the land. When used with adequately grassed waterways, the strips may be used where topography is too irregular to make contour stripping practical.
- The buffer strip cropping technique can be employed by using strips of grass or legume crops laid out between contour strips of crops in irregular rotations. These strips may be even or irregular in width or placed on critical slope areas of the field.

Terraces

- Constructing bench-like channels, otherwise known as terraces, enables water to be stored temporarily on slopes to allow sediment deposition and water infiltration. There are three types of terraces: bench terraces, contour terraces, and parallel terraces. These BMPs also control erosion in wetter areas by reducing the length of the slope.
- Bench terraces reduce land slope and allow run off from the upper side of the terrace to go into a lower portion where it spreads out and infiltrates. This BMP is most often brought to mind when the word terrace is used, and is employed most often in various mountain regions around the world.
- Contour terraces have point rows and grassed waterway outlets that follow the lay of the land.
- Parallel terraces are so named because they are constructed parallel to each other, and where possible, in the direction of field operations. Parallel terraces eliminate the production losses associated with point rows and minimize the interference to farming operations when spaced at multiple widths of planting and harvesting equipment. A more specialized form of the parallel terrace includes the parallel tile outlet terrace. Terraces that are constructed in parallel and discharge runoff through subsurface drains are known as parallel tile outlet terraces. With

these terraces, water that is stored behind a terraced ridge is discharged through a surface inlet into a subsurface drain.

Grass Waterways. When trying to reduce the possibility of severe gully erosion, grassed waterways provide a helpful solution. They force storm runoff water to flow down the center of an established grass strip and can carry very large quantities of storm water across a field without erosion. Grass waterways are also used as filters to remove sediment, but may sometimes loose their effectiveness when too much sediment builds up in the waterways. To prevent this, it is important that crop residues, buffer strips, and other erosion control practices and structures be used along with grass waterways for maximum effectiveness.

Diversion Structures. Diversion structures are channels that are constructed across slopes that cause water to flow to a desired outlet. They are similar to grass waterways and are used most often for gully control.

Drop Structures. Drop structures are small dams used to stabilize steep waterways and other channels. They can handle large amounts of runoff water and are effective where falls are less than 2.5 meters. In channel stabilization, drop structures such as a straight drop spillway are constructed to direct the flow of water through a weir(some type of enclosure such as a fence or dam in a stream to raise the water level or to divert the flow), into a stilling basin where the energy of the water is dissipated before it flows into the channel below. The straight drop spillway may be used with drops only up to ten feet. Chutes and flumes are used much in the same manner for steeper grades.

Riparian Strips. Riparian strips are merely buffer strips of grass, shrubbery, plants, and other vegetation that grow on the banks of rivers and streams and areas with water conservation problems. The strips slow runoff and catch sediment. In shallow water flow, they can reduce sediment and the nutrients and herbicides attached to it by 30% to 50%.

Conservation Tillage. Regular conventional tillage provides a smooth, unridged soil surface that can encourage serious runoff and erosion problems on sloping crop land. Instead, conservation tillage is any tillage planting system that leaves at least 30% of the field surface covered with crop residue after planting is completed and involves reduced or minimum tillage.

There are several types of conservation tillage currently being used in the Midwest Corn Belt as effective BMPs. They include:

- No-till planting. This planting system prepares a seedbed 2 inches wide or less, leaving most of the surface undisturbed and still covered with crop residues. The result is a wetter, colder environment that protects the seed and soil with its insulating effect of the surface residue.

- Strip rotary tillage. A strip four to eight inches wide and two to four inches deep is prepared by a rotary tiller, while the rest of the soil is left undisturbed. The soil is conserved because of the crop residues between the tillage strips.
- Till planting. This plowing technique sweeps the crop residues into the area between the rows of crops. Soil density between these rows remains relatively high because of the absence of tillage. This soil is difficult for raindrops to detach and runoff to move.
- Annual ridges. Also known as permanent ridges or ridge tillage, the annual ridges are formed by using a rolling disk bedder, and planting is done after only minor spring seedbed preparation. The extent of soil conservation depends on the amount of residue left and the row direction. Planting on the contour plus increased surface residues greatly reduce soil loss.
- Chiseling. This system does not turn the soil over, but rather leaves it rough and cloddy with plenty of crop residue remaining. The soil density and amount of covering depends on the depth, size, shape, spacing, and so on of the chisel blades. The residue and rough, cloddy surface fo the soil reduces raindrops impact and reduces runoff velocities thus reducing erosion.
- Disking. This system pulverizes the soil and gives great soil density The effect is similar to that of chiseling with results also depending on the depth, size, spacing, and so on of the disk blades. The deeper the disking, the fewer the residues that remain on the surface.

Artificial Devices. Such artificial devices include earthen dams, broken rock, rock barriers, slat/brush fences, board walls, log, timber, or brick barriers, and verticle burlap windbreakers provide protection against wind water erosion. Brush matting, gravel, rock or spray-on adhesive may be used on the surface itself for protection from erosion. There are many BMPS that may be utilized, depending on the situation, severity, and surroundings of each case.

Earthen Dams. The main reasons for building dams are:

1. To trap sediment.
2. To stabilize drainage ways and reduce erosion.
3. To store excess water temporarily to reduce flood damage.
4. To store water for livestock, irrigation, household, or municipal use.

There are several types of dams, which include soil-saving dams, grade-stabilization dams, and flood control dams.

- Soil-saving Dams. Also known as a sediment storage dam, this

artificial BMP is designed to intercept and trap waterborne sediments. The dam usually has a principal spillway that allows water to slowly flow through, allowing the sediment to settle out. This spillway may be in the form of a notch or box inlet with sufficient freeboard so water will never overtop the dam.

- Grade-stabilization Dams. These dams are used to prevent gullies from eating back into fields, to stabilize or raise gully channel floors, or to drop water from terraces, waterways, or diversions to stream channels at lower elevations. The rapid growth of gullies often makes installation of a dam an urgent matter. The size and cost of the required structure or set of structures increases rapidly as the gully grows.
- Flood Control Dams. Most flood control dams serve two main purposes: flood control and grade stabilization. They also trap sediment but this is not a major objective. Flood control dams are built with the capacity to store the runoff from a ten- to fifty- year storm. This flood water passes from the storage pool by means of a principal spillway, usually a pipe thru the dam, over a period of several days. Runoff in excess of that from the designed storm passes immediately over an emergency spillway- usually a grassd waterway. Some flood control dams in dry and windy areas rarely contain any water but must have large capacities to control flash floods.

Broken Rock. Stone and broken rock coverings are a simple and long used technique to reduce erosion in waterways and gullies. "Riprap," which is a loose covering of stone on the soil surface, has been widely employed for this purpose. It has also been used on the front slopes of earthen dams to prevent wave action from wearing the front of the dam. The stones have been sorted and placed by hand in the past, but are now usually merely dumped over the surface and smoothed over with a machine. More rock is required this way, but the amount of labor is reduced. Broken rock is a very expensive technique that is being used less and less except for in areas where rock is a widely available natural resource.

Rock Barriers. A barrier or series of barriers is often needed to reduce the erosive power of water in steeply sloping waterways and in many gullies so vegetation can be established. Erosion is reduced by the flatter slope between barriers, and vegetation has a chance to grow on the more level areas.

Slat/Brush Fences. To anchor brush barriers in place, two rows of posts are driven vertically into the soil across the waterway or gully bed. Loose branches or small trees are packed tightly in between the rows of posts, making an impermeable barrier. The ends of the brush piles should be dug into the channel walls and the soil should be packed

tightly around them. The top of the brush pile normally is low in the middle so no water will flow around the ends.

Log Barriers. Logs may be used to form barriers in larger gullies. Sturdy posts are driven deeply into the channel sides and bottom as for brush barriers. The logs often must be dug into the bottom as well as the sides so they make firm contact with the soil.

Timber Barriers. Heavy dimension lumber or timber, or a series of thick posts driven closely together can also serve as a barrier. Posts should be driven vertically into the soil, deeper than the length of the exposed part above ground so the force of the water cannot overtop the barrier. Large thick pieces of termite-resistant wood help guarantee the long life of the structure.

Brick Barriers. Brick barriers can be used to stop gully erosion. A good foundation such as poured concrete or layered rock is necessary for any barrier built with bricks or blocks. This, along with supporting butresses, should resist the force of the water where the barrier meets the gully wall.

Soil Abrasion and Erosion Control

Dry soil conditions can present problems with wind erosion. Under windy conditions, dry, loose soil particles can become dislodged and airborne. This had been a serious problem in other parts of the country prior to implementing erosion control conservation practices, such as wind breaks and cover crops. Many microirrigated fields result in dry row middles and other non-cropped areas of the field. Similarly, fields between crop cycles may have bare, non-cropped soil conditions which become susceptible to drying and potential erosion.

Airborne soil particles, particularly sands, can also become abrasive to plants and fruit. These abrasions may provide an entrance on the surface of the plant tissue for plant pathogens or they may simply scar the surface of the fruit. Either situation can result in lower quality plants and fruit.

Drought tolerant cover crops may assist in preventing erosive conditions by taking advantage of natural rainfall. However, sometimes these crops may need initial irrigation water for germination or a periodic irrigation during periods of very low or infrequent rainfall.

Synthetic Polymer for Soil Erosion Control

Results from a USDA Agricultural Research Service study in Kimberly, Idaho indicated that polyacrylamide, a synthetic polymer, can reduce

soil erosion under furrow-irrigated agriculture to nearly zero. The scientists found that just 10 parts per million (equal to about a pinch of salt in 10 gallons of water) of polyacrylamide added to irrigation water prevented water from
carrying soil particles away as it flowed down furrows. The treatment was effective even when added during the first hour of the 8-12 hour irrigation period.

More than 23 million acres of U.S. corn, beans, barley, and other crops are watered by furrows. While furrow irrigation per se is not practiced in Virginia, other forms of irrigation, e.g. travelling gun, employed in the production of furrowed crops, i.e. potatoes, tobacco, etc., possess as much or greater potential for soil erosion. Over two billion tons of soil wash off the world's irrigated croplands annually and a soil additive such as polyacrylamide may have application in other situations where erosion hazards exist.

In another study, straw mulching and polyacrylamide injection treatments for furrow erosion control were evaluated in an on-farm comparison under deficit irrigation for irrigation performance, erosion reduction and crop yield under two slope conditions. Both treatments greatly reduced erosion and significantly affected irrigation performance.

Geomembranes

This material is used to line ponds in areas where the soil continues to seep water. It is also used to cover and protect equipment and other items from the elements.

Intercropping System for Erosion Control

According to a recent study from India, trees and woody tree crops on your farm may control erosion on sloping sites, improve soil physical conditions, fertility, hydrological characteristics. When interplanted with food crops, yields may decline, but the long term benefit to the soil gained from such an intercropping system is considerable.

The experiment was carried out on sloping laterite soils of south India, and included plantings of: Eucalyptus tereticornis, Leucaena leucocephala, cassava, groundnut, and french beans/cowpea.

Each crop was grown in monoculture as well as in intercropped plots. Five types of intercropping treatments were performed: 1 tree crop + cassava; 2 tree crop + cassava + groundnut; 3 tree crop + cassava + cowpea; 4 tree crop + groundnut; 5 tree crop + cowpea. Each set of treatments were carried out once with Leucaena and again with

Eucalyptus.

Effects on Yields. Yields of both cassava and the seasonal intercrops were reduced when grown in association with one of the tree crops. The pod yields of groundnut and cowpea were higher when intercropped with cassava and lower when grown in association with one of the tree crops + cassava. While intercropping with cassava reduced yields of Leucaena, it improved that of Eucalyptus. Forage yield of Leucaena was lowest (4.83 t/ha) when grown in association with cassava, and greatest (7.50 t/ha) when grown with cassava + groundnut.Eucalyptus benefited from association with cassava, as indicated by pre-harvest trunk girth. Cassava + groundnut intercropping resulted in the best growth of Eucalyptus, as judged by percent of trees with a girth greater than 30 cm. The maximum air dried wood yield (43.5 t/ha), however, was reached when the tree was grown with cassava + cowpea. Intercropping had a definite positive effect on Eucalyptus yield since monocropped plantings of Eucalyptus yielded only 30.1 t/ha of wood.

The benefit of intercropping tree crops with cassava is in the reduced run off and soil loss. The disadvantage of intercropping trees with cassava was that yields fell after the first year. Leucaena and Eucalyptus are very efficient in removing nutrients from the soil.

Effect on Soil Qualities. Initially the soil in all the plots was acidic, the organic carbon content was medium to high, and the nutrient availability was low to medium. The pH did not change after three years of cropping. The organic carbon content of the soil improved in plots of monocropped cassava and in plots of cassava intercropped with the tree crops, and showed a decline where tree crops were grown alone. Mono-cropping of Leucaena and Eucalyptus also reduced the available nutrients of the soil. During all three years the nutrient removal by cassava was greater when grown alone, as compared to the cassava-tree crop combinations. Of those combinations, cassava + Eucalyptus had the lowest nutrient removal rate.

Chemical assays of plant parts indicated that cassava utilized more soil nutrients when planted alone, and considerably less when grown with Eucalyptus. These results further demonstrate the aggressive habit of fast growing tree crops; they effectively utilize available nutrients and moisture at the expense of companion crops, and they considerably reduce soil fertility when grown continuously for three years, especially in monocultural plantation forests. If cassava were intercropped with the tree crops, however, the fertility status of the soil could be maintained without much deterioration.

Soil erosion was most effectively controlled in the two tier cropping of tree crop + cassava. Here the soil loss was 70%-80% less than mono crops of cassava, Eucalyptus, or Leucaena. Runoff and soil loss were effectively reduced when cassava was grown on staggered soil mounds

along with Eucalyptus and Leucaena, due to better canopy coverage of the soil surface. Canopy coverage by Leucaena and Eucalyptus was restricted by harvesting, thus reducing their erosion and runoff control potential. Intercropping of cassava has great potential to decrease soil loss substantially. Soil erosion which is normally accelerated by deforestation of tropical rain forests can be successfully minimized by a proper combination of agricultural crops with forest species.

Tropical Erosion/Conservation

Since the 1950s, the residents of Leon, in western Nicaragua, suffered from choking duststorms that blanketed houses and streets with pesticide-laden dirt. Fifteen years ago, landowners rejected a soil-conservation program intended to help solve the problem, but now they have embraced a resurrection of the project that more directly involves them.

The duststorms began when the trees that once covered the flat lands of Leon were cleared to make way for extensive cotton cultivation. Because of the resulting severe wind erosion, soils soon lost their fertility, while the dust-laced air caused serious respiratory illnesses. Villagers planted rows of trees, which totaled 744 miles (1,200 kms.) and covered 99,000 acres (40,000 hectares). Leafy curtains impeded the dusty winds, while tree roots helped hold soils in place. Each curtain was 10 meters wide, made of five rows of trees, with 400 meters between curtains.They planted mostly eucalyptus because it grows quickly and is wind resistant.

But local landowners were less than thrilled that their property had been usurped for the windbreaks. Some burned the trees while others cut them down for firewood or simply bulldozed them to the ground. An inventory taken in 1986 showed that only 384 miles (620 kms.) of windbreaks remained intact. With a total of $1.4 million from Finland, the project was re-introduced in 1992, this time with local participation. Project technicians worked alongside farmers to cultivate organic soybeans, peanuts, sesame seeds, melons and watermelons instead of cotton. They have restored the tree curtains to the original size. Many farmers have received training in how to sustainably manage the windbreaks by harvesting just a few trees at a time. They can use the eucalyptus as a natural medicine, for firewood, and building material.

Animal Wastes/Erosion Management Practice

A BMP (best management practice) means a land-use practice, or combination of practices that is determined to be the most effective, practicable, economical, and technologically sophisticated means to

better manage and utilize farm animal wastes and prevent or reduce soil erosion while at the same time protecting water quality.

A wide selection of voluntary, low-cost, easy-to-install BMP's that will help both small and large farm animal owners and breeders better manage, utilize, and dispose of manure are available. Also crops, vegetable, and nursery farm owners can increase soil fertility and soil water-holding campacity, and eliminate water drainage problems by installing BMP's.

BMP's for Manure Management and Soil Conservation Include:

- Diversions--A surface diversion steers water away from areas where farm animal waste is stored to prevent runoff of bacterial contaminants into nearby streams. It can be used in combination with other BMP's to improve on-farm drainage, reduce flooding of stalls, eliminate wet areas in paddock or pasture areas, and eliminate the safety hazards to
animals caused by rill and gully erosion.
- Filter or Vegetative Strip--Reduces runoff of absorbed nutrients, bacteria, and chemicals in sediment by intercepting and slowing water runoff between fields or from pasture areas following a rainstorm.
- Proper manure storage--Relocation of manure piles away from gutter downspots and concentrated flow areas (where water flows naturally following a rainstorm). Proper waste storage also helps conserve plant nutrients for later application.
- Gutters/Downspouts--Adding gutters to farm animal barns helps to keep water runoff clean so it can be diverted to a neaby waterway uncontaminated by bacteria, chemicals, and sediment. Gutters may also reduce erosion and water drainage problems on certain livestock operations.
- Fencing--Preventing farm animals from entering streams would eliminate any bacterial contamination threat due to direct waste contamination ofa waterway.
- Storage Structure--A storage structure can be custom-built to accommodate the needs of any farm animal owner or operation. A structure will reduce bacteria and nutrient losses. It may also facilitate pickup and disposal of farm animal wastes.
- Composting Management--Composting reduces bacteria and helps to prevent runoff of fecal coliform present in farm animal wastes. It also preserves plant nutrients for later use. Composted material can be spread on paddocks, cropland, nursery stock, or used for landscaping or home gardening needs. Spreading composted manure will also increase soil organic matter and soil moisture/nutrient holding capacity.
- Waste Storage Pond--A waste storage pond or lagoon will reduce

bacterial and nutrient pollution or nearby waterways by trapping bacteria, nutrients, and sediment. It also provides flexibility in managing farm animal wastes.

United States Governments Involvement

Government involvement as well as involvement from other planning agency in preventing the effects of soil erosion is not only important, but essential. In 1935 the Soil Conservation Service was established. It administers a broad program of assistance in soil and water conservation on the land in cooperation with Conservation Districts. This service provides these kinds of assistance at the request of farmers, ranchers, and other landowners:

1. Determining soil suitability guidelines based on the soil surveys for agriculture, housing, recreation, waste disposal, and road construction.
2. Recommending Best Management Practices for erosion control and water protection.
3. Designing sediment interception systems.
4. Designing water facilities such as farm ponds.
5. Planning recreational facilities.
6. Designing terrace, irrigation, and drainage systems.
7. Developing cropping systems to reduce erosion.
8. Recommending pasture plantings.
9. Developing range management guidelines.
10. Promoting wildlife and woodland conservation.
11. Supplying adapted planting materials for conservation planting.
12. Promoting surface mine reclamation guidelines.
13. Providing expertise on land use planning.

Related web pages:

- Communicating for Agriculture is a nonprofit organization dedicated to the needs of America's farmers and ranchers. They can be contacted at: http://www.cainc.org

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Commercial suppliers:

- Geo-Civ Products, Inc. provides a wide variety of civil engineering and architectural products, including:
  - Soil stabilization & drainage products

- Soil & embankment stabilization products
- Drainage control products
- Erosion control products
- Geomembranes

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

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Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Erosion

Soil erosion is a gradual process that occurs when the actions of water, wind, and other factors eat away and wear down the land, causing the soil to deteriorate or disappear completely. The main agents of soil erosion are wind, water, and tillage. Maintaining a continuous vegetative cover on the soil is usually the best way to control erosion. Soil deterioration and low quality of water due to erosion and run off has often become a severe problem around the world. Many times the problems become so severe that the land can no longer be cultivated and is abandoned. The key to minimizing soil erosion and saving the farm lands is the farmer himself. Ultimately, he is the one who must reduce the level at which erosion sediments are dislodged from his cropland.

Studies in water quality relating to agriculture have shown that, of the four to five billion tons of sediment being deposited in the country's streams each year, over half is coming from croplands. The deposited soil, which contains pesticides, farm chemicals, and nutrients vital to the crops but damaging to ground water, gets there mainly as a result of runoff due to rainstorms and sheet erosion.

Runoff occurs when the rainfall rate exceeds the soil's infiltration capacity. On sloping areas, runoff is a concern since it can carry soil particles, nutrients, and other chemicals with it.

Geological erosion occurs where soil is in its natural environment surrounded by its natural vegetation. This has been taking place naturally for millions of years and has helped create balance in uncultivated soil that enables plant growth. A classical example of the results of geological erosion is the Grand Canyon.

Accelerated erosion can be caused by man's activities, such as agriculture and construction, which alter the natural state of the environment.

Wind Erosion

Wind erosion, or "soil drifting" is caused by the action of wind on exposed soil, especially smooth, unprotected surfaces. Wind picks up finer soil particles and deposits them downwind. Improper tillage practices, low soil moisture, poor soil cover or any combinations thereof can increase the risk of wind erosion.

Drip irrigation is a successful, economical way to water new windbreaks.

- **Windbreaks** of trees and shrubs in a subdivision in North Dakota make an interesting pattern on the land.

- **A living snowfence** in Colorado beautifies the landscape and will stop blowing snow, keeping snow on the fields where moisture is needed.
- **Wind barriers** of grass and legume crops are rotated with row crops in Iowa.
- **Wheat residues** are left on the soil surface to protect an Oklahoma crop field.
- **Buffer strips** of weeping lovegrass protect a cottonfield in Texas.
- **Perennial grass** barriers protect cucumbers growing in South Carolina.
- **A combination** of wind barriers and ground cover protects soil.
- **Well-managed rangeland** protects highly erosive soil in Wyoming.

The second most common erosion control practice in Canada is the use of windbreaks or shelterbelts, which are lines of trees or bushes planted at the borders of or within fields, normally at right angles to the prevailing winds (maintaining natural vegetation along fencelines has the same effect). This technique is most commonly used in the Prairies (29 to 37 percent of farms), where the flat terrain, minimal natural brush protection, large fields, and frequency of high winds make cultivated land especially vulnerable to wind erosion. Ontario farms also report substantial use of windbreaks (21 percent of farms).

Water Erosion

Water erosion occurs when rain, spring run-off, or floodwater carry soil particles away. This can occur through sheet erosion, where soil materials are removed relatively uniformly, or rill erosion where flowing water creates small channels in the soil, called rills, and larger channels, called gullies. The extent of water erosion depends on the amount of soil cover, soil texture, the length and grade of the field slope, the amount and timing of heavy rainfall, and the tillage and cropping practices used. Raindrops can be a major problem for farmers when they strike bare soil. With an impact of up to 30 mph, rain washes out seed and splashes soil into the air. If the fields are on a slope the soil is splashed downhill which causes deterioration of soil structure. Soil that has been detached by raindrops is more easily moved than soil that has not been detached.

Sheet erosion is caused by raindrops. Sheet erosion is defined as the uniform removal of soil in thin layers from sloping land. This, of course, is nearly impossible; in reality the loose soil merely runs off with the rain.

Rill erosion is the most common form of erosion. Although its effects can be easily removed by tillage, it is the most often overlooked. It occurs when soil is removed by water from little streamlets that run through land with poor surface draining. Rills can often be found in between crop rows.

Gullies are larger than rills and cannot be fixed by tillage. Gully erosion is an advanced stage of rill erosion, just as rills are often the result of sheet erosion.

Tillage

Tillage erosion happens when the action of tilling drags soil downhill. The extent of tillage erosion

depends on the shape and gradient of the slope, the type of equipment, depth of tillage, the speed at which tillage equipment is used, and the number of tillage operations.

Tillage and planting practices that reduce erosion include contour cultivation and strip-cropping. Contour cultivation is cultivation that follows the contours of a field, producing furrows that run perpendicular or at angles to the slope-line of a field. This creates an irregular surface that breaks up the downslope movement of water and thus reduces water erosion of the soil. This cultivation technique is practiced in Canada in the Prairies (11 to 18 percent of farms) and Prince Edward Island (10 percent of farms). Strip-cropping, a technique that involves alternating strips (50 to 200 metres wide) of crop and summerfallow or of two crops across a field, is less commonly used in Canada.

Tillage practices are used for wind erosion control by producing a rough, cloddy surface that maintains surface residue and conserves soil moisture. When used along with crop residues, also known as stubble mulch tillage, reduced tillage, or conservation tillage, it reduces wind velocity and traps eroding soil.

An implement used for emergency wind erosion control should gently lift the soil, creating as many and as large of clods as possible. Disks and harrow-type implements with several ranks of closely spaced tines generally will not be effective, and should not be used.

In fine or medium textured soils, most types of chisel, lister, or broad shovel points create a ridge and bring clods to the surface. The shank and/or point should produce a gentle lifting action to bring clods to the surface and to avoid breaking them. An angled, wide point which lifts the soil usually creates larger clods and a larger ridge than a point that has a straight, narrow, vertical shape.

Narrow points 2 to 4 inches wide require a shank spacing of about 24 inches for best results. Wider shovels or lister bottoms that create a larger ridge can be spaced 36 to 48 inches apart. Tillage depth to produce maximum roughness generally varies between 4 and 12 inches, depending on soil conditions.

Moist or heavy soils often provide good ridges and clods with tillage depths of 4 to 8 inches. Dry or sandy soils generally require deeper tillage.

Field speed for emergency tillage depends on the implement, soil conditions, and depth of tillage. In general, slow speeds produce more clods while faster speeds provide more ridging effect. Speeds of 3 to 4 mph usually result in the most effective surface. For best results, vary both implement depth and field speed to determine the combination producing maximum overall roughness.

It often is difficult to obtain effective clods and roughness in sandy soils, and the roughness is often short-lived. Wide shovels or lister bottoms spaced 40 to 50 inches apart usually provide the best combination of clods and ridges in sandy soil.

If more than one emergency tillage operation is anticipated, use a shallow depth (4 to 6 inches) the first time. Follow with a deeper tillage the second time, with new furrows spaced between the original furrows. Vary the face angle of the tillage tool, depth of operation, and field speed to obtain the best combination.

In sandy soils it usually is best to anticipate emergency tillage will be required, and time the operation to obtain the best roughness. Some operators obtain best results soon after a rainfall when the soil is moist and the implement shanks follow tractor tire tracks. Clods readily form in sandy soil when the soil surface is moist and has been lightly compacted.

Other operators prefer a soil ripper to bring up large, dry clods when subsurface soil is dry. Still others attempt to time the operation when the top two inches of soil is frozen, to bring up frozen clods. One danger is that the soil may freeze too fast or too deep before the operation is completed.

Emergency tillage can be used in a field planted to winter wheat. If wind erosion occurs, it is better to control the damage early using emergency tillage, rather than risk losing the entire crop. Use narrow chisel points spaced 4 to 6 feet apart, 4 to 6 inches deep. Tillage direction should be perpendicular or at an angle to the wheat row to minimize plant injury.

Data from a five year study at two sites in Kansas suggests this type of emergency tillage has minimal effect on potential yield, but can reduce the damage to growing wheat and can reduce soil loss in moderate erosion situations. This study found emergency tillage caused the most damage to wheat yields when the wheat had just emerged. The least yield reduction was found when the tillage was done in fields with wheat plants already tillered. Emergency tillage is not effective if clods cannot be brought to the surface, and is not possible after the soil has frozen more than 2 inches deep.

Row crops just planted or just emerged often are vulnerable to wind erosion, and can be protected by emergency tillage. Growers often equip their planters with narrow, flat running sweeps to pull clods to the surface during planting. This is especially important between crop rows where tractor or planter tires leave smooth surfaces with no clods.

After planting, rotary hoes, strippers (implements with several rotary hoe type wheels between each crop row) and cultivators are used to create clods on the soil surface. These operations are carried out both in anticipation of wind erosion, and after erosion begins. The most effective time is often after a rain. A heavy rain will melt any clods present and create a soil surface that blows easily.

Effective clods can be created at the soil surface if emergency tillage is done soon after the rain when there is considerable moisture in the top 2 inches of soil. Although emergency tillage can be effective in row crop situations after the soil begins to erode, tillage in moist soil conditions in anticipation of erosion almost always will be better.

Tillage is also very effective in controlling rill and sheet erosion. The rough surface along with crop residues prevents rain water from carrying of soil particles and other organic matter.

Management Practices

Erosion control methods include maintaining a cover on the soil, particularly at times of the year when soil is most vulnerable to erosion. Winter cover crops, such as fall rye and winter wheat, can be planted after fall harvest so that soil is not left exposed over the normally barren and highly erosive fall and spring months. Ontario farms report using winter cover crops at double the figure

for all of Canada (20 percent versus 10 percent). Grassed waterways, which are grassy strips in run-off depressions that provide a route for excess water, are generally used more in western Canada and Ontario than in the east.

There are several accepted Best Management Practices (BMP) that are used frequently in controlling erosion factors of both wind and water. They range from better utilization of the natural environment to the construction of artificial devices, but all can be effective in minimizing potential damage. Some of these BMPs include the following:

Crop rotation improves the overall efficiency of nitrogen uptake and utilization in the soil. If certain cover crops are planted in the winter, erosion and runoff is prevented when the ground thaws, and nutrients are trapped in the soil and released to the spring crops. Growing forages in rotations is the most common erosion control practice in Canada; 42 percent of farms report this practice. In general, the semi-arid regions of the Prairies have little opportunity to use forages for erosion control due to inadequate soil moisture during the growing season; in contrast, the important practice of "stubble mulch cropping" is commonly employed in these areas for erosion control.

There are many reasons why crop rotation is an effective way to make farmlands more productive.

1. The yield advantages of crops being rotated has been proven by data to be much higher than that of continuous crops.
2. There is evidence that conservation tillage systems which leave much of the prior crop residues on the soil surface are much better adapted to crop rotations than to that of continuous crops.
3. Rotating crops provides greater yield advantages when using some form of conservation tillage.
4. Residues from sod crops, corn, and soybeans influence certain soil physical properties that, in turn, influence soil drainage and aeration.
5. Rotating crops can reduce the potential for serious insect and disease infestations associated with specific residues. This is especially important if continuous corn or soybeans is produced under conservation tillage, since residues are left on the surface year 'round harbor insects and disease.

Contour Cultivation. On gently sloping land, contour cultivation, a special tillage practice carried out on the contour of the field, can reduce the velocity of overland flow. Contour cultivation should not be carried out on steep slopes though, because it will merely make the erosion situation worse.

Strip Cropping. Strip cropping is a technique in which alternate strips of different crops are planted in the same field. There are three main types of this BMP: contour strip cropping, field strip cropping, and buffer strip cropping. This BMP is used to control both wind and water erosion. If the strips are planted along the contour, water damage can be minimized; in dry regions, if the strips are planted crosswise to the contour, wind damage is also minimized.

- In contour strip cropping there is a layout in which the crops follow a definite rotational sequence, and tillage is held closely to the exact contour of the field.
- When using the field strip cropping practice, strips of a uniform width are placed across the

general slope of the land. When used with adequately grassed waterways, the strips may be used where topography is too irregular to make contour stripping practical.

- The buffer strip cropping technique can be employed by using strips of grass or legume crops laid out between contour strips of crops in irregular rotations. These strips may be even or irregular in width or placed on critical slope areas of the field.

Terraces

- Constructing bench-like channels, otherwise known as terraces, enables water to be stored temporarily on slopes to allow sediment deposition and water infiltration. There are three types of terraces: bench terraces, contour terraces, and parallel terraces. These BMPs also control erosion in wetter areas by reducing the length of the slope.
- Bench terraces reduce land slope and allow run off from the upper side of the terrace to go into a lower portion where it spreads out and infiltrates. This BMP is most often brought to mind when the word terrace is used, and is employed most often in various mountain regions around the world.
- Contour terraces have point rows and grassed waterway outlets that follow the lay of the land.
- Parallel terraces are so named because they are constructed parallel to each other, and where possible, in the direction of field operations. Parallel terraces eliminate the production losses associated with point rows and minimize the interference to farming operations when spaced at multiple widths of planting and harvesting equipment. A more specialized form of the parallel terrace includes the parallel tile outlet terrace. Terraces that are constructed in parallel and discharge runoff through subsurface drains are known as parallel tile outlet terraces. With these terraces, water that is stored behind a terraced ridge is discharged through a surface inlet into a subsurface drain.

Grass Waterways. When trying to reduce the possibility of severe gully erosion, grassed waterways provide a helpful solution. They force storm runoff water to flow down the center of an established grass strip and can carry very large quantities of storm water across a field without erosion. Grass waterways are also used as filters to remove sediment, but may sometimes loose their effectiveness when too much sediment builds up in the waterways. To prevent this, it is important that crop residues, buffer strips, and other erosion control practices and structures be used along with grass waterways for maximum effectiveness.

Diversion Structures. Diversion structures are channels that are constructed across slopes that cause water to flow to a desired outlet. They are similar to grass waterways and are used most often for gully control.

Drop Structures. Drop structures are small dams used to stabilize steep waterways and other channels. They can handle large amounts of runoff water and are effective where falls are less than 2.5 meters. In channel stabilization, drop structures such as a straight drop spillway are constructed to direct the flow of water through a weir(some type of enclosure such as a fence or dam in a stream to raise the water level or to divert the flow), into a stilling basin where the energy of the water is dissipated before it flows into the channel below. The straight drop spillway may be used with drops only up to ten feet. Chutes and flumes are used much in the same manner for steeper grades.

Riparian Strips. Riparian strips are merely buffer strips of grass, shrubbery, plants, and other vegetation that grow on the banks of rivers and streams and areas with water conservation problems. The strips slow runoff and catch sediment. In shallow water flow, they can reduce sediment and the nutrients and herbicides attached to it by 30% to 50%.

Conservation Tillage. Regular conventional tillage provides a smooth, unridged soil surface that can encourage serious runoff and erosion problems on sloping crop land. Instead, conservation tillage is any tillage planting system that leaves at least 30% of the field surface covered with crop residue after planting is completed and involves reduced or minimum tillage.

There are several types of conservation tillage currently being used in the Midwest Corn Belt as effective BMPs. They include:

- No-till planting. This planting system prepares a seedbed 2 inches wide or less, leaving most of the surface undisturbed and still covered with crop residues. The result is a wetter, colder environment that protects the seed and soil with its insulating effect of the surface residue.
- Strip rotary tillage. A strip four to eight inches wide and two to four inches deep is prepared by a rotary tiller, while the rest of the soil is left undisturbed. The soil is conserved because of the crop residues between the tillage strips.
- Till planting. This plowing technique sweeps the crop residues into the area between the rows of crops. Soil density between these rows remains relatively high because of the absence of tillage. This soil is difficult for raindrops to detach and runoff to move.
- Annual ridges. Also known as permanent ridges or ridge tillage, the annual ridges are formed by using a rolling disk bedder, and planting is done after only minor spring seedbed preparation. The extent of soil conservation depends on the amount of residue left and the row direction. Planting on the contour plus increased surface residues greatly reduce soil loss.
- Chiseling. This system does not turn the soil over, but rather leaves it rough and cloddy with plenty of crop residue remaining. The soil density and amount of covering depends on the depth, size, shape, spacing, and so on of the chisel blades. The residue and rough, cloddy surface fo the soil reduces raindrops impact and reduces runoff velocities thus reducing erosion.
- Disking. This system pulverizes the soil and gives great soil density The effect is similar to that of chiseling with results also depending on the depth, size, spacing, and so on of the disk blades. The deeper the disking, the fewer the residues that remain on the surface.

Artificial Devices. Such artificial devices include earthen dams, broken rock, rock barriers, slat/brush fences, board walls, log, timber, or brick barriers, and verticle burlap windbreakers provide protection against wind water erosion. Brush matting, gravel, rock or spray-on adhesive may be used on the surface itself for protection from erosion. There are many BMPS that may be utilized, depending on the situation, severity, and surroundings of each case.

Earthen Dams. The main reasons for building dams are:

1. To trap sediment.
2. To stabilize drainage ways and reduce erosion.

3. To store excess water temporarily to reduce flood damage.
4. To store water for livestock, irrigation, household, or municipal use.

There are several types of dams, which include soil-saving dams, grade-stabilization dams, and flood control dams.

- Soil-saving Dams. Also known as a sediment storage dam, this artificial BMP is designed to intercept and trap waterborne sediments. The dam usually has a principal spillway that allows water to slowly flow through, allowing the sediment to settle out. This spillway may be in the form of a notch or box inlet with sufficient freeboard so water will never overtop the dam.
- Grade-stabilization Dams. These dams are used to prevent gullies from eating back into fields, to stabilize or raise gully channel floors, or to drop water from terraces, waterways, or diversions to stream channels at lower elevations. The rapid growth of gullies often makes installation of a dam an urgent matter. The size and cost of the required structure or set of structures increases rapidly as the gully grows.
- Flood Control Dams. Most flood control dams serve two main purposes: flood control and grade stabilization. They also trap sediment but this is not a major objective. Flood control dams are built with the capacity to store the runoff from a ten- to fifty- year storm. This flood water passes from the storage pool by means of a principal spillway, usually a pipe thru the dam, over a period of several days. Runoff in excess of that from the designed storm passes immediately over an emergency spillway- usually a grassd waterway. Some flood control dams in dry and windy areas rarely contain any water but must have large capacities to control flash floods.

Broken Rock. Stone and broken rock coverings are a simple and long used technique to reduce erosion in waterways and gullies. "Riprap," which is a loose covering of stone on the soil surface, has been widely employed for this purpose. It has also been used on the front slopes of earthen dams to prevent wave action from wearing the front of the dam. The stones have been sorted and placed by hand in the past, but are now usually merely dumped over the surface and smoothed over with a machine. More rock is required this way, but the amount of labor is reduced. Broken rock is a very expensive technique that is being used less and less except for in areas where rock is a widely available natural resource.

Rock Barriers. A barrier or series of barriers is often needed to reduce the erosive power of water in steeply sloping waterways and in many gullies so vegetation can be established. Erosion is reduced by the flatter slope between barriers, and vegetation has a chance to grow on the more level areas.

Slat/Brush Fences. To anchor brush barriers in place, two rows of posts are driven vertically into the soil across the waterway or gully bed. Loose branches or small trees are packed tightly in between the rows of posts, making an impermeable barrier. The ends of the brush piles should be dug into the channel walls and the soil should be packed tightly around them. The top of the brush pile normally is low in the middle so no water will flow around the ends.

Log Barriers. Logs may be used to form barriers in larger gullies. Sturdy posts are driven deeply into the channel sides and bottom as for brush barriers. The logs often must be dug into the bottom

as well as the sides so they make firm contact with the soil.

Timber Barriers. Heavy dimension lumber or timber, or a series of thick posts driven closely together can also serve as a barrier. Posts should be driven vertically into the soil, deeper than the length of the exposed part above ground so the force of the water cannot overtop the barrier. Large thick pieces of termite-resistant wood help guarantee the long life of the structure.

Brick Barriers. Brick barriers can be used to stop gully erosion. A good foundation such as poured concrete or layered rock is necessary for any barrier built with bricks or blocks. This, along with supporting butresses, should resist the force of the water where the barrier meets the gully wall.

Soil Abrasion and Erosion Control

Dry soil conditions can present problems with wind erosion. Under windy conditions, dry, loose soil particles can become dislodged and airborne. This had been a serious problem in other parts of the country prior to implementing erosion control conservation practices, such as wind breaks and cover crops. Many microirrigated fields result in dry row middles and other non-cropped areas of the field. Similarly, fields between crop cycles may have bare, non-cropped soil conditions which become susceptible to drying and potential erosion.

Airborne soil particles, particularly sands, can also become abrasive to plants and fruit. These abrasions may provide an entrance on the surface of the plant tissue for plant pathogens or they may simply scar the surface of the fruit. Either situation can result in lower quality plants and fruit.

Drought tolerant cover crops may assist in preventing erosive conditions by taking advantage of natural rainfall. However, sometimes these crops may need initial irrigation water for germination or a periodic irrigation during periods of very low or infrequent rainfall.

Synthetic Polymer for Soil Erosion Control

Results from a USDA Agricultural Research Service study in Kimberly, Idaho indicated that polyacrylamide, a synthetic polymer, can reduce soil erosion under furrow-irrigated agriculture to nearly zero. The scientists found that just 10 parts per million (equal to about a pinch of salt in 10 gallons of water) of polyacrylamide added to irrigation water prevented water from carrying soil particles away as it flowed down furrows. The treatment was effective even when added during the first hour of the 8-12 hour irrigation period.

More than 23 million acres of U.S. corn, beans, barley, and other crops are watered by furrows. While furrow irrigation per se is not practiced in Virginia, other forms of irrigation, e.g. travelling gun, employed in the production of furrowed crops, i.e. potatoes, tobacco, etc., possess as much or greater potential for soil erosion. Over two billion tons of soil wash off the world's irrigated croplands annually and a soil additive such as polyacrylamide may have application in other situations where erosion hazards exist.

In another study, straw mulching and polyacrylamide injection treatments for furrow erosion control were evaluated in an on-farm comparison under deficit irrigation for irrigation performance, erosion reduction and crop yield under two slope conditions. Both treatments greatly

reduced erosion and significantly affected irrigation performance.

Geomembranes

This material is used to line ponds in areas where the soil continues to seep water. It is also used to cover and protect equipment and other items from the elements.

Intercropping System for Erosion Control

According to a recent study from India, trees and woody tree crops on your farm may control erosion on sloping sites, improve soil physical conditions, fertility, hydrological characteristics. When interplanted with food crops, yields may decline, but the long term benefit to the soil gained from such an intercropping system is considerable.

The experiment was carried out on sloping laterite soils of south India, and included plantings of: Eucalyptus tereticornis, Leucaena leucocephala, cassava, groundnut, and french beans/cowpea.

Each crop was grown in monoculture as well as in intercropped plots. Five types of intercropping treatments were performed: 1 tree crop + cassava; 2 tree crop + cassava + groundnut; 3 tree crop + cassava + cowpea; 4 tree crop + groundnut; 5 tree crop + cowpea. Each set of treatments were carried out once with Leucaena and again with Eucalyptus.

Effects on Yields. Yields of both cassava and the seasonal intercrops were reduced when grown in association with one of the tree crops. The pod yields of groundnut and cowpea were higher when intercropped with cassava and lower when grown in association with one of the tree crops + cassava. While intercropping with cassava reduced yields of Leucaena, it improved that of Eucalyptus. Forage yield of Leucaena was lowest (4.83 t/ha) when grown in association with cassava, and greatest (7.50 t/ha) when grown with cassava + groundnut.Eucalyptus benefited from association with cassava, as indicated by pre-harvest trunk girth. Cassava + groundnut intercropping resulted in the best growth of Eucalyptus, as judged by percent of trees with a girth greater than 30 cm. The maximum air dried wood yield (43.5 t/ha), however, was reached when the tree was grown with cassava + cowpea. Intercropping had a definite positive effect on Eucalyptus yield since monocropped plantings of Eucalyptus yielded only 30.1 t/ha of wood.

The benefit of intercropping tree crops with cassava is in the reduced run off and soil loss. The disadvantage of intercropping trees with cassava was that yields fell after the first year. Leucaena and Eucalyptus are very efficient in removing nutrients from the soil.

Effect on Soil Qualities. Initially the soil in all the plots was acidic, the organic carbon content was medium to high, and the nutrient availability was low to medium. The pH did not change after three years of cropping. The organic carbon content of the soil improved in plots of monocropped cassava and in plots of cassava intercropped with the tree crops, and showed a decline where tree crops were grown alone. Mono-cropping of Leucaena and Eucalyptus also reduced the available nutrients of the soil. During all three years the nutrient removal by cassava was greater when grown alone, as compared to the cassava-tree crop combinations. Of those combinations, cassava + Eucalyptus had the lowest nutrient removal rate.

Chemical assays of plant parts indicated that cassava utilized more soil nutrients when planted alone, and considerably less when grown with Eucalyptus. These results further demonstrate the aggressive habit of fast growing tree crops; they effectively utilize available nutrients and moisture at the expense of companion crops, and they considerably reduce soil fertility when grown continuously for three years, especially in monocultural plantation forests. If cassava were intercropped with the tree crops, however, the fertility status of the soil could be maintained without much deterioration.

Soil erosion was most effectively controlled in the two tier cropping of tree crop + cassava. Here the soil loss was 70%-80% less than mono crops of cassava, Eucalyptus, or Leucaena. Runoff and soil loss were effectively reduced when cassava was grown on staggered soil mounds along with Eucalyptus and Leucaena, due to better canopy coverage of the soil surface. Canopy coverage by Leucaena and Eucalyptus was restricted by harvesting, thus reducing their erosion and runoff control potential. Intercropping of cassava has great potential to decrease soil loss substantially. Soil erosion which is normally accelerated by deforestation of tropical rain forests can be successfully minimized by a proper combination of agricultural crops with forest species.

Tropical Erosion/Conservation

Since the 1950s, the residents of Leon, in western Nicaragua, suffered from choking duststorms that blanketed houses and streets with pesticide-laden dirt. Fifteen years ago, landowners rejected a soil-conservation program intended to help solve the problem, but now they have embraced a resurrection of the project that more directly involves them.

The duststorms began when the trees that once covered the flat lands of Leon were cleared to make way for extensive cotton cultivation. Because of the resulting severe wind erosion, soils soon lost their fertility, while the dust-laced air caused serious respiratory illnesses. Villagers planted rows of trees, which totaled 744 miles (1,200 kms.) and covered 99,000 acres (40,000 hectares). Leafy curtains impeded the dusty winds, while tree roots helped hold soils in place. Each curtain was 10 meters wide, made of five rows of trees, with 400 meters between curtains.They planted mostly eucalyptus because it grows quickly and is wind resistant.

But local landowners were less than thrilled that their property had been usurped for the windbreaks. Some burned the trees while others cut them down for firewood or simply bulldozed them to the ground. An inventory taken in 1986 showed that only 384 miles (620 kms.) of windbreaks remained intact. With a total of $1.4 million from Finland, the project was re-introduced in 1992, this time with local participation. Project technicians worked alongside farmers to cultivate organic soybeans, peanuts, sesame seeds, melons and watermelons instead of cotton. They have restored the tree curtains to the original size. Many farmers have received training in how to sustainably manage the windbreaks by harvesting just a few trees at a time. They can use the eucalyptus as a natural medicine, for firewood, and building material.

Animal Wastes/Erosion Management Practice

A BMP (best management practice) means a land-use practice, or combination of practices that is

determined to be the most effective, practicable, economical, and technologically sophisticated means to better manage and utilize farm animal wastes and prevent or reduce soil erosion while at the same time protecting water quality.

A wide selection of voluntary, low-cost, easy-to-install BMP's that will help both small and large farm animal owners and breeders better manage, utilize, and dispose of manure are available. Also crops, vegetable, and nursery farm owners can increase soil fertility and soil water-holding campacity, and eliminate water drainage problems by installing BMP's.

BMP's for Manure Management and Soil Conservation Include:

- Diversions--A surface diversion steers water away from areas where farm animal waste is stored to prevent runoff of bacterial contaminants into nearby streams. It can be used in combination with other BMP's to improve on-farm drainage, reduce flooding of stalls, eliminate wet areas in paddock or pasture areas, and eliminate the safety hazards to animals caused by rill and gully erosion.
- Filter or Vegetative Strip--Reduces runoff of absorbed nutrients, bacteria, and chemicals in sediment by intercepting and slowing water runoff between fields or from pasture areas following a rainstorm.
- Proper manure storage--Relocation of manure piles away from gutter downspots and concentrated flow areas (where water flows naturally following a rainstorm). Proper waste storage also helps conserve plant nutrients for later application.
- Gutters/Downspouts--Adding gutters to farm animal barns helps to keep water runoff clean so it can be diverted to a neaby waterway uncontaminated by bacteria, chemicals, and sediment. Gutters may also reduce erosion and water drainage problems on certain livestock operations.
- Fencing--Preventing farm animals from entering streams would eliminate any bacterial contamination threat due to direct waste contamination ofa waterway.
- Storage Structure--A storage structure can be custom-built to accommodate the needs of any farm animal owner or operation. A structure will reduce bacteria and nutrient losses. It may also facilitate pickup and disposal of farm animal wastes.
- Composting Management--Composting reduces bacteria and helps to prevent runoff of fecal coliform present in farm animal wastes. It also preserves plant nutrients for later use. Composted material can be spread on paddocks, cropland, nursery stock, or used for landscaping or home gardening needs. Spreading composted manure will also increase soil organic matter and soil moisture/nutrient holding capacity.
- Waste Storage Pond--A waste storage pond or lagoon will reduce bacterial and nutrient pollution or nearby waterways by trapping bacteria, nutrients, and sediment. It also provides flexibility in managing farm animal wastes.

United States Governments Involvement

Government involvement as well as involvement from other planning agency in preventing the effects of soil erosion is not only important, but essential. In 1935 the Soil Conservation Service was established. It administers a broad program of assistance in soil and water conservation on the

land in cooperation with Conservation Districts. This service provides these kinds of assistance at the request of farmers, ranchers, and other landowners:

1. Determining soil suitability guidelines based on the soil surveys for agriculture, housing, recreation, waste disposal, and road construction.
2. Recommending Best Management Practices for erosion control and water protection.
3. Designing sediment interception systems.
4. Designing water facilities such as farm ponds.
5. Planning recreational facilities.
6. Designing terrace, irrigation, and drainage systems.
7. Developing cropping systems to reduce erosion.
8. Recommending pasture plantings.
9. Developing range management guidelines.
10. Promoting wildlife and woodland conservation.
11. Supplying adapted planting materials for conservation planting.
12. Promoting surface mine reclamation guidelines.
13. Providing expertise on land use planning.

Related web pages:

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Commercial suppliers:

- Geo-Civ Products, Inc. provides a wide variety of civil engineering and architectural products, including:
  - Soil stabilization & drainage products
  - Soil & embankment stabilization products
  - Drainage control products
  - Erosion control products
  - Geomembranes

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Erosion Control Management

Frequently Asked Questions Other Information Sources Return to Property Management

Frequently Asked Questions:

- Erosion Control Management

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Erosion Control Management

Erosion can reduce the productive value of your land, degrade surface water quality, and cause sedimentation problems on adjoining land.

Soil in surface water causes several problems:

- Increases filtration costs for downstream domestic, municipal, and irrigation uses
- Degrades habitat for salmon, trout, and other beneficial wildlife
- Reduces scenic and recreational values of the river
- Undesirable pesticides, bacteria, or phosphorus may be attached to soil particles

Benefits of Effective Erosion Control:

- Protects long term productivity of the topsoil.
- Prevents damage to lands or property.
- Improves land appearance.
- Prevents complaints.

Objectives:

- Reduce soil and sediment in stream water to protect all beneficial uses.
- Maintain productivity of soil on your land.
- Reduce need for fertilizer and/or tillege, which can reduce production costs
- Maintain desirable land values and appearance.

Erosion Control recommendations include two basic components

With increasing concern for protection of water quality for beneficial

uses, management plans for rural erosion control are being considered or have been adopted in watersheds throughout Oregon.

- Manage lands so that runoff does not cause gully erosion on the managed land, or on lands downslope.
- Conduct livestock and crop activities so that any resulting erosion is below the established tolerable rate. As a rule of thumb, if erosion is noticable, erosion is probably exceeding the tolerable erosion rate.

Recommendations:

- **Pasture management -** Cross fence pastures for grazing rotation to maintain good ground cover. Remove livestock from field before forage is below three inches in height. In late May or early June, clip pasture to restore plant vigor and reduce weed seed formation. Turn animals back into the pasture when grass is six to eight inches high. To increase total pasture productivity and protect soil, hold animals in a winter paddock or level sacrifice area and provide hay when pasture is not actively growing. (See Pasture Management).
- **Roof runoff management** - Install gutters on roofs, with downspout outlets on grassed, level, non-erosive areas. Locate water outlets to avoid runoff to bare soil, steep slopes, or areas with manure.
- **Protect streambanks and hills from erosion -** Keep animals away from slopes during wet weather. Keep slopes in thick ground cover. (See Near-Stream Management). Plant slopes with grass, shrubs, and small trees to stabilize soil. Native varieties are recommended.
- **Contour tillage** - On slopes, make tillage and planting operations on the contour. This will slow runoff, increase infiltration, and reduce erosion.
- **Waterways -** Plant turf grass in ditches, swales, or other waterways or install an inlet structure with pipeline to carry water safely around an erosive area. Thick grass ground cover will hold the soil, slow runoff speed, and increase infiltration.
- **Cover cropping** - If a field needs renovation, establish a cover crop by early October. Include oats or annual rye in the fall seed mix as good winter "nurse" crops to start growing fast and protect soil. Perennial grasses in the seed mix will often crowd them out by next fall.
- **Residue management -** Leave abundant plant debris on soil surface from October to April. Leaves and stems on soil slow runoff, trap soil particles, increase infiltration, and improve soil

structure.

Related web pages:

- Communicating for Agriculture is a nonprofit organization dedicated to the needs of America's farmers and ranchers. They can be contacted at: http://www.cainc.org

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

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Periodicals:

- None identified.

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Frequently Asked Questions:

- Erosion Control Management

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Commercial suppliers:

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Suggested references:

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Periodicals:

- None identified.

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Pasture Management

Frequently Asked Questions Other Information Sources Return to Property Management

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Pasture Management

Inadequate pasture management can result in:

- Reduced forage production
- Excess soil erosion
- Increased weed populations
- Nutrient or manure runoff
- Soil compaction
- Deep mud

In addition to problems directly on the pasture site, increased nutrients, manure and soil are washed off the land and damage surface water quality.

Benefits of appropriate pasture management may include:

- Increase forage production over 200%
- Reduce weed population.
- Prevent erosion.
- Reduce expense for feed, herbicides and fertilizers.
- Prevent runoff of animal wastes.

Recommendations

- Pasture and other lands shall be managed to prevent both gully and sheet erosion.
- Pasture and livestock shall be managed to prevent any manure or fertilizer from washing off the site.
- Pasture near streams shall be managed to establish and maintain a well vegetated buffer extending 35 feet back from the stream.

Objectives

- To develop healthy pastures which will filter wastes from surface

water run-off before it gets to streams and groundwater.

- To increase pasture quality, yield, and utilization.
- To protect the natural functions of wetlands and near-stream areas which serve to filter pollution, move surface water to ground water storage, and provide habitat for wildlife.

Grazing Management

- **Respect your farm's animal carrying capacity** - the number of animals on your pasture should not exceed the capacity of the forage to regrow. Minimum recommended area on non-irrigated pasture is 2-3 acres per horse, 1-2 acres per cow and calf, or 2-3 sheep per acre.
- **Graze pastures to 3 inches in height** - rest the pasture until it has regrown to 6-8 inches. Sufficient leafy material is necessary for rapid regrowth, increased nitrogen utilization and filtration of contaminants such as animal wastes and fertilizers.
- **Cross fence pastures and rotate animals** - to increase pasture growth and utilization. Divide large pastures into at least four smaller pastures or paddocks using temporary or permanent fencing. Rotate animals from one pasture to the next, while allowing pasture to grow.
- **Keep animals off saturated rain soaked pasture from November through March** - pastures cannot survive continuous grazing and trampling in winter when they are saturated with water.
- **Create a sacrifice area (winter paddock) for use in the rainy season** - this area should be on higher ground and well away from streams. It keeps animals from destroying pastures and confines waste to an area surrounded by healthy pasture that can filter contaminated run-off.
- **Feed animals hay until the pasture can support grazing** - buy and feed plenty of hay until pastures are 6-8 inches in height and are regrowing rapidly. This produces more forage and saves money by keeping pasture plants more productive.
- **Clip pastures in late May or early June** - before weed seeds have a chance to form. Clipping prior to a rest period will promote uniform growth. Clipping reduces weed seeds; removes older, less palatable leaves and promotes new growth.
- **Reseed and renovate as needed** - renovation is the improvement of pastures through aerating, liming, fertilizing, and perhaps, interseeding more desirable forage species with minimum tillage.
- **Test soil before reseeding or renovating pastures** - to determine lime, fertilizer, and manure application rates based on soil needs to avoid over or under application.

- **Test soil before fertilizing with phosphorus or postassium or manuring** - Apply fertilizer and manure in calibrated rate according to soil test needs, avoiding streamsides.
- **Apply no more than 60 lbs of nitrogen per acre when temperature in upper 2 inches of soil stays above 42F** - usually February. Avoid streambanks.
- **Apply 20 to 30 lbs sulfate per acre annually** - or 30 to 40 lbs of sulfate every other year.
- **Spread 1 ton per acre of dolomite lime for grass pastures when soil pH is less than 5.4** - or clover pastures with pH less than 5.8. This adds calcium, magnesium, and neutralizes acid soil.
- **Consider your soil drainage type and intended use to select seed species when establishing or renovating a pasture**.
- **Include legumes such as white or sub clover in pasture reseeding programs** - legumes can naturally add adequate amounts of nitrogen to pastures so pasture growth and quality are improved to reduce or eliminate the need for nitrogen fertilization.
- **Spread fertilizers and manure only when soil is not saturated**. (See Manure Management) - this prevents fertilizers and manure from entering ditches and streams.
- **Do not apply manure to fields during plant dormancy** (October-March) - Plants will not use the nutrients and they will wash away in the rains.
- **Do not use manure as fill material** - It will remain saturated, it will not compact, and it will only grow weeds.
- **Do not put uncomposted shavings on pastures**. Shavings can take years to break down in the field, compared to three months in a functioning compost pile. Uncomposted shavings and wood chips can produce toxic runoff (For more information on composting and manure management see Manure Management)

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Commercial suppliers:

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Electronic mailing lists:

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Suggested references:

- None identified.

Periodicals:

- None identified.

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Manure Mangement

Frequently Asked Questions Other Information Sources Return to Property Management

Frequently Asked Questions:

- Manure Management

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Manure Management

Manure contains high concentrations of bacteria, phosphates, and nitrates. When manure enters surface or groundwater, its constituents can cause serious water quality problems including:

- **Bacteria:** can spread disease to other livestock and people in the watershed
- **Phosphates:** promote algae growth when dissolved in surface waters. As algae dies, decomposing bacteria removes oxygen from the water - killing fish. Algae also plugs irrigation filters and reduces scenic and recreational values for streams.
- **Nitrogen:** Can be detrimental to livestock and human infants through excessive nitrate levels in well water. Ammonia forms of nitrogen remove oxygen from water, killing fish. Nitrogen also promotes algae growth.

Benefits of Storing and Composting Manure

- Reduces parasite reinfestation in your horse or livestock (The heat generated in the composting process kills worm eggs as well as parasites and weed seeds)
- May reduce fly populations
- May reduce odor
- Reduces volume of manure and shavings, etc. by approximately 50%
- Reduces the manure contaminated runoff to surface or groundwater
- Provides a free, easy source of compost/fertilizer - a valuable addition to pastures, gardens, and yard
- Makes property appearance pleasing and enjoyable to look at

Requirements:

- No activities shall be conducted which result in the discharges of wastes into waters of the state. Wastes include, but are not limited to, livestock manures, composts and fertilizers.
- No wastes shall be placed where they are likely to escape or be carried into the waters of the state.

Objectives:

- Keep animal waste run-off from reaching streams, by storing it and recycling it properly.
- Utilize your natural resources and reduce costs for chemicals.

What can be done?

- **Store manure at least 150 feet from streams. under a roof or tarp to protect it from rain.** This prevents leaching of nutrients into surface or ground waters.
- **Select a storage site where run-off from surrounding area cannot run into manure pile and pose a threat to groundwater**. Optimal storage is on a concrete slab with walls or curbs.
- **Locate animal confinement and manure storage areas away from surface waters.**
- **Install gutters on manure storage structures to capture and divert runoff away from buildings.** This will prevent run-off from flowing through manure areas.
- **Add grass clippings and other green yard debris to the pile to reach the proper carbon to nitrogen balance for speedy and hot composting**. Green leaves are high in nitrogen.
- **Add just enough water to the new compost pile to reach the consistency of a wrung out sponge.** Horse and some other manures are not wet enough with dry bedding to compost.
- **Turn the pile to aerate it.** or place a few PVC pipes with big holes drilled in them, into the pile to add air. Avoid compacting the pile. This will speed the compost process, reduce odors, and increase the temperature.
- **Reduce parasite and fly problems by managing the compost to reach 115°F** for several days and harrow the manure in the pasture. Experiment to get a balance of air, moisture, nitrogen and fiber for hot compost.
- **Clean confinement areas regularly** (such as stalls and dry lots) to properly store, utilize, or dispose of manure.

- **Do not add lime or enzymes to the compost pile.** They are not needed.
- **Consider hauling manure off your property.** Store in a covered trailer and deliver trailer to a nursery, crop farm, or neighbors. Properly composted wastes may be more marketable than raw manure.
- **Composted Manure is ready to spread when it has reduced in volume by about 50% and it looks evenly textured and crumbly like soil.**

Manure Use:

- *Apply only as much manure as your crop or pasture can use.* Test soils and manure at least every three years. A minimum of one acre of well vegetated land is needed for annual spreading of manure from two horses or cows. The recommended acreage is two acres per horse or cow for spreading of manure. Test your soil at least every three years for over fertilization. Contact nurseries, crop producers, or gardeners to use manure in excess of your soil needs. Otherwise, remove annually to a landfill.
- Requirements for Manure Spreading between March 15-May 15 (Must meet all):
  - Slope of less than 15%
  - Depth of water table greater than 2 feet from ground surface
  - More than 50 feet to nearest waterbody or well
  - No flooding on site

  Unless all of these requirements are met, manure spreading must wait until May 15th
- **Avoid applying manure to soils from October to mid-March**. Slow growing plants will not capture the nutrients. Nutrients can wash into streams or leach to groundwater
- **Apply composted manure evenly to pastures, fields, and gardens at rates not exceeding plant nutrient needs**. Six months storage of manure from two horses should be spread on not less that 1.5 acres of pasture.
- **Apply manure carefully, leavin a well vegetated buffer at least 50 feet wide** between manure application and all streams, ditches, ponds, wet areas, or wells.
- **Avoid putting uncomposted shavings on pastures.** Shavings can take years to break down in the field, compared to less than three months in a functioning compost pile. Runoff from shavings piles can be toxic to fish and wildlife.
- **Do not use manure as fill material.** It will remain saturated,

will not compact, will only grow weeds, and will leach nutrients and bacteria to streams or groundwater.

- **Use manure mixed with sand or other materials in a riding arena** - to make an excellent exercise surface for horses.

Related web pages:

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Commercial suppliers:

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Electronic mailing lists:

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Suggested references:

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Periodicals:

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- No wastes shall be placed where they are likely to escape or be carried into the waters of the state.

Objectives:

- Keep animal waste run-off from reaching streams, by storing it and recycling it properly.
- Utilize your natural resources and reduce costs for chemicals.

What can be done?

- **Store manure at least 150 feet from streams. under a roof or tarp to protect it from rain.** This prevents leaching of nutrients into surface or ground waters.
- **Select a storage site where run-off from surrounding area cannot run into manure pile and pose a threat to groundwater**. Optimal storage is on a concrete slab with walls or curbs.
- **Locate animal confinement and manure storage areas away from surface waters.**
- **Install gutters on manure storage structures to capture and divert runoff away from buildings.** This will prevent run-off from flowing through manure areas.
- **Add grass clippings and other green yard debris to the pile to reach the proper carbon to nitrogen balance for speedy and hot composting**. Green leaves are high in nitrogen.
- **Add just enough water to the new compost pile to reach the consistency of a wrung out sponge.** Horse and some other manures are not wet enough with dry bedding to compost.
- **Turn the pile to aerate it.** or place a few PVC pipes with big holes drilled in them, into the pile to add air. Avoid compacting the pile. This will speed the compost process, reduce odors, and increase the temperature.
- **Reduce parasite and fly problems by managing the compost to reach 115°F** for several days and harrow the manure in the pasture. Experiment to get a balance of air, moisture, nitrogen and fiber for hot compost.
- **Clean confinement areas regularly** (such as stalls and dry lots) to properly store, utilize, or dispose of manure.
- **Do not add lime or enzymes to the compost pile.** They are not needed.
- **Consider hauling manure off your property.** Store in a covered trailer and deliver trailer to a nursery, crop farm, or neighbors. Properly composted wastes may be more marketable than raw manure.
- **Composted Manure is ready to spread when it has reduced in volume by about 50% and it looks evenly textured and crumbly like soil.**

Manure Use:

- *Apply only as much manure as your crop or pasture can use.* Test soils and manure at least every three years. A minimum of one acre of well vegetated land is needed for annual spreading of manure from two horses or cows. The recommended acreage is two acres per horse or cow for spreading of manure. Test your soil at least every three years for over fertilization. Contact nurseries, crop producers, or gardeners to use manure in excess of your soil needs. Otherwise, remove annually to a landfill.
- Requirements for Manure Spreading between March 15-May 15 (Must meet all):
  - Slope of less than 15%
  - Depth of water table greater than 2 feet from ground surface
  - More than 50 feet to nearest waterbody or well
  - No flooding on site

Unless all of these requirements are met, manure spreading must wait until May 15th

- **Avoid applying manure to soils from October to mid-March**. Slow growing plants will not capture the nutrients. Nutrients can wash into streams or leach to groundwater
- **Apply composted manure evenly to pastures, fields, and gardens at rates not exceeding plant nutrient needs**. Six months storage of manure from two horses should be spread on not less that 1.5 acres of pasture.
- **Apply manure carefully, leavin a well vegetated buffer at least 50 feet wide** between manure application and all streams, ditches, ponds, wet areas, or wells.
- **Avoid putting uncomposted shavings on pastures.** Shavings can take years to break down in the field, compared to less than three months in a functioning compost pile. Runoff from shavings piles can be toxic to fish and wildlife.
- **Do not use manure as fill material.** It will remain saturated, will not compact, will only grow weeds, and will leach nutrients and bacteria to streams or groundwater.
- **Use manure mixed with sand or other materials in a riding arena** - to make an excellent exercise surface for horses.

Related web pages:

- Communicating for Agriculture is a nonprofit organization dedicated to the needs of America's farmers and ranchers. They can be contacted at: http://www.cainc.org

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Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 15, 2002

Fences

Frequently Asked Questions Other Information Sources Return to Property Management

Frequently Asked Questions:

Other Information Sources:

Warning:

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Is there such a thing as a metal T-post hole auger that will go through rock?

- **Suggestion A:** As a consulting soil scientist, I have to use soil augers on a daily basis. While you can crunch through saprolite with a manual auger, if doing it all day, it ain't fun. A company which carries several varieties of hand and power augers is Ben Meadows Company. They are at 1-800-241-6401.

Does anyone have a good source for solar cells and energizers for use in electric fences?

- **Suggestion A:** We're using a total of 3 "ParMak" brand energizers (they're made by Parker McCrory, 200 Forest Ave., Kansas City, MO 816-221-2000). We've got two 6 volt "DF-SP-SS" units on portable stands, which are used with poly tape & fiberglass poles for moveable paddocks for horses. They don't have much oomph, particularly with temporary ground rods, so they don't really deter goats, even when used with netting. We've got one "Magnum 12 Solar Pak" unit permanently connected to a gate post on a 5-wire high-tensile paddock with alternating hot & ground wires; this is advertised as "low impedance" and makes a nice loud spark when a goat gets venturesome. So far, they seem to respect it. It's got a meter calibrated in kilovolts to indicate if the fence is ok, but I haven't checked it for accuracy. One of the portables got dropped, totaling the solar panel; I called ParMak and was able to order a new panel, which arrived promptly and was simple to install. We're buying another Magnum 12 for a much larger system of electrified paddock fence, but it isn't complete yet. Several of the local tack shops can order this equipment, but we've also seen it listed in catalogs, like Lehman's Non-Electric.

Do these underground dog fences work?

- **Suggestion A:** My dog has been able to discover another problem with the radio fences. If he notices a subject which requires his immediate attention (say, a squirrel, or the neighbors cat) on the other side of the fence, he will momentarily forget about the fence, and sprint full speed towards (and across) the 'penalty zone'. By the time he remembers or notices the shock, it's too late: He's over the fence. Later, when his business has been concluded and he decides to mosey on back to the porch, the threat of shock is more clearly remembered, perhaps because the adrenaline level is lower. The dog is now effectively stuck on the outside of the fence.
- **Suggestion B:** Some dogs are more stubborn than others. If you are having problems, you may want to try increasing the "width" of "shock field". If that fails, you can also add additional prongs by just running wire from the existing prongs to new prongs that you can insert halfway around the collar. (My fence dealer did this for me)

Is there such a thing as a drive thru gate?

- **Suggestion A:** There is a drive thru electric gate that works well. It is a horizontal bar with electrically charged wire that hangs down from it. The livestock stays away from it and you can drive thru it without it damaging your vehicle.

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- None identified.

Electronic mailing lists:

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Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Building Fences of Wood, Stone, Metal, and Plants - by John Vivian - Publication Date: March 1987 - List: $13.95
- Fences for Pasture and Garden - by Gail Damerow - Publication Date: March 1, 1992 - List: $16.95
- Rural Architecture of Northern New Mexico and Southern Colorado : Featuring : Fences, Barns and Corrals - by Myrtle Stedman - Publication Date: April 1, 1989 - List: $10.95
- Selected ASTM Standards for Fence Materials and Products - Publication Date: April 1994 - List: $43.00
  Booknews, Inc. , 06/01/91:
  This booklet, compiled by ASTM Committee F-14 on Fences, contains all the formally approved ASTM standard specifications, test methods, classifications, definitions, and practices related to fences. Annotation copyright Book News, Inc. Portland, Or. --This text refers to the paperback edition of this title.

Periodicals:

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This page was last updated on August 31, 2002

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Periodicals:

- None identified.

This page was last updated on August 31, 2002

Maintaining Gravel Roads

Frequently Asked Questions Other Information Sources Return to Property Management

Frequently Asked Questions:

Other Information Sources:

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When I grade our road with my tractor and 3pt grader blade, I end up with ripples. How can I get rid of these?

- **Suggestion A:** I use a landscape rake in a similar fashion about once every other month or so. Two passes up each side (rake angled in) and one pass down the middle to re-spread the mounded gravel. No ripple problems.
- **Suggestion B:** Something that may work better to flatten a gravel drive is a grid of steel or hardwood that is weighted down with junk that you drag behind you to level the gravel out.
- **Suggestion C:** Use a box scraper. This does a good job of keeping ripples out of the road, but does not allow you to move the gravel back onto the road from the edges. I've found that one pass with an angled grader blade, then another pass with the box scraper gives excellent results.

How can one get a private road converted to a county road?

- **Suggestion A:** Some townships here in Illinois will accept responsibility for maintaining roads as long as they are first brought up to their standards. You would incur a one time charge for improvements, then are relieved of the responsibility thereafter.

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Electronic mailing lists:

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Suggested references:

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Periodicals:

- None identified.

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Logging and Land Clearing

Frequently Asked Questions Other Information Sources Return to Property Management

Frequently Asked Questions:

Other Information Sources:

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I'm thinking about logging some of my land. What should I know?

Log market prices fluctuate widely and often. The value of timber on your property is directly related to the difficulty of harvesting it and the distance your property is from a mill. Timber can be a great long-term investment. As you wait, the wood continues to grow, and add Volume and Value. Historically there has been a real price increase (over and above inflation) in timber prices. So a wait and see strategy works well for many landowners. If you are considering a timber harvest, It is suggest that you:

- Learn more about timber harvesting as it is practiced in your area. Locate information sources on timber prices, watch how they have moved through time, and be prepared to conduct a harvest when prices are high. The Cooperative Extension Service is one source of information - check the government pages in the phone book for the nearest office. A local Forest Landowners organization (who often sponsor the Tree Farm program) will usually provide a great deal of price info, local contacts, advice about loggers and such.
- Prepare a Forest Management Plan which specifies YOUR goals for YOUR property. A forest management plan often begins with a statement of your goals, followed by an INVENTORY. This expense is crucial - how can you realistically sell something when you don't know the value or even the quantity on hand? There are cost-share assistance programs available if you want to go that route. The Forest Stewardship program will cost-share the expense of preparing a Stewardship Plan.
- Contact a professional forester to help with the details and "ride herd" on the logger. For recommendations see number 1. A good forester will know the local markets, loggers and other

contractors. Use the forester for inventory expertise, to mark the timber that YOU want to sell, and put the timber out to bid, usually on a per thousand board feet harvested basis. Rarely does a lump-sum sale work out for the landowner, especially in New England where grade and quality are so important to the purchase price.

- Learn more about forest management in general (see the below suggested references).

Who makes personal sawmills?

- WOOD-MIZER [from $6995] "World's Largest Manufacturer of Portable Sawmills" Wood-Mizer Products, Inc., 8180 West 10th St, Indianapolis, IN 46214-2400. 1-800-553-0219 32-Page full-color catalog $2, 66-minute demonstration video$10.

What about these chainsaw mills?

- **Suggestion A:** I have used Alaskan Mark III for about 5 years now and it has many ups and downs. 1. You need a lot of power. I use a Husky 2100 (6 CI) saw and it must be running well to do a good job. Low power (poor running or too small a head) causes you to work way too hard. 2. You need gravity working for you, logs should be raised as dramatically as possible in the back. If the log is laying flat you are "pushing" the mill and will experience poor cuts and horrendous back aches. 3. You should be realistic with hardwoods. I use my mill for Douglas Fir, Cedar, Hemlock, and Grand Fir. These are very soft and it works great (we have sided several buildings and built many animal sheds with the wood). Hardwoods would have to be low volume to be practical. 4. You may want a respirator and goggles when running the mill as the sawdust and two-stroke exhaust gets thick and can really get you sick. I have toyed with the idea of just extending the expansion chamber straight up about 2 feet (the normal worry about making a saw too heavy does not apply with the mill). 5. It is a lot of work (personally I think this is a pro not a con). There are some books on it (Chainsaw Lumbermaking) that recommend winch and throttle control cables etc to pull the mill through the log but I view this as needless complexity. If you go that far with a chainsaw lumbermill, you should just go buy a portable bandsaw mill. 6. The Kerf wastes a lot of wood. Imagine >3/8 inch for every cut. You get a lot of sawdust for whatever purpose you might have! 7. Use a 0 degree chain. I have used regular bucking chains and it does not leave a smooth surface. My siding usually looks ready to use after I mill it. None

of those irregularities that a Circular rig leaves (i.e., you don't need to plane it). On the whole I think they are great. It has saved us substantial dollars on wood. The power head was 250, the Mk III was 136, the bars have been about 40 apiece. We have cut about 10K worth of Cedar Siding and dimension lumber! Aside from cost, you can mill things that you just could not find at a lumberyard.

- **Suggestion B:** One recommendation that I (as a WoodMizer Bandsaw mill owner) have heard for the chainsaw mills is to use them to cut the logs into cants that are of handleable sizes then doing the re-sawing (final cutting) on an ordinary bandsaw or table saw. This is especially recommended for getting lumber out of places such as deep in your woods where vehicles can't go. This way you save a bit on the kerf and your overall labor.
- **Suggestion C:** I took this route (use the chainsaw mill to cut the logs into cants that are of handleable sizes then doing the final cutting on an ordinary bandsaw or table saw) after the initial experiences with using only the Chainsaw Mill. My practice has been to slab logs if they are in long sections so they can be carried. Initially I would trim these into dimension lumber with the table saw but found this was too hard on the motor (10' Delta 110volt motor). I eventually purchased a worm drive Skil that seems to have no problem. The downside is that you need a straight cutting arm to stay on the snap line. I have produced some extremely nice lumber this way. It also allows me to stack and store the slabs which gives the flexibility to cut boards for the width you need when you need them (as opposed to having a pile of 2x6s stockpiled when you need 2x8s). If the sections are under 8 feet you can get by with carrying and storing the cants. This is especially true with lightweight Cedar that will become siding.
- **Suggestion D:** I own a 24", 32", and 48" chainsaw mill. I also own 6 Stihl 090 direct drive power heads, and 3 gear drive 090's. (These motors are 137 cc's.) I would highly recommend using them for rough work, for beams, and for cutting furniture grade rough planks. (I would argue that the Stihl 090 is the best high-torque, low rpm, high duty-cycle motors for milling work (engine running at constant speed for 15-20 minutes while making a 24' cut 48" wide.) I do not recommend these mills for repetitive dimensional lumber as it takes a lot of diligence to make accurate repetitive cuts. The mills are especially clumsy when working small logs, for example making 1x6 siding. Your time is better spent tracking down some rich hobbyist with an idle bandsaw mill in their backyard, and spend your energy cutting cants to drag to the mill. It also helps to have a winch, a chain grinder, an extra cross-cut saw, a peavy and a very strong

back. If your time is worth less than $5 an hour and you like breathing two-stroke fumes with your face and arms only inches away from a high speed cutting chain, and you do not mind moving 500lb-4000lb logs, then go have fun!

How do I get rid of the stumps?

- **Suggestion A1:** Burning them is the way I do it - but there is an art to it. First, with a chain saw (and using the nose of the saw - so be sure you know what you are doing!) make radial slots about half way up the stump from the outside, to the inside where they should all meet. For a 2 foot diameter stump about four slots is enough. Then make a slot vertically downwards from the centre of the stump so it meets with the radial slots. The idea of this is to give airways in the stump, so that it burns on the inside. Next you need heaps of wood, at least about four time the volume of the stump. Most of this should be a foot or so in diameter. Take the longer, smaller diameter pieces (about half of the stockpile) and build these around the stump - tepee style. Light this fire, and when it burns down, add the bigger pieces of wood around the stump. Monitor every four hours or so, and make sure that the bigger pieces of wood are pushed close to the stump. After a while the stump will start burning inside, but it will still need an extra supply of wood to sustain it. In my experience, about 24 to 36 hours is required to burn down a 2ft diameter, 3ft high stump. Note that the slots are ESSENTIAL. Just lighting a fire around a stump just blackens it. Perhaps this method may not be environmentally friendly but the wood in the stump is pretty useless - full of dirt and sometimes rot. In addition the wood I use to maintain combustion is from old fallen trees, or other junk wood useless for anything else.
- **Suggestion A2:** The burning method I saw used some kind of accelerant that was poured into a hole drilled in the middle of the stump.
- **Suggestion B1:** Pulling out with tractor (I sometimes do this if 1: not many roots 2: not too big 3: ground is damp. It is rarely successful for stumps over 1 foot diameter. Generally all that happens is the chain stretches/breaks or the wheels of the tractor spin. Of course if the removal is successful the stump still has to be disposed of - knock off the dirt (back into the hole preferably and then burn (perhaps as fuel for a bigger stump that is burnt).
- **Suggestion B2:** Pulling out with draft animals. Some years ago, I was at a fair where they exhibited a method for pulling them out with a draft animal. First, you cut the roots that extend out away from the stump. Next, you use a "machine" and the draft animal.

(My description won't do justice, but you'll likely not do this anyway - I just think it is a neat idea.) The machine is kind of like a set of wagon wheels and a strong axle. This thing is placed over the stump and a chain is run from the axle down under the stump. The draft animal then pulls this thing and the rotation of the axle causes the chain to pull up on the stump. Slow going, but I've been told it works very well.

- **Suggestion C1:** Blow up the stumps with dynamite. A 1/4 stick of dynamite and a long fuse. Park your truck a ways away - my father watched a stump get launched and land in the bed of the vehicle. Was handy for taking back to cut up for firewood, but the bed was destroyed.
- **Suggestion C2:** Blow up the stumps with Tovex. It's more available to the public anymore than dynamite. It's more stable, and is less messy to use. Several possibilities. Call your nearest BATF office and ask for the information for a license for purchasing explosives. These aren't too difficult to get. Buy or build a storage facility. The ATF has a publication that describes all the rules and regulations for explosives (on the Federal level), including storage, documentation, and use. Also remember that transportation of explosives falls under the DOT, **not** the ATF. Anyway, with such a license, one can purchase explosives from any manufacturer. Second possibility, and is becoming increasingly more difficult to do, is find an explosives distributor and buy a small quantity off them. You'll have to fill out the day-use license form, and must use the explosives that day. Again, transport falls under the guise of the DOT. Typically Tovex comes in 1lb sticks, and though not ideal for stumps, will work fine. Around here, Tovex is about $3 a stick, and caps are $3.50 if bought in single use quantities. It's a lot cheaper if bought in bulk. Anyway, find someone, preferably someone who is a certified blaster, to show you how to use them. It's pretty easy, and fairly safe as long as you have some basic idea of what you are doing. An alternative is blasting powder, which can be obtained easily and without the need to fill out a form if bought in small quantities. In some ways blasting powder is better because it has more heaving power (tovex is more "brisiant", it has more shattering power). Anyway, just using explosives isn't a panacea, you still have to dig under the stump, quite a job unto itself, place the charge, stem it (filling the dirt back in and making sure you're not just going to blow the dirt plug back out. It generally takes about 2 hours of work per stump. Which is much better than the 6-10 hours it takes to dig and chop all the roots. One advantage of using higher brisiance explosives is you don't have to be as careful about stemming the charge.
- **Suggestion D:** Use a block and tackle and small tractor. Use 5/8"

cable and a set of double blocks. This is a slow method, but has the advantage of usually leaving the dirt off of the roots, unlike a dozer. Done properly, this can get you down to one stump.

How do I get rid of brush?

- **Suggestion A:** I've cleared about two acres of blackberries, cleared a 7 acre pasture, and built a mountain bike trail of about two miles with a "DR Field and Brush Mower". I used a sickle bar mower first, but it shook too much. I didn't want to buy one because it would shake itself apart. The "DR"is like a self-propelled, walk-behind Bush Hog. I've mowed hills that are almost too tough to walk. The DR will pull you up and cut a swathe as it does. It'll cut through trees up to about 2" in diameter. I cleared my trail today with it. It's a good machine. Check it out. DR Field and Brush Mower, Country Home Products, Ferry Road, Box 89, Charlotte, VT 05445 1-800-376-9637 FAX: 802-425-3791
- **Suggestion B:** I use an old Gravely Model L tractor with a 30" bushhog type mower deck. I have blackberries, wild grapes, multi-flora rose and miscellaneous weeds. It goes right thru them. In case you are not familiar with the type, it is a two wheel walk-behind, with a single cylinder engine, and a transmission that gives you two speeds forward and reverse. The tractor will accommodate about 20 different tools, including several mowers, a rotary plow, a roto-tiller, a cultivator, circular saw, (horizontal or vertical), snow blower, chainsaw, pusher blade, a sulky (to convert it to a rider for large lawns), and others.

How many BTU's are in a cord of wood?

- Silver Maple: 20 million BTU per cord
- Red Oak: 30 million BTU per cord
- White Oak: 32 million BTU per cord
- Ponderosa Pine: 20 million BTU per cord

Efficiency will depend on the moisture content and your stove.

Can wood be burned in a coal stove?

- Coal stoves can be used to burn wood, but wood stoves cannot be used to burn coal. The reason is that coal burns much hotter than wood and the grates are different. Also, if the coal stove is small, you will spend much of your time feeding wood into it. Wood

burns much to fast in small amounts.

What wood is best to burn?

- **Suggestion A:** Madrone burns very hot and very clean with little soot. The smoke is pleasantly fragrant in a not overwhelming way. The wood is very hard and is hard to split by hand. The grain is not normally straight.

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- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- Fazio, James R. The woodland steward : a practical guide to the management of small private forests / James R. Fazio ; illustration & design, Kristin R. Aufdenberg. Moscow, Idaho : Woodland Press, c1985.
- The Woodland workbook / Oregon State University Extension Service. [Corvallis, Or.] : The Service, [1990]- Series title: Extension circular / Oregon State University Extension Service. Though some of the articles (it is a collection of Extension Leaflets) are specific to Oregon, many of the planning, economics and timber harvesting pamphlets are general and apply most places. Send for a free catalog Publications Orders Agricultural Communications Oregon State University Administrative Services A422 Corvallis, OR 97331-2119. Phone: 503/737-2513 FAX: 503/737-0817

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

Warning:

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I'm thinking about logging some of my land. What should I know?

Log market prices fluctuate widely and often. The value of timber on your property is directly related to the difficulty of harvesting it and the distance your property is from a mill. Timber can be a great long-term investment. As you wait, the wood continues to grow, and add Volume and Value. Historically there has been a real price increase (over and above inflation) in timber prices. So a wait and see strategy works well for many landowners. If you are considering a timber harvest, It is suggest that you:

- Learn more about timber harvesting as it is practiced in your area. Locate information sources on timber prices, watch how they have moved through time, and be prepared to conduct a harvest when prices are high. The Cooperative Extension Service is one source of information - check the government pages in the phone book for the nearest office. A local Forest Landowners organization (who often sponsor the Tree Farm program) will usually provide a great deal of price info, local contacts, advice about loggers and such.
- Prepare a Forest Management Plan which specifies YOUR goals for YOUR property. A forest management plan often begins with a statement of your goals, followed by an INVENTORY. This expense is crucial - how can you realistically sell something when you don't know the value or even the quantity on hand? There are cost-share assistance programs available if you want to go that route. The Forest Stewardship program will cost-share the expense of preparing a Stewardship Plan.
- Contact a professional forester to help with the details and "ride herd" on the logger. For recommendations see number 1. A good forester will know the local markets, loggers and other contractors. Use the forester for inventory expertise, to mark the timber that YOU want to sell, and put the timber out to bid, usually on a per thousand board feet harvested basis. Rarely does a lump-sum sale work out for the landowner, especially in New England where grade and quality are so important to the purchase price.
- Learn more about forest management in general (see the below suggested references).

Who makes personal sawmills?

- WOOD-MIZER [from $6995] "World's Largest Manufacturer of Portable Sawmills" Wood-Mizer Products, Inc., 8180 West 10th St, Indianapolis, IN 46214-2400. 1-800-553-0219 32-Page full-color catalog $2, 66-minute demonstration video$10.

What about these chainsaw mills?

- **Suggestion A:** I have used Alaskan Mark III for about 5 years now and it has many ups and downs. 1. You need a lot of power. I use a Husky 2100 (6 CI) saw and it must be running well to do a good job. Low power (poor running or too small a head) causes you to work way too hard. 2. You need gravity working for you, logs should be raised as dramatically as possible in the back. If the log is laying flat you are "pushing" the mill and will experience poor cuts and horrendous back aches. 3. You should be realistic with hardwoods. I use my mill for Douglas Fir, Cedar, Hemlock, and Grand Fir. These are very soft and it works great (we have sided several buildings and built many animal sheds with the wood). Hardwoods would have to be low volume to be practical. 4. You may want a respirator and goggles when running the mill as the sawdust and two-stroke exhaust gets thick and can really get you sick. I have toyed with the idea of just extending the expansion chamber straight up about 2 feet (the normal worry about making a saw too heavy does not apply with the mill). 5. It is a lot of work (personally I think this is a pro not a con). There are some books on it (Chainsaw Lumbermaking) that recommend winch and throttle control cables etc to pull the mill through the log but I view this as needless complexity. If you go that far with a chainsaw lumbermill, you should just go buy a portable bandsaw mill. 6. The Kerf wastes a lot of wood. Imagine >3/8 inch for every cut. You get a lot of sawdust for whatever purpose you might have! 7. Use a 0 degree chain. I have used regular bucking chains and it does not leave a smooth surface. My siding usually looks ready to use after I mill it. None of those irregularities that a Circular rig leaves (i.e., you don't need to plane it). On the whole I think they are great. It has saved us substantial dollars on wood. The power head was 250, the Mk III was 136, the bars have been about 40 apiece. We have cut about 10K worth of Cedar Siding and dimension lumber! Aside from cost, you can mill things that you just could not find at a lumberyard.
- **Suggestion B:** One recommendation that I (as a WoodMizer Bandsaw mill owner) have heard for the chainsaw mills is to use them to cut the logs into cants that are of handleable sizes then doing the re-sawing (final cutting) on an ordinary bandsaw or table saw. This is especially recommended for getting lumber out of places such as deep in your woods where vehicles can't go. This way you save a bit on the kerf and your overall labor.
- **Suggestion C:** I took this route (use the chainsaw mill to cut the logs into cants that are of handleable sizes then doing the final cutting on an ordinary bandsaw or table saw) after the initial experiences with using only the Chainsaw Mill. My practice has been to slab logs if they are in long sections so they can be carried. Initially I would trim these into dimension lumber with the table saw but found this was too hard on the motor (10' Delta 110volt motor). I eventually purchased a worm drive Skil that seems to have no problem. The downside is that you need a straight cutting arm to stay on the snap line. I have produced some extremely nice lumber this way. It also allows me to stack and store the slabs which gives the flexibility to cut boards for the width you need when you need them (as opposed to having a pile of 2x6s stockpiled when you need 2x8s). If the sections are under 8 feet you can get by with carrying and storing the cants. This is especially true with lightweight Cedar that will become siding.
- **Suggestion D:** I own a 24", 32", and 48" chainsaw mill. I also own 6 Stihl 090 direct drive power heads, and 3 gear drive 090's. (These motors are 137 cc's.) I would highly recommend using them for rough work, for beams, and for cutting furniture grade rough planks. (I would argue that the Stihl 090 is the best high-torque, low rpm, high duty-cycle

motors for milling work (engine running at constant speed for 15-20 minutes while making a 24' cut 48" wide.) I do not recommend these mills for repetitive dimensional lumber as it takes a lot of diligence to make accurate repetitive cuts. The mills are especially clumsy when working small logs, for example making 1x6 siding. Your time is better spent tracking down some rich hobbyist with an idle bandsaw mill in their backyard, and spend your energy cutting cants to drag to the mill. It also helps to have a winch, a chain grinder, an extra cross-cut saw, a peavy and a very strong back. If your time is worth less than $5 an hour and you like breathing two-stroke fumes with your face and arms only inches away from a high speed cutting chain, and you do not mind moving 500lb-4000lb logs, then go have fun!

How do I get rid of the stumps?

- **Suggestion A1:** Burning them is the way I do it - but there is an art to it. First, with a chain saw (and using the nose of the saw - so be sure you know what you are doing!) make radial slots about half way up the stump from the outside, to the inside where they should all meet. For a 2 foot diameter stump about four slots is enough. Then make a slot vertically downwards from the centre of the stump so it meets with the radial slots. The idea of this is to give airways in the stump, so that it burns on the inside. Next you need heaps of wood, at least about four time the volume of the stump. Most of this should be a foot or so in diameter. Take the longer, smaller diameter pieces (about half of the stockpile) and build these around the stump - tepee style. Light this fire, and when it burns down, add the bigger pieces of wood around the stump. Monitor every four hours or so, and make sure that the bigger pieces of wood are pushed close to the stump. After a while the stump will start burning inside, but it will still need an extra supply of wood to sustain it. In my experience, about 24 to 36 hours is required to burn down a 2ft diameter, 3ft high stump. Note that the slots are ESSENTIAL. Just lighting a fire around a stump just blackens it. Perhaps this method may not be environmentally friendly but the wood in the stump is pretty useless - full of dirt and sometimes rot. In addition the wood I use to maintain combustion is from old fallen trees, or other junk wood useless for anything else.
- **Suggestion A2:** The burning method I saw used some kind of accelerant that was poured into a hole drilled in the middle of the stump.
- **Suggestion B1:** Pulling out with tractor (I sometimes do this if 1: not many roots 2: not too big 3: ground is damp. It is rarely successful for stumps over 1 foot diameter. Generally all that happens is the chain stretches/breaks or the wheels of the tractor spin. Of course if the removal is successful the stump still has to be disposed of - knock off the dirt (back into the hole preferably and then burn (perhaps as fuel for a bigger stump that is burnt).
- **Suggestion B2:** Pulling out with draft animals. Some years ago, I was at a fair where they exhibited a method for pulling them out with a draft animal. First, you cut the roots that extend out away from the stump. Next, you use a "machine" and the draft animal. (My description won't do justice, but you'll likely not do this anyway - I just think it is a neat idea.) The machine is kind of like a set of wagon wheels and a strong axle. This thing is placed over the stump and a chain is run from the axle down under the stump. The draft animal then pulls this thing and the rotation of the axle causes the chain to pull up on the

stump. Slow going, but I've been told it works very well.

- **Suggestion C1:** Blow up the stumps with dynamite. A 1/4 stick of dynamite and a long fuse. Park your truck a ways away - my father watched a stump get launched and land in the bed of the vehicle. Was handy for taking back to cut up for firewood, but the bed was destroyed.
- **Suggestion C2:** Blow up the stumps with Tovex. It's more available to the public anymore than dynamite. It's more stable, and is less messy to use. Several possibilities. Call your nearest BATF office and ask for the information for a license for purchasing explosives. These aren't too difficult to get. Buy or build a storage facility. The ATF has a publication that describes all the rules and regulations for explosives (on the Federal level), including storage, documentation, and use. Also remember that transportation of explosives falls under the DOT, **not** the ATF. Anyway, with such a license, one can purchase explosives from any manufacturer. Second possibility, and is becoming increasingly more difficult to do, is find an explosives distributor and buy a small quantity off them. You'll have to fill out the day-use license form, and must use the explosives that day. Again, transport falls under the guise of the DOT. Typically Tovex comes in 1lb sticks, and though not ideal for stumps, will work fine. Around here, Tovex is about $3 a stick, and caps are $3.50 if bought in single use quantities. It's a lot cheaper if bought in bulk. Anyway, find someone, preferably someone who is a certified blaster, to show you how to use them. It's pretty easy, and fairly safe as long as you have some basic idea of what you are doing. An alternative is blasting powder, which can be obtained easily and without the need to fill out a form if bought in small quantities. In some ways blasting powder is better because it has more heaving power (tovex is more "brisiant", it has more shattering power). Anyway, just using explosives isn't a panacea, you still have to dig under the stump, quite a job unto itself, place the charge, stem it (filling the dirt back in and making sure you're not just going to blow the dirt plug back out. It generally takes about 2 hours of work per stump. Which is much better than the 6-10 hours it takes to dig and chop all the roots. One advantage of using higher brisiance explosives is you don't have to be as careful about stemming the charge.
- **Suggestion D:** Use a block and tackle and small tractor. Use 5/8" cable and a set of double blocks. This is a slow method, but has the advantage of usually leaving the dirt off of the roots, unlike a dozer. Done properly, this can get you down to one stump.

How do I get rid of brush?

- **Suggestion A:** I've cleared about two acres of blackberries, cleared a 7 acre pasture, and built a mountain bike trail of about two miles with a "DR Field and Brush Mower". I used a sickle bar mower first, but it shook too much. I didn't want to buy one because it would shake itself apart. The "DR"is like a self-propelled, walk-behind Bush Hog. I've mowed hills that are almost too tough to walk. The DR will pull you up and cut a swathe as it does. It'll cut through trees up to about 2" in diameter. I cleared my trail today with it. It's a good machine. Check it out. DR Field and Brush Mower, Country Home Products, Ferry Road, Box 89, Charlotte, VT 05445 1-800-376-9637 FAX: 802-425-3791
- **Suggestion B:** I use an old Gravely Model L tractor with a 30" bushhog type mower deck. I have blackberries, wild grapes, multi-flora rose and miscellaneous weeds. It goes right thru

them. In case you are not familiar with the type, it is a two wheel walk-behind, with a single cylinder engine, and a transmission that gives you two speeds forward and reverse. The tractor will accommodate about 20 different tools, including several mowers, a rotary plow, a roto-tiller, a cultivator, circular saw, (horizontal or vertical), snow blower, chainsaw, pusher blade, a sulky (to convert it to a rider for large lawns), and others.

How many BTU's are in a cord of wood?

- Silver Maple: 20 million BTU per cord
- Red Oak: 30 million BTU per cord
- White Oak: 32 million BTU per cord
- Ponderosa Pine: 20 million BTU per cord

Efficiency will depend on the moisture content and your stove.

Can wood be burned in a coal stove?

- Coal stoves can be used to burn wood, but wood stoves cannot be used to burn coal. The reason is that coal burns much hotter than wood and the grates are different. Also, if the coal stove is small, you will spend much of your time feeding wood into it. Wood burns much to fast in small amounts.

What wood is best to burn?

- **Suggestion A:** Madrone burns very hot and very clean with little soot. The smoke is pleasantly fragrant in a not overwhelming way. The wood is very hard and is hard to split by hand. The grain is not normally straight.

Related web pages:

- Communicating for Agriculture is a nonprofit organization dedicated to the needs of America's farmers and ranchers. They can be contacted at: http://www.cainc.org

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Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- Fazio, James R. The woodland steward : a practical guide to the management of small private forests / James R. Fazio ; illustration & design, Kristin R. Aufdenberg. Moscow, Idaho : Woodland Press, c1985.
- The Woodland workbook / Oregon State University Extension Service. [Corvallis, Or.] : The Service, [1990]- Series title: Extension circular / Oregon State University Extension Service. Though some of the articles (it is a collection of Extension Leaflets) are specific to Oregon, many of the planning, economics and timber harvesting pamphlets are general and apply most places. Send for a free catalog Publications Orders Agricultural Communications Oregon State University Administrative Services A422 Corvallis, OR 97331-2119. Phone: 503/737-2513 FAX: 503/737-0817

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Pasture Management

Frequently Asked Questions Other Information Sources Return to Property Management

Frequently Asked Questions:

- What can be done to control weeds and brush in my pasture?

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

Warning:

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What can be done to control weeds and brush in my pasture?

- **Suggestion A:** Cashmere goats will eradicate the weeds and also produce a crop of cashmere wool you can then sell for around $190 per pound. In a pasture that was over run with bind weed, Canadian thistle and a patch of solid poison ivy, the introduction of goats eradicated the poison ivy and the bind weed. There is still some Canadian thistle, but the goats eat it right away. There is only grass and alfalfa left in the field.

Related web pages:

- Ronald Florence maintains an excellent FAQ on pastures, which we highly recommend.
- Communicating for Agriculture is a nonprofit organization dedicated to the needs of America's farmers and ranchers. They can be contacted at: http://www.cainc.org

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Commercial suppliers:

- None identified.

Electronic mailing lists:

GRAZE-L: Grazing Discussion List

Subscription address: listserv@taranaki.ac.nz

Topics: Intensive rotational grazing and seasonal dairying. Discuss MIRG and seasonal dairying issues. Connect farmers in New Zealand and the US.

Subscribe to GRAZE-L. Type "subscribe GRAZE-L Your Name" in the message body. (Not supported by all browsers.)

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- The Evolving Science of Grassland Improvement - by L. R. Humphreys - Publication Date: March 1997 - List: $74.95
- Alternative Agriculture: Committee of the Role of Alternative Farming Methods in Modern Production Agriculture - by National Research Council - List: $30.25 - Publication Date: September 1989
  Book News, Inc., 01/01/90:
  Eleven case studies explore how alternative farming systems have been adopted--and with what economic results--on farms of various sizes producing different crops across the country. Annotation copyright Book News, Inc. Portland, Or.
- Farm Management (McGraw-Hill Series in Agricultural Economics) - by Ronald D. Kay, William M. Edwards - List: $63.15 - Publication Date: September 1993
  Book News, Inc., 08/01/94:
  Takes decision making as the central task of a farm manager, and shows how doing it well requires a close analysis of the problem and the application of economic principles, budgeting procedures, and information systems. Among the specific problems considered are whole farm planning, analyzing the balance sheet and income statement, acquiring resources, and credit. Earlier editions were published his 1981 and 1986. Annotation copyright Book News, Inc. Portland, Or.

Periodicals:

- The Stockman Grass Farmer, 1-800-748-98908. Ask for a sample copy.

This page was last updated on August 31, 2002

Frequently Asked Questions:

- What can be done to control weeds and brush in my pasture?

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Maintaining Ponds and Lakes

Frequently Asked Questions Other Information Sources Return to Property Management

Frequently Asked Questions:

Other Information Sources:

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How do you remove algae from ponds and lakes?

- **Suggestion A:** Sprinkle a handful of straw on the pond surface; a flake of straw should be sufficient for a three acre lake. Bacteria from the straw will eat the algae.
  Note: One of our web site visitors stated that this is primarily a wive's tale. The straw only adds to the existing organic loading of the pond that causes the algae.

Planning an Excavated Pond:

Design of an excavated pond is based on the required storage capacity, depth to the water table, other available water sources, and the stability of the side-slope materials. The topographic conditions at the site must allow economical construction. Cost is a direct function of the volume of excavated material required to obtain a certain storage capacity in the pond. This method of construction results in the limited practical size of excavated ponds. However, these ponds can be designed to minimize evaporation losses by decreasing pond surface area in proportion to stored volume.

A rectangular shape is usually the most convenient for excavation equipment. The size of the pond is determined by the purpose for which water is needed, the site conditions, and the amount of inflow that can be expected. The required capacity of an excavated pond fed by a shallow water table is difficult to determine since the estimated rate of inflow into the pond can rarely be estimated with reasonable accuracy. Long narrow ponds will yield (or lose) more water from (or to) the surrounding area than square ponds. In some cases it may be necessary to augment the pond volume with water pumped from a nearby well or other water source. More information on pond sizing can be found in IFAS Extension Bulletin 257.

The proposed pond site should be thoroughly investigated prior to

design and construction. Core samples of the soil profile should be obtained to provide information on the permeability of the material within all depths and below the bottom of the proposed pond. Permeability requirements for pond construction vary with the type of water supply into the excavated area. For a pond supplied by a surficial aquifer source the permeability of the surrounding soil must be high to assure sufficient inflow into the pond. Conversely, a pond supplied with water from another source as discussed above must be located in an area with low permeability soils in order to avoid seepage losses.

Permeability is defined as the readiness with which soil transmits water under standard field conditions. It depends primarily on the size and shape of the soil grains, the porosity of the soil, the shape and arrangement of the pores, and the degree of saturation. There are several laboratory methods to determine permeability for a given soil.

Indications of soil permeability can also be obtained at the sites by filling test holes with water and observing the seepage characteristics of the material. Permeability tests performed in the field are frequently more representative of the actual site conditions since the soil is not disturbed as much as when the samples are transferred from the field to the laboratory. The simplest method used in the field in the presence of high water table is to dig an auger hole into the soil below the water table. First determine the elevation of the existing natural water table by allowing the water surface in the hole to reach equilibrium with the surrounding area. Next, the water in the auger hole is pumped out to lower the elevation of the water surface in the hole, then the rate of rise of water in the hole is measured. From this measurement soil permeability can be calculated.

At sites without natural water tables, other permeability tests must be used. An infiltration test over a large area (13 ft or 4 m in diameter) may be used as a field test. This avoids the soil compression that is inherent in core sampling, which is necessary for the lab samples. The area is diked with a ring of soil and filled with water to form a shallow pond. A circular pond is recommended rather than a rectangular one because the circular pond has less lateral and undesirable seepage loss per unit area than a rectangular one. To perform this test water is added to the pond area as needed to saturate the soil in the surrounding area, then the falling water level of the pond in the absence of added water is observed and used to determine permeability. This rate should be a measure of the ability of the soil to pass water into and through the observed soil layer.

When excavated ponds are supplied by surface runoff or by water pumped from a well, relatively impervious soils at the site are essential to avoid excess seepage losses. Soil materials must be available to provide a stable, impervious fill where needed. Clays and silty clays are

the most desirable, however sandy clays may also be satisfactory. In some regions of the Florida Panhandle, the soils contain sufficient clay to allow pond construction without adding soil amendments or artificially lining the pond. Unfortunately, most of the soils in peninsula Florida are very sandy, and additional measures to prevent seepage are necessary for pond construction. In some cases the only solution may be an artificial lining material. An artificial lining is expensive but should be considered at sites where soils are porous or are underlined by sands or gravel. Methods of pond sealing are discussed in IFAS Extension Circular 870.

In addition to permeability tests, the core sample holes may be used to determine the existing level of the water table from the shallow aquifer. The depth to the water table generally varies throughout the year. Therefore, several observations may be necessary to help with design. The performance of other nearby ponds may provide useful information with respect to the suitability of the proposed site and for design purposes.

Larger ponds should be equipped with some drainage facilities. A drain pipe is necessary to facilitate maintenance and fish management. On flat topography a pump may be necessary to drain the pond.

Excavated Pond Construction:

Proper construction practices should be followed to ensure safety and to reduce potential problems. After the pond site has been selected, an area or areas for spoil placement (excavated material) should be located. Stake the boundaries of the pond and spoil placement locations with the depth of cut from the ground surface to the pond sides or bottom clearly marked on the stakes. All woody vegetation should be cleared from these areas.

The type of excavating equipment for construction will depend on availability, climate, and physical conditions at the site. During dry periods most types of equipment can be used. The most common are tractor-pulled wheeled scrapers, draglines, and bulldozers. Inefficiency in transporting material limits the use of a bulldozer for excavation to relatively small ponds. Dragline excavators are commonly used for pond construction in the high natural water table areas of Florida. This is the only type of equipment that will operate under saturated soil conditions.

It is desirable to keep topsoil separated from subsoil materials during excavation. Place topsoil material in a location where it can be accessed after excavation has been completed. After excavation, this material should be placed on the surface of the side slopes, berms, spoil banks and spillways. These areas should be seeded or plugged with a grass or

other cover material for erosion control. The grass or cover material should require minimal maintenance, be tolerant to local drought or wet conditions, and be relatively easy to establish.

Farm Pond Safety

The farm pond has been an important economic unit in many farming programs. Ponds are used as part of a soil and water conservation program to water livestock, as an irrigation water source, and for fire protection and recreation, such as fishing, boating, swimming and ice skating.

Unfortunately, farm ponds contribute to accidental drownings. Children are the victims of the majority of farm pond drownings. Small children get too close to the water and lose their balance on the soft bank. Many wade in the cool shallow water only to fall into deep holes. Some drown for no apparent reason. Lack of close adult supervision contributes to pond drownings.

Adults often overestimate a child's curiosity. A short attention span, coupled with the attractiveness of a farm pond as a play area may render most verbal instructions ineffective. Adults, too, drown in farm ponds. Most of these pond drownings occur while swimming. These are most often young active adults and visitors.

It is the farm operator's responsibility to see that his/her farm pond is as safe as possible. In most cases it is recommended that all ponds be fenced and posted to keep out unwanted persons. Liability may increase with non-posted, non-fenced ponds. Restrict entry to your pond to keep out uninvited guests.

Accidents can be prevented and lives saved by placing signs warning of specific dangers or indicating safe areas for swimming.

All farm ponds used for swimming should have a rescue post. It should be set firmly in the ground near the water. The post should be painted yellow. Attach a long shelf bracket, peg or nail to the post. Obtain enough nylon rope to reach across the pond. Attach a life buoy or ring to one end of the rope and a wooden block to the other end. Hang this rescue device on the post. A thin, lightweight 12' to 14' pole should be attached to the rescue post to aid in rescue. Finally, attach the location of the nearest telephone and emergency numbers to the top of the post.

It should be emphasized that all farm ponds may not be suitable for swimming. If the water is cloudy, has a foul odor or excess algae, it may contain infectious agents or be contaminated by fertilizers,

pesticides or livestock wastes. Ponds used for swimming should be analyzed for bacteria during swimming season to determine water quality. Contact your county office of Ohio State University Extension for publications AEX 314, Water Testing and AEX 315, Where To Have Your Water Tested.

Make Your Farm Pond Safe for Swimming

- DO teach children to swim.
- DO mark safe swimming areas with posts or floats.
- DO remove submerged rocks, stumps, broken bottles, and other hazards.
- DO keep simple rescue devices near your pond.
- DO post life saving warning signs.
- DO have your pond tested for contamination.
- DON'T swim alone or allow anyone to swim by themselves.
- DON'T let small children swim near a farm pond without adult supervision.

Related web pages:

- Communicating for Agriculture is a nonprofit organization dedicated to the needs of America's farmers and ranchers. They can be contacted at: http://www.cainc.org

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Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Earth Ponds : The Country Pond Maker's Guide to Building, Maintenance and Restoration - by Tim Matson - Publication Date: May 1, 1991 - List: $18.00

- The Home Water Supply : How to Find, Filter, Store and Conserve It - by Stu Campbell - List: $18.95 - Publication Date: October 1983

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

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How do you remove algae from ponds and lakes?

- **Suggestion A:** Sprinkle a handful of straw on the pond surface; a flake of straw should be sufficient for a three acre lake. Bacteria from the straw will eat the algae.
  Note: One of our web site visitors stated that this is primarily a wive's tale. The straw only adds to the existing organic loading of the pond that causes the algae.

Planning an Excavated Pond:

Design of an excavated pond is based on the required storage capacity, depth to the water table, other available water sources, and the stability of the side-slope materials. The topographic conditions at the site must allow economical construction. Cost is a direct function of the volume of excavated material required to obtain a certain storage capacity in the pond. This method of construction results in the limited practical size of excavated ponds. However, these ponds can be designed to minimize evaporation losses by decreasing pond surface area in proportion to stored volume.

A rectangular shape is usually the most convenient for excavation equipment. The size of the pond is determined by the purpose for which water is needed, the site conditions, and the amount of inflow that can be expected. The required capacity of an excavated pond fed by a shallow water table is difficult to determine since the estimated rate of inflow into the pond can rarely be estimated with reasonable accuracy. Long narrow ponds will yield (or lose) more water from (or to) the surrounding area than square ponds. In some cases it may be necessary to augment the pond volume with water pumped from a nearby well or other water source. More information on pond sizing can be found in IFAS Extension Bulletin 257.

The proposed pond site should be thoroughly investigated prior to design and construction. Core samples of the soil profile should be obtained to provide information on the permeability of the material within all depths and below the bottom of the proposed pond. Permeability requirements for pond construction vary with the type of water supply into the excavated area. For a pond supplied by a surficial aquifer source the permeability of the surrounding soil must be high to assure sufficient inflow into the pond. Conversely, a pond supplied with water from another source as discussed above must be located in an area with low permeability soils in order to avoid seepage losses.

Permeability is defined as the readiness with which soil transmits water under standard field conditions. It depends primarily on the size and shape of the soil grains, the porosity of the soil, the shape and arrangement of the pores, and the degree of saturation. There are several laboratory methods to determine permeability for a given soil.

Indications of soil permeability can also be obtained at the sites by filling test holes with water and

observing the seepage characteristics of the material. Permeability tests performed in the field are frequently more representative of the actual site conditions since the soil is not disturbed as much as when the samples are transferred from the field to the laboratory. The simplest method used in the field in the presence of high water table is to dig an auger hole into the soil below the water table. First determine the elevation of the existing natural water table by allowing the water surface in the hole to reach equilibrium with the surrounding area. Next, the water in the auger hole is pumped out to lower the elevation of the water surface in the hole, then the rate of rise of water in the hole is measured. From this measurement soil permeability can be calculated.

At sites without natural water tables, other permeability tests must be used. An infiltration test over a large area (13 ft or 4 m in diameter) may be used as a field test. This avoids the soil compression that is inherent in core sampling, which is necessary for the lab samples. The area is diked with a ring of soil and filled with water to form a shallow pond. A circular pond is recommended rather than a rectangular one because the circular pond has less lateral and undesirable seepage loss per unit area than a rectangular one. To perform this test water is added to the pond area as needed to saturate the soil in the surrounding area, then the falling water level of the pond in the absence of added water is observed and used to determine permeability. This rate should be a measure of the ability of the soil to pass water into and through the observed soil layer.

When excavated ponds are supplied by surface runoff or by water pumped from a well, relatively impervious soils at the site are essential to avoid excess seepage losses. Soil materials must be available to provide a stable, impervious fill where needed. Clays and silty clays are the most desirable, however sandy clays may also be satisfactory. In some regions of the Florida Panhandle, the soils contain sufficient clay to allow pond construction without adding soil amendments or artificially lining the pond. Unfortunately, most of the soils in peninsula Florida are very sandy, and additional measures to prevent seepage are necessary for pond construction. In some cases the only solution may be an artificial lining material. An artificial lining is expensive but should be considered at sites where soils are porous or are underlined by sands or gravel. Methods of pond sealing are discussed in IFAS Extension Circular 870.

In addition to permeability tests, the core sample holes may be used to determine the existing level of the water table from the shallow aquifer. The depth to the water table generally varies throughout the year. Therefore, several observations may be necessary to help with design. The performance of other nearby ponds may provide useful information with respect to the suitability of the proposed site and for design purposes.

Larger ponds should be equipped with some drainage facilities. A drain pipe is necessary to facilitate maintenance and fish management. On flat topography a pump may be necessary to drain the pond.

Excavated Pond Construction:

Proper construction practices should be followed to ensure safety and to reduce potential problems. After the pond site has been selected, an area or areas for spoil placement (excavated material) should be located. Stake the boundaries of the pond and spoil placement locations with the depth of cut from the ground surface to the pond sides or bottom clearly marked on the stakes. All woody vegetation should be cleared from these areas.

The type of excavating equipment for construction will depend on availability, climate, and physical conditions at the site. During dry periods most types of equipment can be used. The most common are tractor-pulled wheeled scrapers, draglines, and bulldozers. Inefficiency in transporting material limits the use of a bulldozer for excavation to relatively small ponds. Dragline excavators are commonly used for pond construction in the high natural water table areas of Florida. This is the only type of equipment that will operate under saturated soil conditions.

It is desirable to keep topsoil separated from subsoil materials during excavation. Place topsoil material in a location where it can be accessed after excavation has been completed. After excavation, this material should be placed on the surface of the side slopes, berms, spoil banks and spillways. These areas should be seeded or plugged with a grass or other cover material for erosion control. The grass or cover material should require minimal maintenance, be tolerant to local drought or wet conditions, and be relatively easy to establish.

Farm Pond Safety

The farm pond has been an important economic unit in many farming programs. Ponds are used as part of a soil and water conservation program to water livestock, as an irrigation water source, and for fire protection and recreation, such as fishing, boating, swimming and ice skating.

Unfortunately, farm ponds contribute to accidental drownings. Children are the victims of the majority of farm pond drownings. Small children get too close to the water and lose their balance on the soft bank. Many wade in the cool shallow water only to fall into deep holes. Some drown for no apparent reason. Lack of close adult supervision contributes to pond drownings.

Adults often overestimate a child's curiosity. A short attention span, coupled with the attractiveness of a farm pond as a play area may render most verbal instructions ineffective. Adults, too, drown in farm ponds. Most of these pond drownings occur while swimming. These are most often young active adults and visitors.

It is the farm operator's responsibility to see that his/her farm pond is as safe as possible. In most cases it is recommended that all ponds be fenced and posted to keep out unwanted persons. Liability may increase with non-posted, non-fenced ponds. Restrict entry to your pond to keep out uninvited guests.

Accidents can be prevented and lives saved by placing signs warning of specific dangers or indicating safe areas for swimming.

All farm ponds used for swimming should have a rescue post. It should be set firmly in the ground near the water. The post should be painted yellow. Attach a long shelf bracket, peg or nail to the post. Obtain enough nylon rope to reach across the pond. Attach a life buoy or ring to one end of the rope and a wooden block to the other end. Hang this rescue device on the post. A thin, lightweight 12' to 14' pole should be attached to the rescue post to aid in rescue. Finally, attach the location of the nearest telephone and emergency numbers to the top of the post.

It should be emphasized that all farm ponds may not be suitable for swimming. If the water is cloudy, has a foul odor or excess algae, it may contain infectious agents or be contaminated by fertilizers, pesticides or livestock wastes. Ponds used for swimming should be analyzed for bacteria during swimming season to determine water quality. Contact your county office of Ohio State University Extension for publications AEX 314, Water Testing and AEX 315, Where To Have Your Water Tested.

Make Your Farm Pond Safe for Swimming

- DO teach children to swim.
- DO mark safe swimming areas with posts or floats.
- DO remove submerged rocks, stumps, broken bottles, and other hazards.
- DO keep simple rescue devices near your pond.
- DO post life saving warning signs.
- DO have your pond tested for contamination.
- DON'T swim alone or allow anyone to swim by themselves.
- DON'T let small children swim near a farm pond without adult supervision.

Related web pages:

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Commercial suppliers:

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Electronic mailing lists:

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Frequently Asked Questions:

Other Information Sources:

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What is the best way to remove snow from a long driveway?

- **Suggestion A:** Look at something bigger than a lawn tractor. We have 1/4 mile of driveway with about a 6% slope. An Oliver OC-3 crawler tractor with blade is working most nicely. It is however without a cab so operator comfort is marginal, however traction is quite excellent.
- **Suggestion B:** Don't get a four-wheel drive pickup with a snowplow. The snowplow on the front of the truck does nothing but move a bit of snow, sack the front springs, require large outlays of cash for the hydraulics and tire chains and funky lights, and finally requires you to get the kit for another truck in five years when you trade in the old model.
- **Suggestion C:** An alternative is to acquire a small tractor (20 - 30 HP) with a PTO and 3 pt. hitch, and attach a 3pth snowblower. The blower lets you throw the snow (and avoid building banks that cause drifting). I use a FORD 2000 tractor with a 5.5 ft. snowblower to clear my driveway. Takes about 20 minutes to do 500 ft. plus the yard in front of the workshop if the snow isn't higher than the snowblower. Just have to watch turfing big rocks onto the roof of the house! Plowing is only useful if you can avoid building banks that will drift in the next time the snow blows.
- **Suggestion D:** A 3-point grader blade behind a tractor works pretty well, as long as the blade can be angled enough. With too many snowfalls, you can run out of space to plow the snow to (due to the previously plowed snow), at which time you would either need a snowblower or a loader to move the excess plowed snow further off of the road
- *A site visitor wrote: I very much disagree with your conclusion in FAQ that a blade is superior to a loader for moving snow. A blade may be adequate in South Texas, but in Iowa it only works on the first snow and then only if it's a light snow. Once there's drifts, a blade can only push snow until you run out of places to push snow. You can't drive a 20 hp tractor through a 3 foot deep drift, you have to bash it backwards with a blade (been there done that, sold the tractor and blade years ago). After a snow or*

two, there's no place I can push snow, without lifting it. I replaced the 8N and blade with a much smaller JD garden tractor and snow blower. It's a single stage blower and worthless in wet snows. Then I got a tractor with a full hydraulic loader so I would be able to LIFT the snow to the tops of previous snow piles. But a blade just doesn't cut it.

How do you remove snow buildup from roofs?

- **Suggestion A:** Nail a rope to a couple of short 2X4's. Toss the rope/2X4 over the house and pull back. This will losen most (non-wet) snow enough to start an avalanche. This isn't perfect but it is better than a roof cave-in.
- **Suggestion B:** Using pvc sprinkler tubing and connectors, make a long rectangle maybe 2 feet wide and 20 feet or so long. Duct tape plastic sheeting over the pvc frame. Use this to make verticle slices in the snow. Just slide the tubing into the snow and the slickness of the plastic causes the snow to slide down off the roof.

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Electronic mailing lists:

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Suggested references:

- None identified

Periodicals:

- None identified.

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Stock Watering

Frequently Asked Questions Other Information Sources Return to Property Management

Frequently Asked Questions:

- Stock Watering for Pastures Near Streams

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

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Stock Watering for Pastures Near Streams

Problem:

Animals drinking in streams or creeks contribute to erosion, water borne sediments, and manure contamination of the water. Providing a water supply away from the stream is an important part of the overall pasture management plan.

Benefits of Stock Watering away from Streams

- Prevent animal injuries from steep and/or crumbling streamside slopes.
- Protect areas near the water source from becoming infested with undesirable plants due to overgrazing and trampling.
- Watering location can control where and what forage the animals will consume.
- Animals have access to cleaner water, whether the source is from a protected stream, well or city water.
- Animal wastes will be kept out of streams and creeks.
- Streamside plants can provide habitat and food for desirable fish and wildlife.

Recommendations

- Prevent any activities which may result in the discharge of wastes into the waters of the state. Wastes include but are not limited to, livestock manures, composts and fertilizers.
- Pasture near streams should be managed to establish and maintain a well vegetated buffer extending at least 35 feet back from the normal high water mark for the stream.

- A water right may not be necessary to provide water from a stream to livestock, if certain conditions are met.
- Proper placement of watering devices can be a valuable part of effective pasture management. Trough locations can be designed to reduce overgrazing in some areas.

Stock Watering Guidelines

- **Prevent overflow from water troughs** - The area near a watering trough is heavily used. Overflow causes mud, mess, runoff contamination, and possible animal injuries. Use float valves or other controls to prevent overflow. All troughs need an overflow system and overflows should outlet at least 15 feet from the pad. All troughs should have at least a 11/2 inch drain plug to aid cleaning. Guard rails may be needed to keep stock out and keep smaller animals from being pushed in. A ramp on the inside of the trough will help small wildlife, such as birds and squirrels, escape from drowning.
- **Instruction hints** - protect float valves from animals and vandalism. The trough should be large enough to allow stock to drink without shoving. Concrete or rock pads installed around drinking facilities reduce mud, disease, and erosion problems.
- **Check the capacity of the water source** - a milk cow may need as much as 35 gallons of water per day, a beef cow or a horse may need 15 gallons, a sheep or goat may need 5 gallons. Add more if any wildlife will be drinking the water.
- **Locate water troughs** - in under used pasture areas to assist in pasture management. Livestock graze more in areas near available water. Plan water facilities as part of your rotational grazing and pasture management plan. (See Pasture Management)
- **Provide watering areas and shade away from streams -** a shaded water trough at an easily accessible location draws the animals away from loitering in the stream. Place the water supply in or close to the animals normal path toward the creek. Other out-of-stream shaded areas allows the stock to move to the coolest spots during the day.
- **Method** - water from the stream can be pumped or gravity fed to the trough. Nose pumps, gravity filled storage tanks, hydraulic rams, solar pumps, or in-stream propeller pumps, can be used to provide water in areas without electrical power.
- **Allow animal access to only small stream stretches -** Where out of stream watering systems are not feasible, fences can be used to limit access. Fenced openings guide animals to a water gap to drink from the creek. High rainfall and flooding may require regular maintenance and repairs on the water gaps and

fence.

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Suggested references:

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Periodicals:

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Frequently Asked Questions:

- Stock Watering for Pastures Near Streams

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Periodicals:

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Management of Near Stream Areas

Frequently Asked Questions Other Information Sources Return to Property Management

Frequently Asked Questions:

- Erosion Control Management

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- Commercial suppliers
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Management of Near Stream Areas

Quality management of land near the stream is critical to protect water quality and habitat for beneficial wildlife. Inadequate near-stream management has reduced salmon and trout populations, increased the costs of domestic water treatment, increased livestock diseases, increased sediment in irrigation, increased algae growth, and reduced downstream scenic and recreational values. Appropriate near-stream management benefits water quality by reductions in water temperatures, erosion, sediment, and bacteria in streams.

Land near streams should be managed wisely to avoid two primary problems; lack of ground cover and lack of shade. Without ground cover, runoff carries soil, bacteria, pesticides, and fertilizer into the stream. Without shade, stream water gets warmer. Warm water can not hold enough dissolved oxygen for salmon or trout. Warm water promotes growth of bacteria and algae.

Benefits of Effective Near Stream Management:

- Keep soil, sediment, chemicals, heat, manure, and other pollutants from entering a stream.
- Prevent degradation of land by excessive erosion.
- Allow more productive use of fertilizer and pesticides.
- Improve land appearance.
- Improve habitat for desirable trout, salmon, songbirds, and other wildlife.
- Protect water quality for all users.
- Increase forage production.

Recommendations

- Conduct no activities within 35 feet of the normal stream waterline which may result in soil, manure, or other solids entering a stream.
- Establish grass or another appropriate vegetative buffer at least 35 feet wide bordering streams. Maintain the vegetative cover to provide thick ground cover, soil stabilization, and to filter runoff. Plant shrubs and trees to shade the stream to keep it cool for fish, and to reduce algae growth.
- Avoid using this area for construction, barnyards, feedlots, or other uses which may cause soil, waste, or chemicals to be washed as runoff into a stream.

Guidelines

Establish a vegetated buffer at least 35 feet wide beside streams to reduce erosion and filter runoff.

- **Plants** - Surface or shallow ground water can carry fertilizer, bacteria, soil, manure, or pesticides toward the stream. A thick grass ground cover can slow this movement, capture some problem materials, and protect water quality. Wider buffer strips will increase filtering benefits. Shrubs and small trees have long, strong roots which stabilize streambanks, reduce erosion from the stream current, and capture more nutrients. Shrubs and trees planted in the buffer area can shade the stream keeping water temperatures cooler. This helps trout and salmon and reduces bacteria and algae. Trees and shrubs also provide habitat for desired birds which eat insect pests.
- **Pasture** - The basic guidelines are that pastures near streams should be managed to keep the grass at least 3 inches high. Livestock grazing should be monitored and animals moved to another location before the grass gets lower. Rest the pasture until forage regrows to 6 - 8 inches. Providing off-stream watering with troughs, piped water, or animal powered "nose pumps" will help keep animals from abusing the near-stream area with overgrazing, manure, or by trampling vegetation and compacting soil. Proper water placement can promote more uniform pasture utilization and increased forage production.
- **Fertilizer** - On all fields and pastures, care must be taken with fertilizer or manure applications to protect both stream and well water quality. Apply materials at rates and times to benefit plant growth while protecting water quality. Application rates should be determined by soil tests and nutrient analysis of the fertilizer or manure. No fertilizer or manure should be used within 25 or more feet of streams, drainage ditches, or tile inlets, regardless of soil tests, except for initial plant establishment.

- **Animals** - Livestock holding areas should be kept as far from streams as possible, with a dense plant cover maintained near the stream. Areas near streams should not be used for paddocks, feedlots, or stalls.

What can be done?

- Establish a buffer strip at least 35 ft. wide from the streams water line. Use a thick cover crop of grass to control erosion and filter runoff. Good pasture grasses for streambanks include orchardgrass, perennial ryegrass, and tall fescue. Native grasses adapted to our area include Arlington and Elkton. These are recommended varieties of native blue wildrye which have recently become available in many northwest seed stores. Where no livestock will use the area, wild lily of the valley, sword fern, or small fruited bulrush are good native species ground covers.
- Shrubs have strong root systems, give more protection from streambank erosion, provide shade to the stream, and their roots capture fertilizers and other pollutants. For planting near streams, good native small shrubs include Salmonberry, Nootka Rose, Twinberry, Douglas Spirea, Salal, Snowberry, Kinnikinnik, or Oregon Grape.
- Shrubs growing over 10 feet tall provide more shade and have stronger root systems for more erosion control and nutrient capture. Taller native shrubs include: Red Osier Dogwood, Indian Plum, Pacific Ninebark, Oceanspray, Elderberry, Vine Maple, Western Crabapple, Sitka and Pacific Willow, and Cascara.
- Avoid planting large trees near streams where future erosion may cause them to fall and tear out the streambank. Good trees that generally stay under 60 feet, grow well in damp soils, and which have strong root systems include Oregon Ash, Quaking Aspen, and Western Paperbirch.
- If the near-stream area is used for pasture, manage grazing so grass is never less than three inches high to control erosion, and filter runoff. This may require streambank fencing. Keep livestock off all pastures while they are water saturated. This forage is often poor quality. Grazing on saturated ground compacts soil, reducing both water filtering capacity and forage production.
- Provide off-stream watering for livestock using "nose-pumps", troughs, or other means.
- Protect wetlands and streams through careful waste and nutrient management. Match application of fertilizers or manures to plant needs determined by soil testing. Do not apply these materials near streams, or elsewhere when runoff may carry them to the

stream.

- Follow labeled safety guidelines carefully when using pesticides. Pesticides in streams kill insects fish use for food, and accumulate in fish tissue to kill fish later. Bats and birds can eat over 600 insects per hour. Installing bird and/or bat houses can help reduce insect problems. Plans and guides for building bird or bat houses are available from Oregon Dept. of Fish & Wildlife in Clackamas at (503) 657-2000 Ext. 221, the Audubon Society, or commercial bird supply stores.

Related web pages:

- Communicating for Agriculture is a nonprofit organization dedicated to the needs of America's farmers and ranchers. They can be contacted at: http://www.cainc.org

---

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 15, 2002

Frequently Asked Questions:

- Erosion Control Management

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

Weed Management

Frequently Asked Questions Other Information Sources Return to Property Management

Frequently Asked Questions:

- Weed Management

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

Warning:

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Weed Management

Weeds and brush compete with desirable plants, and some unwanted plants are a threat to animal health and productivity. Weed management is an important part of the overall land management plan. Good management follows the saying, an ounce of prevention is worth a pound of cure.

Benefits of Weed and Brush Management

- Prevent buildup of damaging or toxic weed populations and their seeds.
- Controlling the weeds helps to develop and maintain a desirable plant growth.
- Increased pasture quality, forage yield, animal capacity, and animal health protection.
- Reduced need to buy supplemental feed in the winter.

Recommendations:

- Lands must be managed to prevent both gully and sheet erosion.
- Lands near streams must be managed to establish and maintain a well vegetated buffer extending at least 35 feet back from the normal high water mark for the stream.
- All pesticides must be used only as directed on the label.
- **Identify the weed or brush** - weed controls are specific to a species, or a plant type. Know what you are trying to control to get the best match with an effective herbicide or alternative. Some plants are best sprayed when they're small, with 2 or 3 leaves; others are best controlled before budding or when in bloom. Know what to spray, when to spray it and the limitations

on animal grazing.

- **Identify any poisonous weed** - Most poisonings occur from hay, so check your hay supply for weeds. Most, though not all, toxic plants are unattractive to animals and avoided. However, if the harmful plants are intermingled with the good plants, or if there is insufficient forage and the animal is hungry, harm can happen. Poisonings are most likely with very young animals, or animals newly brought into the area. Examine your pasture in August, the weeds left untouched are either toxic or unpalatable.
- **Read the directions with chemical controls** - the toxicity of most chemicals used in pasture weed control is low, as long as you follow the directions on the container label or booklet. More is not better. It may take several applications to control some weeds and brush.
- **Weed Control** - hoeing, spot spraying, and re-checking the location, will keep the weeds from spreading.
- **Brush Control** - often the best control of undesirable brush is to physically remove the plants, by hand or using equipment. Some chemical control may be required for a limited time to control re-sprouting or new growth.
- **Alternative** - both goats and sheep have been used to control weeds and brush. They are browsing animals, meaning they search out what they want to eat. They prefer brush, tree leaves, and rough plants. Each species prefers different plants.
- **Consider biological controls** - some insects feed on specific weeds.
- Control Program - often an ongoing control program is necessary to control unwanted weeds and brush. Be prepared to check and re-check.

- **Expect more and different weeds or brush** - land management is an on-going program. An effective weed and brush program is never over. Once the existing undesirable plants are controlled, watch for new plants.

- **Respect your pastures grazing capacity** - overgrazing will allow unwanted weeds and brush to thrive over the weakened pasture grasses. Minimum area is 2-3 acres per horse and 1-2 acres per cow and calf, or 2-3 sheep per acre. A control program begins with a healthy pasture. Consider rotational grazing for your animals.

- **Graze pastures to no less than 3 inches in height -** rest the pasture until it has regrown to 6-8 inches.

- **Keep animals off the pasture as much as possible from November through March** - Consider an all-weather paddock or sacrifice area.
- **Renovation and re-seeding** - in some cases complete replacement of the pasture is needed. This involves destroying the old sod, either by herbicides or plowing, and then re-seeding to establish a new, less weed infested pasture.
- **Clipping** the pasture can help, depending on the weed species or type. Pasture mowing is recommended in late May before weed seeds are mature.

Related web pages:

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Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 15, 2002

Frequently Asked Questions:

- Weed Management

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---

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 15, 2002

Wildlife

Return to the Small Farm Resource

- Bats
- Deer
- Elk
- Pheasant
- Rabbits
- Squirrels
- Turkey

If you have a question, we will post the question in the appropriate contents page to get suggestions from our site visitors.

Questions and suggestions can be sent to us via our Feedback form.

Visitor Questions:

Bats

Frequently Asked Questions Other Information Sources Return to Wildlife Contents

Frequently Asked Questions:

Other Information Sources:

Warning:

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Anyone know an average radius a bat will go from its home to find food? We have an awful mosquito problem, and I'm thinking of putting up a bat house to attract some bats. How far away from my house can I put it and still radically reduce the mosquito population?

Varies somewhat by species. Some on the order of hundreds of yards, some much less. Having a bat house near a clearing, or even better near an open body of water (stream, pond, etc) will help attract bats. Be sure your bat house has a variety of roosting slit thicknesses; this will increase the odds of your bat house being occupied by the bats in your area. Some people have reported success mounting the bat house on their house. Most instructions tell you to mount the bat house on the south side of the structure (wall, tree, etc) and make sure it's in the sun for all or part of the day (more sun further north you are located). Female bats (and young) prefer very warm conditions for roosting.

My bat house (homemade) was not occupied in its first year. Second and subsequent years there have been a few occupants. By all means, please try to install a bat house; encourage your neighbors to do the same. Place it between 10 and 20 feet above the ground, with a clear, unobstructed opening underneath. Bat populations are on a decline in the USA, and whatever we can do to forestall thus decline will help in keeping check on the mosquito and other flying pest populations far better than chemical means. They are marvelous, interesting creatures as worthy as our feathered friends who receive much more attention.

Related web pages:

- Check out Bat Conservation International, Inc. at: http://www.batcon.org/

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on August 02, 2002

Frequently Asked Questions:

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Electronic mailing lists:

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Suggested references:

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Periodicals:

- None identified.

This page was last updated on August 02, 2002

Miscellaneous

Return to the Small Farm Resource

- Maple Syrup

If you have a question, we will post the question in the appropriate contents page to get suggestions from our site visitors.

Questions and suggestions can be sent to us via our Feedback form.

Visitor Questions:

Other Miscellaneous information

Making Maple Syrup

Frequently Asked Questions Other Information Sources Return to Miscellaneous

Frequently Asked Questions:

Other Information Sources:

Warning:

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When do you harvest the sap?

According to people who make maple syrup in Ohio, a sugar run is when the sap from maple trees is running and can be boiled into syrup. This occurs when the nights have been cold (32 degrees F. or colder) and the daytime temps. are 40 degrees F. or above. You can tap a maple tree and get sap from it, even if it doesn't freeze at night. But, you probably won't get enough sap to boil down into syrup.

Where should I boil the syrup?

It is a good idea to boil outside. My father-in-law removed every last shred of wallpaper in his kitchen the first time he ever tried to boil indoors, and you can use a lot of power doing it with an electric stove. Outside is inferior to a purpose-built sugaring house, but far better than inside.

Related web pages:

- Michigan State University site related to Maple Syrup and links to relevant Maple Syrup resources on the Internet. This site can be reached at: http://www.msue.msu.edu/msue/iac/agnic/maple.html

---

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Amateur Sugar Maker - by Noel Perrin, Robert MacLean (Illustrator) - Publication Date: April 1992 - List: $10.95
- Backyard Sugarin' - by Rink Mann - Publication Date: March 1992 - List: $9.50
- Sugartime : The Hidden Pleasures of Making Maple Syrup With a Primer for the Novice Sugarer - by Susan Carol Hauser - Publication Date: October 1997 - List: $16.95
- The Maple Syrup Cookbook - by Ken Haedrich - Publication Date: March 1989 - List: $12.95

Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

Other Information Sources:

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Electronic mailing lists:

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Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

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Periodicals:

- None identified.

This page was last updated on November 16, 2002

Miscellaneous

Nonprofit Agriculture Exchange Program

Some basic information:

- CAEP is now in the 10th year of operating under the United States Information Agency guidelines.
- The visa used is the J1 visa which allows a trainee to stay in the United States and participate in a host family's operation for a period of time for at least 3 months not to exceed 18 months.
- Trainees must be between the ages 18-28, have at least one year practical experience in the field chosen and be able to speak and understand English.
- Minimum guidelines established by CAEP is the host family will provide room and board and a monthly $500 stipend. In exchange, the trainee agrees to participate in the host family's operation for at least 55 hours a week.
- Trainees pay CAEP $ 425 and come with health insurance that meets the specifications of the U.S.I.A., or will agree to purchase health insurance provided by CAEP for $ 50 per month.
- Areas provided for training in agriculture include: dairy, field crops and machinery, swine, beef, sheep and horses.
- Areas provided in horticulture include: fruit and vegetables, landscaping, tree nursery, cut flowers and potted plants.
- CAEP also provides an enology program.
- CAEP works with country partners - organizations that are set up in each country that provide screening and information to prospective trainees.

You can contact us:

by phone: (218) 739-3241
by fax: (218) 739-3832
by mail: CAEP, 112 East Lincoln Ave., Fergus Falls, MN 56537
by email: dspeer@fergus.cfa.org

And please don't forget to mention that you found this message on the Internet

---

Related web pages:

- None identified.

Electronic mailing lists:

- **AGENG-L: Agricultural Engineering**

  Subscription address: listserv@gwdg.de

  Topics: All areas of agricultural engineering, including intelligent technology on farm machinery. Related themes are ergonomic aspects and farm planning.

  Subscribe to AGENG-L. Type "subscribe ageng-l Your Name" in the message body. (Not upported by all browsers.)

- **AGENVIR-L: Discussion of Environmental Issues in the Agricultural Sciences**

  Subscription address: majordomo@io.com

  Topics: alternative cropping systems, organic farming, animal agriculture, vegetarianism, sustainability issues

  Subscribe to AGENVIR-L. Type "subscribe agenvir-l Your Name" in the message body. (Not supported by all browsers.)

- **AGLAW-L: Agricultural Law Discussion Group**

  Subscription address: listserv@lawlib.wuacc.edu

  Topics: A communication vehicle between law professors and attorneys practicing agricultural law. Content includes discussions on agricultural law, rural development, land titles, wetlands regulations or anything attorneys are interested in talking about.

  Number of subscribers: 49

  Subscribe to AGLAW-L. Type "subscribe aglaw-l Your Name" in the message body. (Not supported by all browsers.)

- **AGMODELS-L: Agricultural Simulation Models Mailing List**

  Subscription address: listserv@unl.edu

  Topics: A forum for topics relating to agricultural simulation models sanctioned by the Electronic Communications Committee of the American Society of Agronomy. Although originally intended for discussing more traditional agricultural models such as GLEAMS, Ceres-Maize, EPIC, etc. the list discussion is open to any type of model, from spreadsheets to global change models. Also, the meta-topics of what is modeling and modeling philosophy are encouraged. Plant growth, micro-meteorlogical, soil hydrology, transport, economic, farm systems, and many other models may be discussed. Problems and advantages of computer simulation models for agriculture as well as the role played by models in the future of agriculture.

  Subscribe to AGMODELS-L. Type "subscribe agmodels-l Your Name" in the message body. (Not supported by all browsers.)

- **AGRIC-L: Agriculture Discussion Mailing List**

  Subscription address: listserv@uga.cc.uga.edu

  Topics: Anything remotely related to agriculture. Topics may include grassland husbandry, crop science, simulation of ecological processes and crop production, forestry, plant physiology, land development, water resource management, irrigation science, soil science, plant propagation, cattle breeding, pig farming.

  Subscribe to AGRIC-L. Type "subscribe agric-l Your Name" in the message body. (Not supported by all browsers.)

- **AQUA-L: Aquaculture Discussion List**

  Subscription address: listproc@upei.ca

  Topics: Assorted topics related to aquaculture.

  Number of subscribers: 692 Subscribe to AQUA-L. Type "subscribe aqua-l Your Name" in the message body. (Not supported by all browsers.)

- **BIOSPH-L: Biosphere and Ecology Discussion List**

  Subscription address: listserv@ubvm.cc.buffalo.edu

  Topics: Discussion of environmental issues.

  Subscribe to BIOSPH-L. Type "subscribe BIOSPH-L Your Name" in the message body. (Not supported by all browsers.)

- **BIOTECH: Biotechnology Discussion List**

  Subscription address: listserv@umdd.umd.edu

  Topics: Biotechnology issues.

  No. of subscribers: 838

  No. of countries: 45

  Subscribe to BIOTECH. Type "subscribe BIOTECH Your Name" in the message body. (Not supported by all browsers.)

- **CARLU: Contemporary Agriculture and Rural Land Use Discussion List**

  Subscription address: LISTSERV@ukcc.uky.edu

  Subscribe to CARLU. Type "SUBSCRIBE CARLU Yourfirstname Yourlastname" in the first line of the body.

Suggested references:

- None identified.

Periodicals:

- None identified.

Return to The Small Farm Resource

This page was last updated on August 02, 2002

Farming Conferences

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Upcoming Conferences:

- None identified.

Related web pages:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

Return to The Small Farm Resource

This page was last updated on August 02, 2002

Farm related links and mailing lists

Related Web Sites:

- The Online Homesteading Resource has general information on homesteading, small farm management, and other things rural.
- The Rural Resource Center, has links to many web sites of interest to the rural landowner.
- The PANUPS (Pesticide Action Network North America Updates Service) gopher server can be accessed here.
- Information from the Extension Service USDA can be accessed via gopher://zeus.esusda.gov or gopher://ra.esusda.gov. The information server (CYFER-net) can be accessed via gopher://esusda.gov.
- SCS (Soil Conservation Service) Gopher Information System gopher://gopher.scs.ag.gov.
- The Sustainable Agriculture Network archives can be accessed via http://www.ces.ncsu.edu.
- The Department of Agricultural and Resource Economics at the University of Arizona now has a WWW server on the information highway. It has crop budgets, a ranchers' management guide, access to information from the Livestock Marketing Information Center in Denver and general information about the department. The URL is http://ag.arizona.edu/AREC/arechome.html .
- Gardening info at http://www.prairienet.org/ag/garden/homepage.htm .
- Successful Farming magazine has started a web site at http://www.agriculture.com. It's mostly under construction right now but will have weather, markets, forums, and excerpts from both SF andit's daughter magazine ag/INNOVATOR.

Related Mailing Lists:

FAOLIST: Food and Agriculture Organization Open Discussion List

Subscription address: listserv@irmfao01.bitnet

Topics:

Subscribe to FAOLIST. Type "subscribe FAOLIST Your Name" in the message body. (Not supported by all browsers.)

Return to The Small Farm Resource

This page was last updated on November 15, 2002

Search The Small Farm Resource

Search for:

Start Search Reset

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Small Farm Resource Contributions

We welcome contributions to the Small Farm Resource. In fact, most of our information comes from contributions from other people who have some experience in some area of running a small farm. Getting us information is very easy. The easiest approach is to just send us an email message with the information you would like to share. The best email address to use is Sally_Farmer@hotmail.com. We can accept both text documents and binary documents (e.g., from a word processor or an image file). We are looking at providing access to our site for key contributors such that they can maintain pages of their own on our web.

Return to The Small Farm Resource

This page was last updated on August 02, 2002

Dairy Index

Return to the Small Farm Resource Return to the Livestock Index

Reproductive Management

Frequently Asked Questions Other Information Sources Return to Dairy Contents

Frequently Asked Questions:

Other Information Sources:

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Reproductive Management

Disease Control

Disease control is an important part of a herd reproductive management program. In addition to vaccination, efforts to isolate the herd from sources of infection are important. The use of artificial insemination permits the use of the best genetic material available without the risk of introducing new animals and diseases into the herd. The health control of animals producing semen for studs is such that little chance exists for the introduction of diseases by this route. The complete isolation of the herd is possible and gives good protection against disease introduction. When females must be added to a herd, a complete sequence of isolation, observation, and retesting should be carried out. Maintaining an environmentally closed herd, using veterinary help in a vaccination program and having prompt diagnosis in cases of suspicious animals should combine to keep a herd trouble-free.

Use Of The Veterinarian

A veterinarian should be involved in giving all vaccinations and in implementing a disease prevention program. A good reproductive health control program should include vaccinating for leptospirosis, IBR (infectious bovine rhinotracheitis), and BVD (bovine viral diarrhea).

The value of having scheduled visits by a veterinarian at designated intervals to conduct post calving examinations, pregnancy diagnosis and treatment of problem cows appears to have some advantages. Work at The Ohio State University indicated that the cost of veterinary services was not different whether the program was on a scheduled or emergency basis. However, an advantage did accrue to the regularly

scheduled herd in reduced services per conception and fewer animals culled for reproductive problems. The net value of the use of a veterinarian on a scheduled basis was about $6.00 per cow per month (as of 1978). Work at other institutions has produced results that indicate the use of a veterinarian on a regular basis for routine work will return up to $5.00 for each $1.00 invested in such a program.

Cystic Ovaries

Cystic ovaries continue to be a problem in dairy herds. The interacting causes are not known. Inheritance plays a small role as the cause of some problems. At present, the method to minimize this problem rests with early diagnosis by post calving examination and early treatment. Cases which are detected by anestrus or irregular heat cycles require more time for correction and this time adds to that already lost in late detection.

Items To Consider In Deciding To Treat Or Cull

Most cows that are culled because of reproductive failure are not permanently sterile. With the expenditure of money for treatment and loss of much production time, cows can usually be restored to a fertile state. Economics dictates that few cows are of sufficient merit to justify much of this expenditure. Many factors go into the decision to cull a cow for delayed rebreeding. These include current prices of milk, feed and cattle. The temptation to continue to salvage an aged cow that is slow in rebreeding should be tempered by certain facts.

- A cow, if retired, will be 1'/2 years older when she refreshers than at the last calving.
- Because the repeatability of records is only about 50 percent, a good cow will not be expected to produce as well as she did in previous lactations.
- If a good program of sire selection is employed, the young cows coming into the herd will represent a higher genetic level than will older cows.

If a cow does refreshen, her anticipated years of usefulness is determined by her age. Anticipated useful years for different ages are as follows:

- 5 years of age -- 3.2 years of usefullness
- 6 years of age -- 2.9 years of usefullness
- 7 years of age -- 2.5 years of usefullness
- 8 years of age -- 2.2 years of usefullness

Age For Breeding Heifers

Age at puberty is affected by both age and growth. Within normal ranges, the age at first breeding has little effect on conception. However, excessive delay in first breeding (3 to 4 years) results in animals with poor lifetime reproductive performances. Delays to 21 months of age for first breeding has shown no effect on lifetime performance. The most important item is the ability of the heifers to deliver a calf. Minimum weight for safe calving by breeds appears to be as follows:

- Ayrshire -- 815 pounds
- Brown Swiss -- 1000 pounds
- Guernsey -- 780 pounds
- Holstein -- 1070 pounds
- Jersey -- 765 pounds

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These techniques would give wider use of the genetic material from superior females. While they are possible, they have not yet been refined to the point where they can be routinely and economically used by commercial dairymen. To date they have been used mostly by the purebred cattle breeders on superior cows. The cost of these procedures often totals about $2,000 for each successful pregnancy. In order for the procedures to be justified from just the increased herd milk production that would be realized by using the best cows as dams of all the herd replacements, the cost will need to be reduced below $100. The improvements that could bring this within a realm of practicality are:

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Reproductive Management

Disease Control

Disease control is an important part of a herd reproductive management program. In addition to vaccination, efforts to isolate the herd from sources of infection are important. The use of artificial insemination permits the use of the best genetic material available without the risk of introducing new animals and diseases into the herd. The health control of animals producing semen for studs is such that little chance exists for the introduction of diseases by this route. The complete isolation of the herd is possible and gives good protection against disease introduction. When females must be added to a herd, a complete sequence of isolation, observation, and retesting should be carried out. Maintaining an environmentally closed herd, using veterinary help in a vaccination program and having prompt diagnosis in cases of suspicious animals should combine to keep a herd trouble-free.

Use Of The Veterinarian

A veterinarian should be involved in giving all vaccinations and in implementing a disease prevention program. A good reproductive health control program should include vaccinating for leptospirosis, IBR (infectious bovine rhinotracheitis), and BVD (bovine viral diarrhea).

The value of having scheduled visits by a veterinarian at designated intervals to conduct post calving examinations, pregnancy diagnosis and treatment of problem cows appears to have some advantages. Work at The Ohio State University indicated that the cost of veterinary services was not different whether the program was on a scheduled or emergency basis. However, an advantage did accrue to the regularly scheduled herd in reduced services per conception and fewer animals culled for reproductive problems. The net value of the use of a veterinarian on a scheduled basis was about $6.00 per cow per month (as of 1978). Work at other institutions has produced results that indicate the use of a veterinarian on a regular basis for routine work will return up to $5.00 for each $1.00 invested in such a program.

Cystic Ovaries

Cystic ovaries continue to be a problem in dairy herds. The interacting causes are not known. Inheritance plays a small role as the cause of some problems. At present, the method to minimize this problem rests with early diagnosis by post calving examination and early treatment. Cases which are detected by anestrus or irregular heat cycles require more time for correction and this

time adds to that already lost in late detection.

Items To Consider In Deciding To Treat Or Cull

Most cows that are culled because of reproductive failure are not permanently sterile. With the expenditure of money for treatment and loss of much production time, cows can usually be restored to a fertile state. Economics dictates that few cows are of sufficient merit to justify much of this expenditure. Many factors go into the decision to cull a cow for delayed rebreeding. These include current prices of milk, feed and cattle. The temptation to continue to salvage an aged cow that is slow in rebreeding should be tempered by certain facts.

- A cow, if retired, will be 1'/2 years older when she refreshers than at the last calving.
- Because the repeatability of records is only about 50 percent, a good cow will not be expected to produce as well as she did in previous lactations.
- If a good program of sire selection is employed, the young cows coming into the herd will represent a higher genetic level than will older cows.

If a cow does refreshen, her anticipated years of usefulness is determined by her age. Anticipated useful years for different ages are as follows:

- 5 years of age -- 3.2 years of usefullness
- 6 years of age -- 2.9 years of usefullness
- 7 years of age -- 2.5 years of usefullness
- 8 years of age -- 2.2 years of usefullness

Age For Breeding Heifers

Age at puberty is affected by both age and growth. Within normal ranges, the age at first breeding has little effect on conception. However, excessive delay in first breeding (3 to 4 years) results in animals with poor lifetime reproductive performances. Delays to 21 months of age for first breeding has shown no effect on lifetime performance. The most important item is the ability of the heifers to deliver a calf. Minimum weight for safe calving by breeds appears to be as follows:

- Ayrshire -- 815 pounds
- Brown Swiss -- 1000 pounds
- Guernsey -- 780 pounds
- Holstein -- 1070 pounds
- Jersey -- 765 pounds

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Breeding Programs

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Postpartum Breeding

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Frequently Asked Questions:

- Post Calving Insemination
- Timing of Insemination
- Site of Semen Deposition

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Postpartum Breeding

Post Calving Insemination

A 60-day waiting period between parturition and the first rebreeding insemination has long been the practice recommended. Only recently has this practice been challenged. Recent work reveals that waiting 60 days is not necessary. Considerable time can be saved by beginning rebreeding at the first heat after 40 days postpartum. Reducing the voluntary waiting period by 20 days will shorten the calving internal by about 15 days. About five days are lost because of missed heats and a slightly reduced conception rate. Estimates of services required per conception at various days open are in Table 1.

Table 1. Relationship of Days Open to Services Per Conception

Days Open	Services per Conception*
30	2.50
40	2.25
50	2.05
60	1.85
70	1.75

*It is estimated that an extra 0.2 ampules or straws of semen will be needed per cow in a herd that has a voluntary waiting period of 40 days as contrasted to 60 days.

By beginning rebreeding at 40 days, a dairyman can usually reduce expenses enough through reducing days open to offset the slight cost of the extra semen used. With rebreeding beginning at 40 days, the 15 days saved might be valued at $15.00. This savings will be achieved at a cost of $2.00 (0.2 service x $10.00 per straw). The concerns about greater embryonic loss, abortion, metritis, retained placentas, or weak

calves at birth have not been observed in several extensive studies with early rebreeding.

With earlier rebreeding, about 45 percent of the cows bred will become pregnant to the first insemination. Since a 40 to 60 day dry period is required for cows to produce at their potential the next lactation, those conceiving prior to 60 days postpartum will have lactations shorter than 305 days. This should be a minor concern with most cows, since they will produce more during their lifetime in the herd by being dried off and allowed a 40 day dry period before their next lactation.

Timing of Insemination

Proper timing of insemination in the heat period affects the conception rate. Careful monitoring indicates that the average heat period length is 18 $\pm$ 5 hours. The first six hours of this period is the time of poorest conception. The next 12 hours, which extends to the end of heat, is a period in which the probability of conception doubles. The period extending to six hours after heat is an intermediate period in conception probability.

This figure indicates that a substantial increase in the conception rate (up to 15 percent) could result if insemination timing is precisely controlled. The reference point for proper timing is the entry into heat and this usually is difficult to determine with intermittent observation or with marking devises. A cow either observed or found marked at 6:00 a.m. may have come into heat anytime after the last observation the previous evening. When a cow is found in heat, shorter time periods since the previous observation will help in estimating when she came "into heat." This will in turn help to estimate the most fertile time to breed.

Dr. Olds of Kentucky has developed a "breeding wheel" based upon the best time to breed. Rules of thumb from this "wheel" follow:

- If a cow in heat was not observed in heat 3 hours earlier, wait 12 hours to breed.
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Site of Semen Deposition

Fertility will be lowered if the semen is deposited at the entrance of the cervix compared to deposition in the cervix. Little difference in fertility exists when semen in placed in the cervix, body of the uterus, or split and deposited in both uterine horns. Deep penetration of inseminating intruments offers risk of disruption of an existing pregnancy. Ohio data indicates that cows will show heat in about 5 percent of the pregnancies, and that two-thirds of those heats occur within the first 60 days of pregnancy. Because of the possibility of disrupting an established pregnancy, it is important that cows serviced for two or more times be inseminated so that the instrument penetrates only to within and not through the cervix.

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Selecting Sires

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Selecting Sires for Heifer Breeding

The extent which artificial insemination is used to breed virgin heifers is difficult to estimate. Experience would indicate that the majority of breedings in this group is by natural service. Reasons for continued use of young sires on heifers are real, and returns from giving up these advantages need to be established.

Some of the advantages of using a young sire in natural service are as follows:

- No labor is involved in restraining heifers for insemination.
- No time is involved in observing for heat cycles.
- Age is reduced at first calving due to elimination of missed cycles.
- Direct cash outlay for semen is eliminated.

However, there are balancing factors that must be weighed in deciding whether to breed heifers AI at first breeding. One of the advantages in using AI on Holstein heifers is that there is an opportunity to reduce calving difficulties by selecting Holstein sires that contribute to less dystocia. This advantage is valid only if the breeder has already concluded that he cannot afford to sacrifice the offspring from heifers by breeding them to small breed beef sires.

Beef Sires

If the Holstein breeder is still using beef sires, he needs to consider the following:

- Holstein heifers bred to small breed sires will have slightly less dystocia.
- This difference will be slight because the dam has more influence

on calf size than does the sire.

- The heterotic effect of crossing breeds will cause the resulting calves to be somewhat larger than would be expected from averaging birth weights of the two breeds.
- The sacrifice of all offspring from heifers reduces to near zero the opportunity to do voluntary culling in the cow herd.

Typically DHI herds replace 30 percent of the cows with heifers each year. In a herd of 100 cows, these heifers would be giving birth to 30 calves. According to a study of Ohio records, the 70 cows that are not replaced would give birth to 59 calves during the year and the 30 replaced cows would give birth to 10 calves prior to removal. Consequently, 30 calves would result from first calf heifers and 69 should result from older cows in the herd. The loss of about 30 percent of replacement heifers that are born to first calf heifers bred to beef bulls would result in the necessity to introduce and keep all replacements in the herd in order to offset cows that must be removed for health and reproductive problems.

It is also likely in herds using high PD bulls that the first calf animals are the mothers with a higher transmitting ability than is to be found in the older cows. Even though the older cows have survived some culling, this is not likely to increase their transmitting value beyond an average 50 pounds of milk. On the other hand, the first calf mothers will be about three years younger than the remainder of the herd and should have resulted from sires that represent three years improvement in sire quality. Sires are improving at the rate of about 50 pounds of milk per year. These unculled two year olds then should be genetically 150 pounds superior to the older cows prior to the older cows being culled and 100 pounds superior to the older cows after culling.

The combination of removing all opportunity to voluntarily cull plus losing replacements from the best mothers makes the use of a beef sire hard to justify in a herd where plans exist for continued operation.

AI Sires vs. Non AI Sires

The best approach to reduce calving problems would be the use of AI sires identified for calving ease.

Another reason for using AI on heifers is that AI bulls have a higher milk transmitting ability than natural service sires. A summary of all sires available in 1982 through AI revealed that the average PD for milk was plus 1138 pounds of milk. At the same time the average of all non-AI sires was plus 183 pounds of milk.

This difference of about 950 pounds of milk is a measure of the actual

situation, but a dairyman need not be limited to the plus 183 pound level as he selects young sires. AI organizations, by using their full resources, have been able to select young sires whose proofs averaged plus 700 pounds of milk. The individual dairyman cannot justify the expenditure of time and money to match the performance of young sires selected for AI sampling. However, he should expect to select young sires for natural service that average between plus 183 pounds and plus 700 pounds. If 500 pounds is chosen as a reasonable figure, this implies a 600 pound (1138-500) of milk advantage by AI sire usage.

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- 50 percent of calves born will be males.
- 20 percent of heifers will not live to enter milking herd.
- Those that enter the herd will be in it for 3.8 lactations.
- The genetic contribution to succeeding generations will equal the contribution to the first generation (a plus 600 pound cow will contribute 300 pounds to daughters, 150 pounds to granddaughters, 75 pounds to great granddaughters, and so on until about plus 1200 pounds of milk is the total contribution).
- 88 percent of predicted difference milk is marketable because of immature records of 2 and 3-year olds.
- Feed cost represents 43 percent of the market value of additional milk.

The cost of semen is usually an added cash expense. However, it may not be different from the actual cost experienced when raising and maintaining a young sire. If the young sire is selected and raised from within the herd, his salvage value at two years of age following one year of service should more than offset the feed cost of raising.

On the other hand, if costs beyond feed are counted, the cost of breeding each heifer to a young sire will equal the cost of semen for AI.

If a calf is purchased from outside the herd, the cost will exceed the cost of purchased semen.

With all the above considered, it appears that the financial advantage is with those that breed their heifers AI.

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In spite of the apparent advantages of breeding heifers AI, there are circumstances where a dairyman may choose to breed heifers naturally to a young sire. In this event, it behooves the dairyman to choose the

best young sire available within the limits of sound economics.

Young Sire Selection from Within the Herd

In a situation where the milking herd is being bred AI and is also on DHI recordkeeping, the dairyman might well consider raising a young sire from within the herd. Like every management decision, this has advantages and disadvantages. Some of the advantages of selecting from within are as follows:

- No cash outlay.
- No risk of introducing new infectious agents into the herd.
- More knowledge regarding dam in unrecorded areas such as disposition and speed of milking.

Disadvantages are:

- Limits in the range of dam selection.
- Slight depression from inbreeding.
- Risk of over-emphasizing low heritability traits in dam (reproduction, longevity).
- Risk of over-estimating the prediction value of certain distant female relatives of the young sire.

If the decision is to raise a young sire from within the herd, then the mating should be planned two years prior to need. Four or five cows should be selected as candidates and bred to the AI bull considered most desirable as the sire of a young sire.

Selecting Dams of Young Sires

While this decision is slightly less important than the sire selection, it is deserving of considerable care. Each cow in DHI herds has been indexed for transmitting ability. This cow index should be relied upon in screening for possible dams. The AI industry has done well relying upon the USDA index as it has selected young sires. The dairyman must be prepared for the fact that occasionally his best producing cow is not listed among the cows with the best probable transmitting ability; therefore, he should resist the temptation to use her son.

In addition to being top indexing cows (+800 pounds milk or better), they should be sound cows, especially in udders. The AI industry has limited their selection to cows classified Very Good (VG) or Excellent in mammary conformation. While this may not be possible within the herd, the udder should be average or above before a cow is to be considered.

Selecting Sire of Young Sires

This is the most important decision and the one for which considerable information is available. The sire used should have as high a PD for milk as possible, with a minimum of at least +1,200 pounds. Information should show that the sire is well above average in siring udders. Even though no information is available showing that a bull identified as above average in calving ease will transmit this to his sons, logic suggests that the sire of a young sire to use on heifers should be one with a good performance in each of calving. Iowa work showed no correlation between calving ease and production, so the selection for calving ease should not limit PD milk selection.

In summary, when a sire is selected from within the herd, the following guidelines appear appropriate:

- Screen several cows with high cow indexes (above 800 if possible).
- Eliminate from consideration cows with unsoundness (especially udder).
- Mate four or five cows to a sire with high milk PD, siring above average udders and identified for calving ease.

Young Sire Selection from Outside the Herd

If a dairyman is expecting to select a young sire from a registered cow, he will be in competition with AI organizations for sons of the top indexing cows. For limited use on heifers, expenditures to obtain sons of these cows cannot be supported. Therefore, the dairyman will have to select from the second layer of cows. For this reason he cannot expect to duplicate the AI industries' success in selecting young sires. An alternative might be to select a son of a high indexing cow that had not scored VG but is well above average in mammary system.

One other possibility exists in that there are high indexing cows in herds with medium or low herd averages for production. Such cows are sometimes passed over by AI organizations because of lack of promotional appeal of the resulting young sires. From a genetic standpoint, such cows would be a better gamble than would those that result from going too deep in selecting cows in high producing herds.

The sire of a young sire should follow the same criteria as those sought when selecting a young sire from within the herd. These are as follows:

- Select high PD sire (1,200 pounds milk or greater).
- Select bulls siring above average udders.
- Select bulls above breed average in calving ease.

Selecting Bulls for Use on Grade Heifers

If the dairyman has no reason to select a young sire from a registered cow, he will have fewer limitations on selection for production.

All grades on DHI are indexed the same as registered cows. These cow indexes on grade cows are sent to the owners of the animals. There is little competition for the sons of high indexing grade cows. Therefore, a dairyman should be able to select sons of the top indexing grade cows and nearly equal the success experienced by AI young sire programs without sacrificing udder conformation. Also, the cost will be less than the cost of obtaining sons of the second layer of registered cows.

By selecting a new young sire each year, the grade dairyman should be able to withstand the occasional mediocre young sire and, over a number of years, average a PD milk of 500 pounds or better. This is considerably lower than he can expect if he breeds his heifers to proven AI sires, but higher than he is likely to attain if he selects sons from afforable second layer registered cows.

In summary, it is only under unusual circumstances that a grade or registered dairy man can justify using other than artificial insemination on virgin breedings. If such circumstances do exist, a dairyman should select a young son from a high predicted difference sire and from as high indexing a cow as he can reasonably afford. If the heifers to be bred are grade, the dairyman can likely afford higher genetic potential if he selects a son of one of the high indexing grade cows that are identified in Ohio.

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Selecting Sires for Heifer Breeding

The extent which artificial insemination is used to breed virgin heifers is difficult to estimate. Experience would indicate that the majority of breedings in this group is by natural service. Reasons for continued use of young sires on heifers are real, and returns from giving up these advantages need to be established.

Some of the advantages of using a young sire in natural service are as follows:

- No labor is involved in restraining heifers for insemination.
- No time is involved in observing for heat cycles.
- Age is reduced at first calving due to elimination of missed cycles.
- Direct cash outlay for semen is eliminated.

However, there are balancing factors that must be weighed in deciding whether to breed heifers AI at first breeding. One of the advantages in using AI on Holstein heifers is that there is an opportunity to reduce calving difficulties by selecting Holstein sires that contribute to less dystocia. This advantage is valid only if the breeder has already concluded that he cannot afford to sacrifice the offspring from heifers by breeding them to small breed beef sires.

Beef Sires

If the Holstein breeder is still using beef sires, he needs to consider the following:

- Holstein heifers bred to small breed sires will have slightly less dystocia.
- This difference will be slight because the dam has more influence on calf size than does the sire.
- The heterotic effect of crossing breeds will cause the resulting calves to be somewhat larger than would be expected from averaging birth weights of the two breeds.
- The sacrifice of all offspring from heifers reduces to near zero the opportunity to do voluntary culling in the cow herd.

Typically DHI herds replace 30 percent of the cows with heifers each year. In a herd of 100 cows, these heifers would be giving birth to 30 calves. According to a study of Ohio records, the 70 cows that are not replaced would give birth to 59 calves during the year and the 30 replaced cows would give birth to 10 calves prior to removal. Consequently, 30 calves would result from first calf heifers and 69 should result from older cows in the herd. The loss of about 30 percent of replacement heifers that are born to first calf heifers bred to beef bulls would result in the necessity

to introduce and keep all replacements in the herd in order to offset cows that must be removed for health and reproductive problems.

It is also likely in herds using high PD bulls that the first calf animals are the mothers with a higher transmitting ability than is to be found in the older cows. Even though the older cows have survived some culling, this is not likely to increase their transmitting value beyond an average 50 pounds of milk. On the other hand, the first calf mothers will be about three years younger than the remainder of the herd and should have resulted from sires that represent three years improvement in sire quality. Sires are improving at the rate of about 50 pounds of milk per year. These unculled two year olds then should be genetically 150 pounds superior to the older cows prior to the older cows being culled and 100 pounds superior to the older cows after culling.

The combination of removing all opportunity to voluntarily cull plus losing replacements from the best mothers makes the use of a beef sire hard to justify in a herd where plans exist for continued operation.

AI Sires vs. Non AI Sires

The best approach to reduce calving problems would be the use of AI sires identified for calving ease.

Another reason for using AI on heifers is that AI bulls have a higher milk transmitting ability than natural service sires. A summary of all sires available in 1982 through AI revealed that the average PD for milk was plus 1138 pounds of milk. At the same time the average of all non-AI sires was plus 183 pounds of milk.

This difference of about 950 pounds of milk is a measure of the actual situation, but a dairyman need not be limited to the plus 183 pound level as he selects young sires. AI organizations, by using their full resources, have been able to select young sires whose proofs averaged plus 700 pounds of milk. The individual dairyman cannot justify the expenditure of time and money to match the performance of young sires selected for AI sampling. However, he should expect to select young sires for natural service that average between plus 183 pounds and plus 700 pounds. If 500 pounds is chosen as a reasonable figure, this implies a 600 pound (1138-500) of milk advantage by AI sire usage.

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Culling Dairy Cows

Deciding when to cull a dairy cow is sometimes not an easy task. Each dairyman, either consciously or unconsciously, has certain criteria that he uses in making this decision. Sometimes the decision is based upon the cow that was the latest problem to the dairyman. This may be a valid reason, especially if the cow has had a history of being a problem animal.

Dairymen should develop a checklist of culling reasons to use in their decision making process. The following list of 10 questions is one that could be used for each cow before deciding her future in the herd.

1. Is her yearly production 20 percent or more below the herd's DHI rolling average? Another way of evaluating her milk production ranking in the herd is to compare her daily production amount with the average for the herd. Is her daily production 50 percent or more below the average produced daily per milking cow in the herd?
2. Is she a chronic mastitis case? Check this one closely, because a cow with chronic mastitis is producing below her capability and, in addtion, could be spreading mastitis to other cows in the herd through the milking equipment.
3. Will she be dry four months or more? Long dry periods are costly to the dairyman and may indicate the cow has a problem of becoming pregnant, a trait not desired.
4. Is she a hard milker? Is her udder shape or teat structure such that she is a nuisance to milk?
5. Does she have a history of calving difficulties or post calving illnesses such as retained placenta, metritis, or milk fever? Cows that cause problems at calving time are not pleasant to have and are costly to keep in the herd.

6. Does she have an undesirable disposition? Is she a nervous cow or does she kick whenever her udder is touched? These are undesirable traits that should be noted along with production and calving problems.
7. Is she below the herd's average body type? Check body confirmation to see if it comes up to specifications for the herd.
8. Is she a timid cow? With the type of drylot housing systems most dairymen have today, timid cows usually will not get the amount of feed required to be high producing animals.
9. Is the price of beef favorable? Check the market prices of beef animals and what the price would probably be for a cow sold for beef purposes.
10. Is she an old cow, and is the available barn space needed for freshening heifers? In other words, should the old make way for the young? Fresh heifers usually have a higher genetic potential for milk production than older cows, especially if a progressive A.I. program is used in the herd.

A yes answer should probably be given to at least two questions before making the cow a strong candidate for culling. In many cases, though, one reason may be enough justification to base a culling decision.

Besides using a checklist in making culling decisions, other facts should be considered.

First-calf heifers:

In evaluating first calf heifers, consider the size of the heifers. Undersized heifers will probably produce less milk the first lactation because of their size. This situation is an indictment of the dairyman's heifer feeding program and not necessarily the producing potential of the heifer. So, among possible culls of equal performance, preference should probably be given to the younger, undersized heifer, especially if she improved during her lactation.

Stage of gestation:

Extremely long calving intervals can be costly. With other factors being equal, cows in mid-lactation with several months to go before freshening are better prospects for culling than cows that will freshen sooner and return to peak production sooner.

Mastitis:

Mastitis CMT (California Mastitis Test) scores, somatic cell counts or

DHI SCC scores should be checked carefully. Cows with CMT scores of 2, somatic cell counts of 1.2 million or greater, or DHI SCC scores of 6 or greater should be culled before other potential culls because they are potential sources of intramammary infections of other cows.

Age:

Other factors being equal, cull older cows before younger cows of comparable relative value. The genetic potential of younger animals should be greater than that of older animals, so keeping the younger cows in the herd longer should be a sound practice.

Past performance:

Given two cows with the same relative value and other factors equal, cull the cow first that has the lowest previous production records. Past performance can be suggestive of future potential. Management errors in the current lactation could adversely affect a cow's performance.

Dairymen participating in the Ohio production testing program (DHI) have another tool to use in deciding which cows to cull. This is the "potential culls" management report that is received each month. On this report are listed cows that meet certain criteria. Most of the checklist questions are considered in the culling criteria.

The first criteria is that the cow must be producing **below** the cull level the dairyman establishes. The cull level should probably be about 20 percent **above** the daily production amount needed to break even. This cushion of 20 percent allows time to make culling decisions and dispose of animals before they become a financial liability. To determine the cull level to use, calculate the daily expenses per animal, both feed and other expenses, and how much milk a cow must produce to cover those expenses. Feed costs are only about 60 percent of the total costs of production.

Besides producing below the cull level, the cow must also meet one of the following criteria:

1. Low production—the cow's estimated lactation production level is less than 80 percent of the herd average the previous month.
2. Reproductive problems—the cow is still not bred by 21 days **beyond** the dairyman's goal for days open and her estimated lactation production level is below 90 percent *of* the herd average the previous month.
3. Mastitis—the cow had a CMT score of 3 or a DHI SCC score of 6 or greater at the most recent check.

The computer develops the cull list from data supplied by the dairyman and testing supervisor. It does not have a bias for or against certain cows that the dairyman sometimes has. Thus, certain "sacred" cows may appear on the list, if they fall within the culling criteria. If such cows appear on the list, dairymen should consider the possibility of culling them.

With the average dairyman culling about 32-percent of his cows each year, sound reasons must be used in deciding which cows to cull. Using a checklist and the DHI management report give the dairyman a good basis for his decisions.

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Past performance:

Given two cows with the same relative value and other factors equal, cull the cow first that has the lowest previous production records. Past performance can be suggestive of future potential. Management errors in the current lactation could adversely affect a cow's performance.

Dairymen participating in the Ohio production testing program (DHI) have another tool to use in deciding which cows to cull. This is the "potential culls" management report that is received each month. On this report are listed cows that meet certain criteria. Most of the checklist questions are considered in the culling criteria.

The first criteria is that the cow must be producing **below** the cull level the dairyman establishes. The cull level should probably be about 20 percent **above** the daily production amount needed to break even. This cushion of 20 percent allows time to make culling decisions and dispose of animals before they become a financial liability. To determine the cull level to use, calculate the daily expenses per animal, both feed and other expenses, and how much milk a cow must produce to cover those expenses. Feed costs are only about 60 percent of the total costs of production.

Besides producing below the cull level, the cow must also meet one of the following criteria:

1. Low production—the cow's estimated lactation production level is less than 80 percent of the herd average the previous month.
2. Reproductive problems—the cow is still not bred by 21 days **beyond** the dairyman's goal for days open and her estimated lactation production level is below 90 percent *of* the herd average the previous month.
3. Mastitis—the cow had a CMT score of 3 or a DHI SCC score of 6 or greater at the most recent check.

The computer develops the cull list from data supplied by the dairyman and testing supervisor. It does not have a bias for or against certain cows that the dairyman sometimes has. Thus, certain "sacred" cows may appear on the list, if they fall within the culling criteria. If such cows appear on the list, dairymen should consider the possibility of culling them.

With the average dairyman culling about 32-percent of his cows each year, sound reasons must be used in deciding which cows to cull. Using a checklist and the DHI management report give the dairyman a good basis for his decisions.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Dairy Development in Sub-Saharan Africa : A Study of Issues and Options (World Bank Technical Paper, Africa Technical Department Series, No 135) - by Michael J. Walshe - Publication Date: March 1991 - List: $7.95 + $1.35 special surcharge
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Periodicals:

- None identified.

This page was last updated on November 16, 2002

Raising Dairy Cattle

Frequently Asked Questions Other Information Sources Return to Dairy Contents

Frequently Asked Questions:

Other Information Sources:

Warning:

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What software exists for managing dairy herds?

- UDDER - Dairy Research Corporation, Private Bag, Hamilton, New Zealand
- CAMDAIRY - somewhere in Australia
- DAIRYMAN - somewhere
- Dairy Decisions Herd Management software
  P.O. Box 85
  New Richmond, WI 54017
  Ph:1-800-248-7656
  Fax:715-243-7686

  Call them and ask for their demo disk.
- The Association of Agricultural Computing Companies (AACC), an affiliate of the American Society of Agricultural Engineers (ASAE) has a Product & Services Directory which is available at no charge by sending an e-mail message to: ag-pr@agpr.com.

Feeding requirements during drought

In the long run it is economical to maintain the present size of your cow herd and feed for high production. Dairy cows need at least 800 pounds of hay or its equivalent each month. This amounts to the cow eating about two percent of her body weight each day as hay. Milking cows need at least 11/2 per cent of their body weight as hay daily or they will have digestive upsets and drop milk fat percentage. Also, cows need 350 pounds of cereal grain for each 1000 pounds of milk they produce. When good quality hay is in short supply, slough hay, cereal hay and in extreme situations, cereal straw, may be used as a substitute. Slough hay may be used as the only forage for dairy cattle. When it is the only

forage they receive, the cattle will need about an 18 per cent protein dairy concentrate. A less costly ration based on slough hay consists of 6 to 12 pounds of dehydrated alfalfa pellets, sun cured alfalfa pellets or alfalfa cubes and enough slough hay to add up to 25 pounds of forage a day.

Cereal hay can replace good quality hay entirely. Feed each cow 25 pounds of cereal hay daily.

When cereal straw has to be used to extend hay supplies, feed only 5 to10 pounds a day to milking cows. Use hay or a mixture of hay and dehydrated alfalfa to make up the balance of the forage needed.

You can feed replacement heifers and dry cows lower quality forages such as slough hay, grass hay and weedy hay. You will also have to feed them 5 to 10 pounds of grain and supplement. To be sure you are feeding your dairy herd balanced rations, have samples of the feed analyzed for energy, protein, vitamins and minerals. Seek advice on how to combine the feeds so they provide the proportions of nutrients the animals need.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- **BSE: Bovine Spongiform Encephalopathy**

  Subscription address: listserv@listserv.net

  Subscribe to BSE. Type "SUB BSE-L Yourfirstname Yourlastname" in the first line of the body.
- **D-MGT: Dairy Management**

  Subscription address: listproc@listproc.wsu.edu

  Topics: Discussion of dairy management.

  Subscribe to D-MGT. Type "subscribe D-MGT Your Name" in the message body. (Not supported by all browsers.)
- **DAIRY-L: Dairy Discussion List**

Subscription address: listserv@umdd.umd.edu

Topics: Dairy production and associated issues for professional educators and extension workers advising the dairy industry. Questions concerning problems or policies faced by dairy producers are encouraged, as are requests for educational tools such as visual aids, computer-aided decision support tools, and outlines of educational programs. Offers to share available educational tools are especially encouraged. Discussions of current problems and controversies facing the dairy industry are also favored.

Subscribe to DAIRY-L. Type "subscribe DAIRY-L Your Name" in the message body. (Not supported by all browsers.)

- **GRAZE-L: Grazing Discussion List**

  Subscription address: listserv@taranaki.ac.nz

  Topics: Intensive rotational grazing and seasonal dairying. Discuss MIRG and seasonal dairying issues. Connect farmers in New Zealand and the US.

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- Feeding requirements during drought.

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Forages For Dairy Cattle

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Forages for Dairy Cattle

Characteristics of a Good Dairy Ration

A ration is the amount of feed fed to a cow in a 24 hour period. Good dairy rations provide the "right" amounts of nutrients to the "right" cow at the "right" time.

Forages are the foundation upon which Ohio dairy rations are built. Since dairy cows are ruminants, they need 1 to 11/2 pounds of hay per 100 pounds of body-weight per day to maintain normal functioning of the rumen and to allow them to produce milk containing a normal percentage of milk fat. Long or chopped forage will fulfill this need for fiberous feeds. Forage that has been ground in a hammermill or through a fine recutter screen has lost its effectiveness as a source of fiber. The concentrate mixture should be formulated to compensate for any deficiencies that remain after the forage intake is considered.

Most forages are high in crude fiber content and relatively low in energy. Wide variation exists due to plant species, stage of maturity at harvest, weather damage leaf loss in the field and improper storage. They are usually produced on the farm and are a source of relatively low priced nutrients. Their bulkiness makes forages difficult and expensive to transport. Some high fiber by-product feeds can be used to replace forage in times of short supply.

High producing dairy cows should be fed the best forage available. The primary factor in determining the quality of grass-legume forages is the date of cutting. The digestibility and palatability of forages decreases rapidly after the heads appear on grasses and the blossoms appear on legumes. The maximum nutritional value of a grass-legume forage is established at the moment it is cut. There is no equipment available for processing, handling, storing or feeding the forage that will improve its

nutritional value. In fact, one always gets less out of a machine or storage structure than he puts into it. Dairymen should harvest forage early while the quality and yield of nutrients are high, even though the yield of dry matter per acre is not maximum. On the average, weather hazards are no greater for early harvested than late harvested forage.

Forage, depending upon its quality and the quantity consumed, will provide for the maintenance needs of a dairy cow and allow her to produce 0 to 40 pounds of milk per day. A concentrate mixture should be fed to support the production of milk in excess of the amount that can be obtained from forage alone. The concentrate mixture is fed to increase the energy and nutrient density of the ration. A ration that contains 68 to 74 percent digestible dry matter (similar to T.D.N.) will meet the energy needs of high producing cows within the limits of their ability to consume feed dry matter. The poorer the quality of the forage, the greater the amount of concentrate mixture needed.

Methods of Handling Forages

Dry Forage

Hay has been the traditional forage provided for dairy cows during the barn feeding season. Cows fed excellent quality hay free-choice consume forage dry matter at a maximum rate. Hay making in Ohio is plagued by weather problems and the operations required have been more difficult to mechanize in comparison to silage.

Hay should contain 80 or more percent dry matter (20 percent or less moisture) when it is baled without a preservative. Baling at lower dry matter percentages leads to high temperature curing and a significant reduction in protein digestibility. This reduction in protein digestibility can run as high as 30 percent. Testing for acid detergent fiber insoluble nitrogen provides an estimate of the amount of protein unavailable for digestion.

Research has shown that propionic acid is an effective fungistat. It's use according to manufacturer's directions will allow hay to be baled at lower dry matter percentages. One commercial product will prevent the over-heating of hay baled between 75 and 80 percent dry matter. This is not an extremely large change in the recommended dry matter percentage, but it does provide for an earlier start in the morning and a later finish in the evening. Sometimes it is the difference between making hay and not making hay. If this system is used, measure the dry matter percentage of the window accurately and do not exceed the manufacturer's recommendations.

Silage

Ensiling is a method of preserving forage crops. Ensiling does not improve the quality of the material stored. Under good management, dairymen can expect to recover 92 to 95 percent of the material stored in a gas-tight silo; 88 to 92 percent of that stored in a conventional silo; and 85 percent of that stored in a bunker or trench silo. Poor management can reduce all of these dry matter recovery estimates significantly. For silage to be preserved, it must be stored in an environment free of oxygen and the material must develop an adequate amount of acid to lower the pH to 4.5 or less. Fine chopping, rapid filling, and even distribution of material in a structurally sound silo are recommended. The dry matter content of the silage should be between 30 and 50 percent (50 and 70 percent moisture) to produce a good quality feed.

The quality of meadow crop silage is dependent primarily upon the kind of crop harvested and the stage of maturity at which it is cut.

Silage is of slightly less value per pound of dry matter than hay made from the same field on the same day. Cattle will eat slightly more dry matter per hundred pounds of bodyweight as hay. However, making silage entails less weather hazard, is easier to mechanize and causes less field losses.

Meadow crop silage should be cut early and chopped fine but not pulverized. Early cut silage should be wilted. For conventional silos, the recommended dry matter percentage for silage is 35 percent (65 percent moisture). Such material packs well to exclude air, seeps very little if at all, is consumed at a rate of dry matter intake per one hundred pounds of bodyweight that is similar to drier material and the moisture content helps assure a low temperature fermentation. A high temperature fermentation is caused by oxygen entering the silage and the silage having a high dry matter content (above about 40 percent). A high temperature fermentation (browning reaction) changes the material from green when ensiled to brown when removed from the silo. Such browning reactions reduce the digestibility of both protein and energy containing compounds. These reductions may be as high as 30 percent.

For gas-tight silos, wilting to 45 percent dry matter (55 percent moisture) may increase the ease of removing silage. Such silos should be filled rapidly and as completely as possible. All gas entrance control mechanisms should be closed as soon as possible. Significant browning losses have been observed in gas-tight silos that have been partially filled and/or improperly sealed. The browning reaction proceeds at maximum speed in the presence of oxygen at 70 percent dry matter (30 percent moisture) and at environmental temperatures over 100° F.

Pasture

Pasture can be a very good or very poor source of nutrients for dairy

cattle. Pasture quality depends upon the plant species present, the stage of growth and the amount of material available. The area available at any one time must be controlled to maintain a legume stand in a pasture, to minimize wastage and to provide high quality forage throughout the pasture season. A sequence of different crops is usually desirable. If milk production increases when cattle are on pasture, it indicates a deficiency in the barn-feeding ration, usually a deficiency of protein. If production decreases when cattle go to pasture, it usually indicates that a more nearly balanced ration was fed during the barn-feeding period. Removing the cattle from pasture several hours before feeding the concentrate mixture will usually increase the amount of dry matter consumed and will increase milk production. Convenient sources of shade and water should be provided for cattle that are pastured during hot weather.

Green-Chop

Chopping and hauling forage to dairy cattle increases the yield per acre of meadows because the losses due to tramping and fouling are avoided. The labor, power and capital costs are similar to harvesting the crop as silage. It is usually necessary to provide a sequence of different forages to have good quality forage available for harvest each day. Rainy weather and poorly drained fields make daily harvest difficult. Harvesting the forage twice each day will reduce the heating of the material and will increase consumption.

Forage Crops

For additional information on these forages, please see our Crop - Forage pages.

Alfalfa: A good, well managed stand of alfalfa on well-drained soil produces greater yields of protein and energy than any other grass or legume crop. Alfalfa must be protected from damage by alfalfa weevils and potato leaf hoppers. Information concerning the number of insects necessary to cause economic losses and approved insecticides can be obtained from your County Extension Agent.

Birdsfoot Trefoil: Birdsfoot Trefoil is similar in composition to alfalfa. It is most useful in long-lay meadows on poorly drained soils. Its yield potential is 80 percent or less than that of alfalfa on well-drained soils. Only upright varieties should be planted if the crop will be harvested for hay. Seedling vigor is low. Stands become established slowly. It is usually seeded with bluegrass or timothy to limit the amount of competition.

Medium Red Clover: The yield of medium red clover on well-drained soils is usually less than 80 percent of that expected from alfalfa. The

nutrient composition is similar to alfalfa. Occasionally, a fungus that produces a toxin called the "slobber factor" grows on late cut red clover. This toxin when consumed by cattle causes a profuse flow of saliva followed by a refusal to eat the affected forage (either hay or silage). There is no practical method of removing the toxin. The best protection is obtained by early harvesting.

Sweet Clover: Although sweet clover is similar in chemical composition to alfalfa, it is seldom harvested as hay for dairy cattle. Moldy sweet clover hay is likely to contain dicoumarol that prevents the normal clotting of blood. Animals with "sweet clover poisoning" hemorrhage severely when cut or bruised.

Soybeans: Soybeans can be used as an emergency hay crop. Forage varieties planted in thick stands develop into a finer stemmed, leafier crop than that produced by soybeans planted for seed production. Soybean hay is difficult to cure and dusty to handle.

Timothy: Timothy is the companion grass usually seeded with medium red clover. The recommended cutting dates for these species are nearly the same. Timothy also matures at a rate nearly equal to varigated varieties of alfalfa. It is seldom planted in pure stands because it does not produce well in dry weather and does not respond well to nitrogen fertilization. It is a palatable grass and will be consumed in large quantities if harvested as the heads emerge from the boot.

Brome Grass: Brome grass is a good companion grass for use with varigated alfalfas. It is rather difficult to establish and is best suited for use in long-lay meadows. It is seldom planted in pure stands.

Orchard Grass: Orchard Grass is the earliest maturing tall grass grown in Ohio. When harvested early (as the heads emerge from the boot) it is a palatable forage. Its dry matter digestibility and palatability are reduced rapidly after the heads emerge from the boots. Orchard grass responds well to nitrogen fertilization. Common orchard grass matures too early to be a good companion grass for alfalfa. The named varieties such as "Pennlate" mature 10-14 days later and can be used as a companion grass with "Flemish" type alfalfas.

Tall Fescue: Tall fescue is an aggressive, productive grass but is not as palatable as the grasses discussed above. It will be consumed in amounts adequate for maintenance diets and will support a limited amount of growth. It is not a desirable forage for milking cows.

Sudan Grass and Sorghum-Sudan Grass Crosses: These crops produce forage during the late summer and early fall when permanent meadows are likely to be dormant. No consistent superiority in yield has been found for any variety or hybrid in the three to four cut system that is necessary to obtain high quality forage. The quality is reduced

rapidly as the heads emerge. The Sudan grasses are finer stemmed and lower in prussic acid than the Sorghum Sudan crosses. Neither of these crops should be grazed or chopped when less than 16 inches tall because of possible high prussic acid content.

Normal Corn Silage: A crop of corn made into whole plant corn silage yields more energy per acre than any other crop adapted to Ohio. The recommended harvest time is the late dent stage when the grain is physiologically mature and contains approximately 36 percent moisture (64 percent dry matter). The stalks at that time contain about 70 percent moisture (30 percent dry matter). At this stage the yield per acre should be maximum, the crop will chop easily, it will pack tightly and little or no seepage should occur. Corn silage should be chopped fine enough to break the cobs into particles of pea-size or smaller, but it is not necessary to break all of the kernels. Corn silage is low in protein and minerals.

Non-Protein-Nitrogen Treated Corn Silage: Corn silage harvested at 30 to 38 percent dry matter can be treated with non-protein-nitrogen compounds such as urea or ammonia to increase the crude protein percentage of the silage. Untreated corn silage contains about 8 percent crude protein on a dry matter basis (2.8 percent as fed). The addition of 10 pounds of urea or 6 pounds of anhydrous ammonia per ton of material ensiled will increase the crude protein percentage 50 percent (12 percent crude protein on a dry matter basis and 4.2 percent as fed). Non-protein-nitrogen compounds can be purchased directly or in combinations that contain minerals, vitamins or energy sources such as molasses.

Supplemental minerals are usually needed when corn silage is a major part of the forage program. They can be added to the silage at ensiling time or added to the ration as it is fed. Maximum flexibility and minimum capital costs are obtained when minerals are added as needed.

If non-protein-nitrogen compounds are to be added to corn silage, observe these recommendations:

1. Harvest the corn crop at 30 to 38 percent dry matter (62 to 70 percent moisture).
2. Determine accurately the amount of chopped material in each load.
3. Add the correct amount of non-protein-nitrogen. Ten pounds of urea can be spread over the top of the load or metered in at the blower. Six pounds of anhydrous ammonia can be added as a water solution or by using a cold-flow meter. It may be added at the blower or at the field chopper. Ammonia additions should be made at the field chopper for silage to be stored in a bunker or trench silo. Do not attempt to use anhydrous ammonia directly as

a gas. The loss of nitrogen is too great.

4. Reduce the amount of non-protein-nitrogen added to the silage that will be fed first to provide a three to six week adjustment period for the microorganisms in the rumen. Silage dry matter intake will be greater and the utilization of non-protein-nitrogen will be more efficient.

The addition of high-calcium limestone to corn silage does not improve its feeding value for dairy cattle.

Mature Corn Silage: Mature corn plants should be made into silage only under emergency conditions such as inclement weather during the normal harvest time or the need to refill limited silage storage capacity. Field losses of dry matter occur after the late dent stage because of leaf shatter, stalk lodging and ear droppage These losses approach 20 percent of the potential dry matter yield as the crop proceeds to full maturity. Non-protein-nitrogen compounds should not be added to mature corn silage, because it does not pack tightly and less fermentation (acid production) occurs. Under these conditions, much of the added nitrogen is lost.

Frosted Corn for Silage: Harvesting a crop of frosted corn as silage will salvage more nutrients per acre than any other option available for a dairyman. The nutritional value per pound of dry matter harvested will be similar to that in normal corn silage. The frosted crop should be allowed to dry to a minimum of 30 percent dry matter (70 percent moisture) to prevent seepage but it should not be allowed to become overly-dry (more than 40 percent dry matter—less than 60 percent moisture).

Sorghum Silage: Forage type sorghums often produce greater yields of green material per acre than does corn. However, this extra weight is usually moisture and the yield of energy per acre is usually less. Forage sorghums should be ensiled when the seeds are in the dough stage. Such silage often seeps large quantities of juice which contain nutrients and is a water pollution hazard. Sorghum grains are not effectively broken by field choppers. A large percentage of them pass undigested through the cow. Grain type sorghums are not recommended for silage. A combination of corn and sorghum for silage is less desirable than either crop planted alone because of the difference in maturity dates.

Corn-Soybean Silage: A combination of corn and soybeans grown for silage is not a desirable crop. When the population of corn plants is adequate for maximum corn production, few soybean plants survive. If the corn plant population is reduced enough to allow soybean plants to grow, the loss of corn production out-weighs the advantages of soybean production.

Soybean Silage: Chopped green soybeans do not make good silage.

They develop into slick, slimey, badsmelling silage. If immature soybeans are frosted, they should be chopped and mixed with green-chopped corn before ensiling in order to provide the necessary amount of fermentable carbohydrate necessary for proper fermentation.

Small Grain Crop Silage: Rye, wheat, barley, oats and spelt can be made into good quality silage if they are cut in the blossom to milk stage, wilted to 35 percent dry matter (65~o moisture), chopped fine, distributed evenly and stored rapidly. Small grains that reach the late dough-stage should be harvested as a grain crop.

Rye: Rye seeded between September 1 and 15 will usually provide a supply of late fall forage for grazing and/or green chopping. It will then live through the winter and provide early spring forage. It is a palatable forage until the heads appear. The fields are usually plowed and seeded to corn for silage or soybeans after the rye has been removed. Balboa is a variety recommended for use as forage.

Straws, Stover and Cobs: Oats and wheat straws, because they are at full-maturity, are usually considered bedding materials rather than feed. When fed to cattle they are likely to provide adequate energy for maintenance but may be deficient in protein and minerals. Limited amounts of clean, bright straw can be fed to producing dairy cows to maintain normal rumen function and butterfat percentage in times of forage shortages.

Corn Stover: Corn stover is equal to average quality hay in energy content. However, it is much lower in protein and mineral content. Corn stover should be harvested only from those fields of corn that were grown under conditions approved for corn silage for dairy cattle. Be sure to check the chemicals that were used to control insects and weeds. Corn stover should be stored in a manner that prevents mold growth.

Corn Cobs: Corn cobs can be used to raise the fiber content of dairy rations or as the fiber portion of complete rations for ruminants. Cobs have an energy value equal to medium to low quality roughage. They are very low in protein and mineral content. Only mold-free cobs should be fed.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

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- None identified.

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Periodicals:

- None identified.

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Frequently Asked Questions:

- Characteristics of a Good Dairy Ration
- Methods of Handling Forages
- Forage Crops

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- Suggested references
- Periodicals

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Forages for Dairy Cattle

Characteristics of a Good Dairy Ration

A ration is the amount of feed fed to a cow in a 24 hour period. Good dairy rations provide the "right" amounts of nutrients to the "right" cow at the "right" time.

Forages are the foundation upon which Ohio dairy rations are built. Since dairy cows are ruminants, they need 1 to 11/2 pounds of hay per 100 pounds of body-weight per day to maintain normal functioning of the rumen and to allow them to produce milk containing a normal percentage of milk fat. Long or chopped forage will fulfill this need for fiberous feeds. Forage that has been ground in a hammermill or through a fine recutter screen has lost its effectiveness as a source of fiber. The concentrate mixture should be formulated to compensate for any deficiencies that remain after the forage intake is considered.

Most forages are high in crude fiber content and relatively low in energy. Wide variation exists due to plant species, stage of maturity at harvest, weather damage leaf loss in the field and improper storage. They are usually produced on the farm and are a source of relatively low priced nutrients. Their bulkiness makes forages difficult and expensive to transport. Some high fiber by-product feeds can be used to replace forage in times of short supply.

High producing dairy cows should be fed the best forage available. The primary factor in determining the quality of grass-legume forages is the date of cutting. The digestibility and palatability of forages decreases rapidly after the heads appear on grasses and the blossoms appear on legumes. The maximum nutritional value of a grass-legume forage is established at the moment it is cut. There is no equipment available for processing, handling, storing or feeding the forage that will improve its nutritional value. In fact, one always gets less out of a machine or storage structure than he puts into it. Dairymen should harvest forage early while the quality and yield of nutrients are high, even though the yield of dry matter per acre is not maximum. On the average, weather hazards are no greater for early harvested than late harvested forage.

Forage, depending upon its quality and the quantity consumed, will provide for the maintenance needs of a dairy cow and allow her to produce 0 to 40 pounds of milk per day. A concentrate mixture should be fed to support the production of milk in excess of the amount that can be obtained from forage alone. The concentrate mixture is fed to increase the energy and nutrient density of the ration. A ration that contains 68 to 74 percent digestible dry matter (similar to T.D.N.) will meet the energy needs of high producing cows within the limits of their ability to consume feed dry matter. The poorer the quality of the forage, the greater the amount of concentrate mixture needed.

Methods of Handling Forages

Dry Forage

Hay has been the traditional forage provided for dairy cows during the barn feeding season. Cows fed excellent quality hay free-choice consume forage dry matter at a maximum rate. Hay making in Ohio is plagued by weather problems and the operations required have been more difficult to mechanize in comparison to silage.

Hay should contain 80 or more percent dry matter (20 percent or less moisture) when it is baled without a preservative. Baling at lower dry matter percentages leads to high temperature curing and a significant reduction in protein digestibility. This reduction in protein digestibility can run as high as 30 percent. Testing for acid detergent fiber insoluble nitrogen provides an estimate of the amount of protein unavailable for digestion.

Research has shown that propionic acid is an effective fungistat. It's use according to manufacturer's directions will allow hay to be baled at lower dry matter percentages. One commercial product will prevent the over-heating of hay baled between 75 and 80 percent dry matter. This is not an extremely large change in the recommended dry matter percentage, but it does provide for an earlier start in the morning and a later finish in the evening. Sometimes it is the difference between making hay and not making hay. If this system is used, measure the dry matter percentage of the window accurately and do not exceed the manufacturer's recommendations.

Silage

Ensiling is a method of preserving forage crops. Ensiling does not improve the quality of the material stored. Under good management, dairymen can expect to recover 92 to 95 percent of the material stored in a gas-tight silo; 88 to 92 percent of that stored in a conventional silo; and 85 percent of that stored in a bunker or trench silo. Poor management can reduce all of these dry matter recovery estimates significantly. For silage to be preserved, it must be stored in an environment free of oxygen and the material must develop an adequate amount of acid to lower the pH to 4.5 or less. Fine chopping, rapid filling, and even distribution of material in a structurally sound silo are recommended. The dry matter content of the silage should be between 30 and 50 percent (50 and 70 percent moisture) to produce a good quality feed.

The quality of meadow crop silage is dependent primarily upon the kind of crop harvested and the stage of maturity at which it is cut.

Silage is of slightly less value per pound of dry matter than hay made from the same field on the same day. Cattle will eat slightly more dry matter per hundred pounds of bodyweight as hay. However, making silage entails less weather hazard, is easier to mechanize and causes less field losses.

Meadow crop silage should be cut early and chopped fine but not pulverized. Early cut silage should be wilted. For conventional silos, the recommended dry matter percentage for silage is 35 percent (65 percent moisture). Such material packs well to exclude air, seeps very little if at all, is consumed at a rate of dry matter intake per one hundred pounds of bodyweight that is similar to

drier material and the moisture content helps assure a low temperature fermentation. A high temperature fermentation is caused by oxygen entering the silage and the silage having a high dry matter content (above about 40 percent). A high temperature fermentation (browning reaction) changes the material from green when ensiled to brown when removed from the silo. Such browning reactions reduce the digestibility of both protein and energy containing compounds. These reductions may be as high as 30 percent.

For gas-tight silos, wilting to 45 percent dry matter (55 percent moisture) may increase the ease of removing silage. Such silos should be filled rapidly and as completely as possible. All gas entrance control mechanisms should be closed as soon as possible. Significant browning losses have been observed in gas-tight silos that have been partially filled and/or improperly sealed. The browning reaction proceeds at maximum speed in the presence of oxygen at 70 percent dry matter (30 percent moisture) and at environmental temperatures over 100° F.

Pasture

Pasture can be a very good or very poor source of nutrients for dairy cattle. Pasture quality depends upon the plant species present, the stage of growth and the amount of material available. The area available at any one time must be controlled to maintain a legume stand in a pasture, to minimize wastage and to provide high quality forage throughout the pasture season. A sequence of different crops is usually desirable. If milk production increases when cattle are on pasture, it indicates a deficiency in the barn-feeding ration, usually a deficiency of protein. If production decreases when cattle go to pasture, it usually indicates that a more nearly balanced ration was fed during the barn-feeding period. Removing the cattle from pasture several hours before feeding the concentrate mixture will usually increase the amount of dry matter consumed and will increase milk production. Convenient sources of shade and water should be provided for cattle that are pastured during hot weather.

Green-Chop

Chopping and hauling forage to dairy cattle increases the yield per acre of meadows because the losses due to tramping and fouling are avoided. The labor, power and capital costs are similar to harvesting the crop as silage. It is usually necessary to provide a sequence of different forages to have good quality forage available for harvest each day. Rainy weather and poorly drained fields make daily harvest difficult. Harvesting the forage twice each day will reduce the heating of the material and will increase consumption.

Forage Crops

For additional information on these forages, please see our Crop - Forage pages.

Alfalfa: A good, well managed stand of alfalfa on well-drained soil produces greater yields of protein and energy than any other grass or legume crop. Alfalfa must be protected from damage by alfalfa weevils and potato leaf hoppers. Information concerning the number of insects necessary to cause economic losses and approved insecticides can be obtained from your County Extension Agent.

Birdsfoot Trefoil: Birdsfoot Trefoil is similar in composition to alfalfa. It is most useful in long-lay meadows on poorly drained soils. Its yield potential is 80 percent or less than that of alfalfa on well-drained soils. Only upright varieties should be planted if the crop will be harvested for hay. Seedling vigor is low. Stands become established slowly. It is usually seeded with bluegrass or timothy to limit the amount of competition.

Medium Red Clover: The yield of medium red clover on well-drained soils is usually less than 80 percent of that expected from alfalfa. The nutrient composition is similar to alfalfa. Occasionally, a fungus that produces a toxin called the "slobber factor" grows on late cut red clover. This toxin when consumed by cattle causes a profuse flow of saliva followed by a refusal to eat the affected forage (either hay or silage). There is no practical method of removing the toxin. The best protection is obtained by early harvesting.

Sweet Clover: Although sweet clover is similar in chemical composition to alfalfa, it is seldom harvested as hay for dairy cattle. Moldy sweet clover hay is likely to contain dicoumarol that prevents the normal clotting of blood. Animals with "sweet clover poisoning" hemorrhage severely when cut or bruised.

Soybeans: Soybeans can be used as an emergency hay crop. Forage varieties planted in thick stands develop into a finer stemmed, leafier crop than that produced by soybeans planted for seed production. Soybean hay is difficult to cure and dusty to handle.

Timothy: Timothy is the companion grass usually seeded with medium red clover. The recommended cutting dates for these species are nearly the same. Timothy also matures at a rate nearly equal to varigated varieties of alfalfa. It is seldom planted in pure stands because it does not produce well in dry weather and does not respond well to nitrogen fertilization. It is a palatable grass and will be consumed in large quantities if harvested as the heads emerge from the boot.

Brome Grass: Brome grass is a good companion grass for use with varigated alfalfas. It is rather difficult to establish and is best suited for use in long-lay meadows. It is seldom planted in pure stands.

Orchard Grass: Orchard Grass is the earliest maturing tall grass grown in Ohio. When harvested early (as the heads emerge from the boot) it is a palatable forage. Its dry matter digestibility and palatability are reduced rapidly after the heads emerge from the boots. Orchard grass responds well to nitrogen fertilization. Common orchard grass matures too early to be a good companion grass for alfalfa. The named varieties such as "Pennlate" mature 10-14 days later and can be used as a companion grass with "Flemish" type alfalfas.

Tall Fescue: Tall fescue is an aggressive, productive grass but is not as palatable as the grasses discussed above. It will be consumed in amounts adequate for maintenance diets and will support a limited amount of growth. It is not a desirable forage for milking cows.

Sudan Grass and Sorghum-Sudan Grass Crosses: These crops produce forage during the late summer and early fall when permanent meadows are likely to be dormant. No consistent superiority in yield has been found for any variety or hybrid in the three to four cut system that is necessary to obtain high quality forage. The quality is reduced rapidly as the heads emerge. The Sudan grasses are finer stemmed and lower in prussic acid than the Sorghum Sudan crosses.

Neither of these crops should be grazed or chopped when less than 16 inches tall because of possible high prussic acid content.

Normal Corn Silage: A crop of corn made into whole plant corn silage yields more energy per acre than any other crop adapted to Ohio. The recommended harvest time is the late dent stage when the grain is physiologically mature and contains approximately 36 percent moisture (64 percent dry matter). The stalks at that time contain about 70 percent moisture (30 percent dry matter). At this stage the yield per acre should be maximum, the crop will chop easily, it will pack tightly and little or no seepage should occur. Corn silage should be chopped fine enough to break the cobs into particles of pea-size or smaller, but it is not necessary to break all of the kernels. Corn silage is low in protein and minerals.

Non-Protein-Nitrogen Treated Corn Silage: Corn silage harvested at 30 to 38 percent dry matter can be treated with non-protein-nitrogen compounds such as urea or ammonia to increase the crude protein percentage of the silage. Untreated corn silage contains about 8 percent crude protein on a dry matter basis (2.8 percent as fed). The addition of 10 pounds of urea or 6 pounds of anhydrous ammonia per ton of material ensiled will increase the crude protein percentage 50 percent (12 percent crude protein on a dry matter basis and 4.2 percent as fed). Non-protein-nitrogen compounds can be purchased directly or in combinations that contain minerals, vitamins or energy sources such as molasses.

Supplemental minerals are usually needed when corn silage is a major part of the forage program. They can be added to the silage at ensiling time or added to the ration as it is fed. Maximum flexibility and minimum capital costs are obtained when minerals are added as needed.

If non-protein-nitrogen compounds are to be added to corn silage, observe these recommendations:

1. Harvest the corn crop at 30 to 38 percent dry matter (62 to 70 percent moisture).
2. Determine accurately the amount of chopped material in each load.
3. Add the correct amount of non-protein-nitrogen. Ten pounds of urea can be spread over the top of the load or metered in at the blower. Six pounds of anhydrous ammonia can be added as a water solution or by using a cold-flow meter. It may be added at the blower or at the field chopper. Ammonia additions should be made at the field chopper for silage to be stored in a bunker or trench silo. Do not attempt to use anhydrous ammonia directly as a gas. The loss of nitrogen is too great.
4. Reduce the amount of non-protein-nitrogen added to the silage that will be fed first to provide a three to six week adjustment period for the microorganisms in the rumen. Silage dry matter intake will be greater and the utilization of non-protein-nitrogen will be more efficient.

The addition of high-calcium limestone to corn silage does not improve its feeding value for dairy cattle.

Mature Corn Silage: Mature corn plants should be made into silage only under emergency conditions such as inclement weather during the normal harvest time or the need to refill limited silage storage capacity. Field losses of dry matter occur after the late dent stage because of leaf shatter, stalk lodging and ear droppage These losses approach 20 percent of the potential dry matter yield as the crop proceeds to full maturity. Non-protein-nitrogen compounds should not be

added to mature corn silage, because it does not pack tightly and less fermentation (acid production) occurs. Under these conditions, much of the added nitrogen is lost.

Frosted Corn for Silage: Harvesting a crop of frosted corn as silage will salvage more nutrients per acre than any other option available for a dairyman. The nutritional value per pound of dry matter harvested will be similar to that in normal corn silage. The frosted crop should be allowed to dry to a minimum of 30 percent dry matter (70 percent moisture) to prevent seepage but it should not be allowed to become overly-dry (more than 40 percent dry matter—less than 60 percent moisture).

Sorghum Silage: Forage type sorghums often produce greater yields of green material per acre than does corn. However, this extra weight is usually moisture and the yield of energy per acre is usually less. Forage sorghums should be ensiled when the seeds are in the dough stage. Such silage often seeps large quantities of juice which contain nutrients and is a water pollution hazard. Sorghum grains are not effectively broken by field choppers. A large percentage of them pass undigested through the cow. Grain type sorghums are not recommended for silage. A combination of corn and sorghum for silage is less desirable than either crop planted alone because of the difference in maturity dates.

Corn-Soybean Silage: A combination of corn and soybeans grown for silage is not a desirable crop. When the population of corn plants is adequate for maximum corn production, few soybean plants survive. If the corn plant population is reduced enough to allow soybean plants to grow, the loss of corn production out-weighs the advantages of soybean production.

Soybean Silage: Chopped green soybeans do not make good silage. They develop into slick, slimey, badsmelling silage. If immature soybeans are frosted, they should be chopped and mixed with green-chopped corn before ensiling in order to provide the necessary amount of fermentable carbohydrate necessary for proper fermentation.

Small Grain Crop Silage: Rye, wheat, barley, oats and spelt can be made into good quality silage if they are cut in the blossom to milk stage, wilted to 35 percent dry matter (65~o moisture), chopped fine, distributed evenly and stored rapidly. Small grains that reach the late dough-stage should be harvested as a grain crop.

Rye: Rye seeded between September 1 and 15 will usually provide a supply of late fall forage for grazing and/or green chopping. It will then live through the winter and provide early spring forage. It is a palatable forage until the heads appear. The fields are usually plowed and seeded to corn for silage or soybeans after the rye has been removed. Balboa is a variety recommended for use as forage.

Straws, Stover and Cobs: Oats and wheat straws, because they are at full-maturity, are usually considered bedding materials rather than feed. When fed to cattle they are likely to provide adequate energy for maintenance but may be deficient in protein and minerals. Limited amounts of clean, bright straw can be fed to producing dairy cows to maintain normal rumen function and butterfat percentage in times of forage shortages.

Corn Stover: Corn stover is equal to average quality hay in energy content. However, it is much lower in protein and mineral content. Corn stover should be harvested only from those fields of

corn that were grown under conditions approved for corn silage for dairy cattle. Be sure to check the chemicals that were used to control insects and weeds. Corn stover should be stored in a manner that prevents mold growth.

Corn Cobs: Corn cobs can be used to raise the fiber content of dairy rations or as the fiber portion of complete rations for ruminants. Cobs have an energy value equal to medium to low quality roughage. They are very low in protein and mineral content. Only mold-free cobs should be fed.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Dairy Development in Sub-Saharan Africa : A Study of Issues and Options (World Bank Technical Paper, Africa Technical Department Series, No 135) - by Michael J. Walshe - Publication Date: March 1991 - List: $7.95 + $1.35 special surcharge
- Milk Quotas : European Community and United Kingdom Law - by Michael Cardwell - Publication Date: July, 1996 - List: $82.00
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Periodicals:

- None identified.

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Disease Prevention

Frequently Asked Questions Other Information Sources Return to Dairy Contents

Frequently Asked Questions:

Other Information Sources:

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Economics

Mortality or death loss often has been used as the only criterion to determine whether raising replacement heifers has been successful. A more sound approach might also include calculating the proportion of a farm's heifers that are well-grown and freshen by 24 months of age. The average heifer in Ohio DHI herds freshens for the first time when she is 28 months old. At least a portion of this time difference might be attributable to those bacterial and viral diseases that often occur in calves and heifers less than 12 months old.

Diarrhea (scours or enteritis) and pneumonia frequently occur together (pneumoenteritis) in young calves.

General Preventive Strategies

Birth through 4 weeks: The major health problem on many farms associated with calves in this age group is diarrhea. Many disease agents are capable of causing diarrhea in calves and research has indicated that many, if not all, of these agents may be present on the typical Ohio dairy farm. Actually, the occurrence of disease is dependent not only upon the presence of a particular infectious agent but also such factors as the dose of infectious agent, calf immunity, and the presence of other stresses on the calf. After the calf is born in a clean and dry environment, prevention and control of diarrhea should be concentrated in 3 areas:

1. **Early feeding of colostrum:** Do not assume that the calf has nursed and received adequate colostrum. Feed at least 2 quarts of colostrum to large breed calves as soon as possible after birth. Promptness of the first feeding is very important. For example, colostrum fed 9 hours after birth will result in only 50 percent of

the antibody level in the calf's bloodstream as compared to the same amount of colostrum fed during the first hour of life. Although it is not absorbed into the bloodstream after the first day, continued feeding of colostrum is suggested for the first 3 days of life. Such feeding will help provide local intestinal protection against diarrhea-causing viruses and bacteria. Colostrum from different cows frequently varies in antibody content. For example, if a cow leaks colostrum or has mastitis prior to freshening, colostrum that remains may be of lower antibody content. Also, when compared to cows, heifers often produce colostrum of lower antibody level. Fortunately, the antibody content of colostrum has been found to be correlated to it's specific gravity. In general, colostrum with a specific gravity of greater than 1.050 is of adequate antibody content. The specific gravity of colostrum may be determined either with a commercially available instrument called a colostrometer or an ordinary battery hygrometer.

2. **Reduction of exposure:** Actual numbers of a disease agent (bacteria, virus, or protozoa), rather than the mere presence of a particular agent in the calf's environment may be the deciding factor in determining disease occurrence. One excellent way to reduce the level of exposure to disease agents is to house calves individually in hutches. For maximum benefit, hutches should be cleaned, disinfected and moved before putting calves in them. In Ohio, the open side of the hutch should face east. If hutches cannot be placed in a well-drained area, limestone bases may be required. During summer months shade or ventilation is suggested.
3. **Diagnosis/Control of Agent:** Early colostrum feeding and rearing of calves in hutches can be safely recommended for use on all Ohio dairy farms. Unfortunately, even after these practices have been implemented occasional problems with calf diarrhea may still be expected. In these cases, working closely with a veterinarian to obtain an accurate diagnosis is necessary. For example, prevention of enterotoxigenic *Escherichia coli* (ETEC), enterotoxemia, and salmonellosis may be aided by vaccination of the pregnant dam. Management of other infectious agents may consist of medications given either at preventive or therapeutic levels (ea. coccidiosis) or rest primarily in the reduction of other stresses and the provision of good supportive care (ea. cryptosporidiosis, coronavirus,rotavirus).
   Disease agents that cause diarrhea early in life *(E. coli,* rotavirus, coronavirus) may result in rapid dehydration, shock and death of young calves. In addition to consulting your local veterinarian, the feeding of oral electrolyte solutions in place of milk or milk replacers is usually recommended during episodes of diarrhea in

calves less than 2 weeks old. A number of effective commercial products are available. A homemade preparation that has proven satisfactory and economical is:

1 teaspoon diet salt (NaCl:KCI)
1 tablespoon baking soda (NaHCO3)
1 can beef consomme'
1 package jam and jelly pectin to 2 quarts of water

Both frequency and duration of feeding electrolyte solutions may vary according to the severity of diarrhea and is best determined by operator experience and consultation with a veterinarian.

Pneumonia

8 weeks through 8 months: Respiratory disease is frequently observed in calves of this age. During this time period, levels of colostrally acquired antibodies naturally decline. This decline is complicated by the fact that, although antibody levels that remain in the bloodstream may not be protective against natural disease exposure, they may interfere with attempts to induce active immunity by vaccination. Additional complications often occur after weaning when calves are moved and when mixing calves of different age groups occurs.

Cause—The formula that has been traditionally used to explain the occurrence of shipping fever in feeder calves (ie. Virus + Bacteria + Stress = Shipping Fever) may also be useful in understanding pneumonia in dairy heifers. Viruses that are frequently implicated in calf pneumonia include parainfluenza (Pl3), infectious bovine rhinotracheitis (IBR) and bovine respiratory syncytial virus (BRSV).

Currently, it is thought that these and other viruses may damage tissues and reduce defense mechanisms; thereby opening the way for bacterial invasion by such agents as Pasteurella sp. and Haemophilus somnus. Interactions by viruses and bacteria are thought to be aided and complicated by a variety of stress factors. Examples of stress include weather changes, poor ventilation, mixing groups of animals and inadequate nutrition. In any case, the end result is often pneumonia.

Prevention—Avoid mixing calves and heifers that differ greatly in age. After weaning, calves should be moved from individual hutches in groups of 6 to 8 to isolated facilities such as super hutches.

Ideally, heifers should remain in this isolated group until they are 6 to 8 months old. When 6 to 8 months old, heifers usually can be expected to respond favorably to active immunization against the common respiratory pathogens. Vaccination for IBR-PI3 is recommended

throughout Ohio. Depending upon the prevalence of other infectious agents on a particular farm or in a community, a veterinarian may elect to vaccinate against other agents.

When heifers must be raised in a conventional barn, segregation by age group should still be attempted. Plywood barrier-walls between pens may be used to help prevent the spread of respiratory pathogens among age groups. At the very least, consider normal air movement patterns within a building. For example, young calves and heifers should not be housed downwind from older animals. Air movement patterns and proper ventilation are extremely important in the prevention of respiratory disease. Therefore, before building a new building or remodeling an existing one, it is wise to consult an agricultural engineer.

Treatment—Even after implementation of the above suggestions, occasional outbreaks of respiratory disease can be expected in young dairy heifers. Early in the course of the disease a veterinarian should be consulted regarding diagnosis and treatment. Too frequently, use of ineffective antibacterials or improper dosage schedules results in animals with residual lung damage. Animals treated improperly, even if they survive may be expected to exhibit poor growth and reduced performance. During an outbreak, in addition to prompt treatment, attempts should be made to correct underlying environmental problems, e.g. drafts and overcrowding. Sick animals should be isolated to help prevent spread of the disease and also to minimize further stress on the affected animals.

Specific Preventive Strategies

Ringworm—Ringworm is caused by a fungus that attacks the skin and forms ringlike or circular areas that are scabby or crusty in appearance. These areas may appear on the neck, shoulders or other parts of the body. It is contagious to both man and other animals upon direct contact. For treatment, scrub the infected areas with a stiff brush and soapy water. Then paint the areas with tincture of iodine or some other fungicide recommended by a veterinarian. Although not always successful, prevention should be attempted. Sunlight, adequate vitamin A supplementation, and cleaning and disinfection of animal facilities, all may be important in the prevention of ringworm.

Pinkeye—Pinkeye (infectious bovine keratoconjunctivitis) is an infectious disease of the eyes. It is characterized by a reddish inflammation of the eye. The disease is usually spread by contact between healthy and infected animals. Flies may also transmit the disease. Animals with Pinkeye are sensitive to light and should be isolated in a dark place away from other animals. Unless treated,

blindness may result. Recently, several vaccines have been licensed for use in the prevention of pinkeye. Consult a veterinarian for specific recommendations regarding treatment and prevention.

Internal Parasites

Ostertagia ostertagi the brown stomach worm, is the most important internal parasite affecting Ohio dairy animals. Signs of infection include unthriftiness and poor growth. It is very cost effective to deworm heifers during their first grazing season. Several approved products are available. While most products require two treatments a sustained release product requiring dosing only at turn-out was licensed recently. A veterinarian should be consulted concerning the use of specific products and treatment schedules.

External Parasites

Lice are a common problem on dairy farms. Lice cause discomfort, a rough, unthrifty appearance and poor growth in affected heifers. With many of the commonly used dusting products, retreatment should be given 10 to 14 days following the initial treatment. However, as with all medications, care should be taken to carefully read and follow label directions.

Flies can be annoying to dairy cattle of all ages and cause reduced gain in young animals. Many are blood sucking such as the horn flies, stable flies, deer flies and other species. These flies not only remove blood but also may transmit other bacterial and parasitic diseases. Although daily use of insecticide sprays is of value when cattle are housed, the best control methods involve the destruction of breeding places.

Blackleg is an acute infectious disease that primarily affects young cattle. The disease results in depression, fever, lameness and death of nonvaccinated animals. Animals become infected by grazing on soils contaminated by the spore-forming Blackleg bacteria. A regular vaccination program should be instituted and maintained in areas where the disease is known to exist.

Selenium Deficiency Soils in Ohio are frequently deficient in selenium and calf losses can occur unless selenium is supplied. Selenium deficiency may be characterized by lameness, stiffness and labored breathing. It is recommended that calves in Ohio receive two injections of selenium (BoSe), one at birth and a second at two weeks of age as a preventive measure against possible deficiency.

Johne's Disease, also known as paratuberculosis, is characterized by chronic diarrhea, wasting and death. Although the disease is usually observed when the cattle are young adults the infection is actually contracted during calfhood. Because the disease is spread by ingestion of the feces of infected cattle, care should be taken to prevent fecal

contamination of housing and feedstuffs used by young animals. Calves should be removed from their dams as soon as possible following birth and raised in isolation from adults as described previously.

Leukosis Enzootic bovine leukosis is caused by a virus carried in the blood of infected cattle. Once infected, an animal remains infected for the rest of it's life. Although tumors may develop later in life, currently the greatest loss is associated with the loss of export markets and semen sales. While a small percentage of animal's contract infection in-utero, the majority of new infections are thought to be acquired by the use of blood-contaminated instruments such as gouge dehorners, tatooing instruments, and common needles used for injection. Electric dehorning, proper disinfection of tatoo equipment between calves, and disposable single-use needles are suggested to help control the spread of leukosis.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- Dairy Development in Sub-Saharan Africa : A Study of Issues and Options (World Bank Technical Paper, Africa Technical Department Series, No 135) - by Michael J. Walshe - Publication Date: March 1991 - List: $7.95 + $1.35 special surcharge

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1. **Early feeding of colostrum:** Do not assume that the calf has nursed and received adequate colostrum. Feed at least 2 quarts of colostrum to large breed calves as soon as possible after birth. Promptness of the first feeding is very important. For example, colostrum fed 9 hours after birth will result in only 50 percent of the antibody level in the calf's bloodstream as compared to the same amount of colostrum fed during the first hour of life. Although it is not absorbed into the bloodstream after the first day, continued feeding of colostrum is suggested for the first 3 days of life. Such feeding will help provide local intestinal protection against diarrhea-causing viruses and bacteria.
   Colostrum from different cows frequently varies in antibody content. For example, if a cow leaks colostrum or has mastitis prior to freshening, colostrum that remains may be of lower antibody content. Also, when compared to cows, heifers often produce colostrum of lower antibody level. Fortunately, the antibody content of colostrum has been found to be correlated to it's specific gravity. In general, colostrum with a specific gravity of greater than 1.050 is of adequate antibody content. The specific gravity of colostrum may be determined either with a commercially available instrument called a colostrometer or an ordinary battery hygrometer.

2. **Reduction of exposure:** Actual numbers of a disease agent (bacteria, virus, or protozoa), rather than the mere presence of a particular agent in the calf's environment may be the deciding factor in determining disease occurrence. One excellent way to reduce the level of exposure to disease agents is to house calves individually in hutches. For maximum benefit, hutches should be cleaned, disinfected and moved before putting calves in them. In Ohio, the open side of the hutch should face east. If hutches cannot be placed in a well-drained area, limestone bases may be required. During summer months shade or ventilation is suggested.
3. **Diagnosis/Control of Agent:** Early colostrum feeding and rearing of calves in hutches can be safely recommended for use on all Ohio dairy farms. Unfortunately, even after these practices have been implemented occasional problems with calf diarrhea may still be expected. In these cases, working closely with a veterinarian to obtain an accurate diagnosis is necessary. For example, prevention of enterotoxigenic *Escherichia coli* (ETEC), enterotoxemia, and salmonellosis may be aided by vaccination of the pregnant dam. Management of other infectious agents may consist of medications given either at preventive or therapeutic levels (ea. coccidiosis) or rest primarily in the reduction of other stresses and the provision of good supportive care (ea. cryptosporidiosis, coronavirus,rotavirus).
   Disease agents that cause diarrhea early in life *(E. coli,* rotavirus, coronavirus) may result in rapid dehydration, shock and death of young calves. In addition to consulting your local veterinarian, the feeding of oral electrolyte solutions in place of milk or milk replacers is usually recommended during episodes of diarrhea in calves less than 2 weeks old. A number of effective commercial products are available. A homemade preparation that has proven satisfactory and economical is:

   1 teaspoon diet salt (NaCl:KCI)
   1 tablespoon baking soda (NaHCO3)
   1 can beef consomme'
   1 package jam and jelly pectin to 2 quarts of water

Both frequency and duration of feeding electrolyte solutions may vary according to the severity of diarrhea and is best determined by operator experience and consultation with a veterinarian.

Pneumonia

8 weeks through 8 months: Respiratory disease is frequently observed in calves of this age. During this time period, levels of colostrally acquired antibodies naturally decline. This decline is complicated by the fact that, although antibody levels that remain in the bloodstream may not be protective against natural disease exposure, they may interfere with attempts to induce active immunity by vaccination. Additional complications often occur after weaning when calves are moved and when mixing calves of different age groups occurs.

Cause—The formula that has been traditionally used to explain the occurrence of shipping fever in feeder calves (ie. Virus + Bacteria + Stress = Shipping Fever) may also be useful in

understanding pneumonia in dairy heifers. Viruses that are frequently implicated in calf pneumonia include parainfluenza (Pl3), infectious bovine rhinotracheitis (IBR) and bovine respiratory syncytial virus (BRSV).

Currently, it is thought that these and other viruses may damage tissues and reduce defense mechanisms; thereby opening the way for bacterial invasion by such agents as Pasteurella sp. and Haemophilus somnus. Interactions by viruses and bacteria are thought to be aided and complicated by a variety of stress factors. Examples of stress include weather changes, poor ventilation, mixing groups of animals and inadequate nutrition. In any case, the end result is often pneumonia.

Prevention—Avoid mixing calves and heifers that differ greatly in age. After weaning, calves should be moved from individual hutches in groups of 6 to 8 to isolated facilities such as super hutches.

Ideally, heifers should remain in this isolated group until they are 6 to 8 months old. When 6 to 8 months old, heifers usually can be expected to respond favorably to active immunization against the common respiratory pathogens. Vaccination for IBR-PI3 is recommended throughout Ohio. Depending upon the prevalence of other infectious agents on a particular farm or in a community, a veterinarian may elect to vaccinate against other agents.

When heifers must be raised in a conventional barn, segregation by age group should still be attempted. Plywood barrier-walls between pens may be used to help prevent the spread of respiratory pathogens among age groups. At the very least, consider normal air movement patterns within a building. For example, young calves and heifers should not be housed downwind from older animals. Air movement patterns and proper ventilation are extremely important in the prevention of respiratory disease. Therefore, before building a new building or remodeling an existing one, it is wise to consult an agricultural engineer.

Treatment—Even after implementation of the above suggestions, occasional outbreaks of respiratory disease can be expected in young dairy heifers. Early in the course of the disease a veterinarian should be consulted regarding diagnosis and treatment. Too frequently, use of ineffective antibacterials or improper dosage schedules results in animals with residual lung damage. Animals treated improperly, even if they survive may be expected to exhibit poor growth and reduced performance. During an outbreak, in addition to prompt treatment, attempts should be made to correct underlying environmental problems, e.g. drafts and overcrowding. Sick animals should be isolated to help prevent spread of the disease and also to minimize further stress on the affected animals.

Specific Preventive Strategies

Ringworm—Ringworm is caused by a fungus that attacks the skin and forms ringlike or circular areas that are scabby or crusty in appearance. These areas may appear on the neck, shoulders or other parts of the body. It is contagious to both man and other animals upon direct contact. For treatment, scrub the infected areas with a stiff brush and soapy water. Then paint the areas with tincture of iodine or some other fungicide recommended by a veterinarian. Although not always successful, prevention should be attempted. Sunlight, adequate vitamin A supplementation, and cleaning and disinfection of animal facilities, all may be important in the prevention of ringworm.

Pinkeye—Pinkeye (infectious bovine keratoconjunctivitis) is an infectious disease of the eyes. It is characterized by a reddish inflammation of the eye. The disease is usually spread by contact between healthy and infected animals. Flies may also transmit the disease. Animals with Pinkeye are sensitive to light and should be isolated in a dark place away from other animals. Unless treated, blindness may result. Recently, several vaccines have been licensed for use in the prevention of pinkeye. Consult a veterinarian for specific recommendations regarding treatment and prevention.

Internal Parasites

Ostertagia ostertagi the brown stomach worm, is the most important internal parasite affecting Ohio dairy animals. Signs of infection include unthriftiness and poor growth. It is very cost effective to deworm heifers during their first grazing season. Several approved products are available. While most products require two treatments a sustained release product requiring dosing only at turn-out was licensed recently. A veterinarian should be consulted concerning the use of specific products and treatment schedules.

External Parasites

Lice are a common problem on dairy farms. Lice cause discomfort, a rough, unthrifty appearance and poor growth in affected heifers. With many of the commonly used dusting products, retreatment should be given 10 to 14 days following the initial treatment. However, as with all medications, care should be taken to carefully read and follow label directions.

Flies can be annoying to dairy cattle of all ages and cause reduced gain in young animals. Many are blood sucking such as the horn flies, stable flies, deer flies and other species. These flies not only remove blood but also may transmit other bacterial and parasitic diseases. Although daily use of insecticide sprays is of value when cattle are housed, the best control methods involve the destruction of breeding places.

Blackleg is an acute infectious disease that primarily affects young cattle. The disease results in depression, fever, lameness and death of nonvaccinated animals. Animals become infected by grazing on soils contaminated by the spore-forming Blackleg bacteria. A regular vaccination program should be instituted and maintained in areas where the disease is known to exist.

Selenium Deficiency Soils in Ohio are frequently deficient in selenium and calf losses can occur unless selenium is supplied. Selenium deficiency may be characterized by lameness, stiffness and labored breathing. It is recommended that calves in Ohio receive two injections of selenium (BoSe), one at birth and a second at two weeks of age as a preventive measure against possible deficiency.

Johne's Disease, also known as paratuberculosis, is characterized by chronic diarrhea, wasting and death. Although the disease is usually observed when the cattle are young adults the infection is actually contracted during calfhood. Because the disease is spread by ingestion of the feces of infected cattle, care should be taken to prevent fecal contamination of housing and feedstuffs used by young animals. Calves should be removed from their dams as soon as possible following birth and raised in isolation from adults as described previously.

Leukosis Enzootic bovine leukosis is caused by a virus carried in the blood of infected cattle. Once infected, an animal remains infected for the rest of it's life. Although tumors may develop later in life, currently the greatest loss is associated with the loss of export markets and semen sales. While a small percentage of animal's contract infection in-utero, the majority of new infections are thought to be acquired by the use of blood-contaminated instruments such as gouge dehorners, tatooing instruments, and common needles used for injection. Electric dehorning, proper disinfection of tatoo equipment between calves, and disposable single-use needles are suggested to help control the spread of leukosis.

Related web pages:

- None identified.

Commercial suppliers:

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Electronic mailing lists:

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Raising Replacements

Frequently Asked Questions Other Information Sources Return to Dairy Contents

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Raising Heifers from Seven Months to One Year

After heifers reach seven months of age, good growth can be achieved without fattening by feeding an abundance of good quality forage along with an adequate amount of a simple grain mixture (14 to 16 percent crude protein). The same mixture being fed the milking herd is often satisfactory. If high quality forage is fed, heifers of the large breeds can be limited to four pounds of grain per day and those of the smaller breeds to three. When forage is of poor quality or in limited supply, grain feeding may need to be increased above these amounts.

Good quality silage or pasture may be the source of forage. Heifers on pasture should have free access to fresh water, iodized salt, a phosphorus mineral mixture such as steamed bone meal and dicalcium phosphate, and adequate shade and protection from flies. Heifers on poor pasture should be fed some hay or silage. When handled in groups of five or more, heifers should be about the same age and/or size.

Raising Heifers from 12 Months to Freshening

Heifers with normal growth through 12 months of age can be grown adequately to freshening age by feeding maximum amounts of good quality forage. Improved pasture, good quality hay and silage are all suitable forages for yearling heifers when fed alone or in combination.

For two-year-olds of adequate size, heifers should be kept growing continuously from birth to freshening. Suggested average daily gains from birth to two years are listed below.

Breed	lb./day
Ayshire	1.2
Brown Swiss	1.4
Guernsey	1.1

Holstein	1.4
Jersey	1.0

To determine how well calves and heifers are being fed and managed, check growth rates periodically against a normal standard. If scales are not available, weights of dairy heifers can be estimated from heart girth measurements. Use a tape measure and place it around the heart girth just behind the front legs and shoulders. Make sure the animal is standing squarely on its legs and then draw the tape firmly to take the reading. Some feed companies have tapes that give a direct reading of the estimated weight of an animal.

Average weights and heart girth measurements of different breeds from birth through 21 months of age may be found in the following table. Because data are unavailable for Brown Swiss, Holstein guidelines should be used to check growth.

Age	**Holstein**		**Ayrshire**		**Guernsey**		**Jersey**	
Mos.	**Inches**	**Lbs.**	**Inches**	**Lbs.**	**Inches**	**Lbs.**	**Inches**	**Lbs.**
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2	37	161	351/2	132	341/2	122	321/2	102
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13	631/4	740	603/4	630	591/4	587	571/2	540
14	641/4	774	62	666	601/2	615	581/2	565
15	651/4	805	63	703	613/4	640	59	585
16	661/4	841	64	731	621/2	674	593/4	611
17	671/4	874	651/4	758	631/2	696	601/2	635
18	681/2	912	66	781	65	727	611/2	660
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21	711/2	1025	681/2	885	671/2	816	64	740

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Yearlings should have free access to good quality forage in the form of hay and/or silage. Heifers should consume two to two and one-half pounds of hay (or its equivalent in silage) per hundred pounds of body

weight daily. To illustrate the conversion of silage to hay equivalent, two pounds of silage with a dry matter content of 45 percent or three pounds of silage with a dry matter content of 30 percent would equal one pound of hay equivalent.

The amount and protein content of the concentrate to be fed will depend on the kind, quality and amount of forage eaten and the condition of the heifers. In most instances, the grain mix fed the milking herd is suitable. When good quality forage is fed, a grain mix containing 10 to 12 percent total protein is adequate. When the forage is medium in quality, feeding two to four pounds of grain daily will generally produce satisfactory growth. Heifers that are thin and not growing well may need more grain to supplement their forage intake.

Feeding Yearlings in Summer

If an adequate amount of good quality pasture is available, yearling heifers will make good gains with little or no grain. When pasture is not available or is of poor quality, then yearlings should be fed the amounts of grain mix recommended for the winter months.

Yearling heifers need a plentiful supply of clean, fresh water all year long. A good supply of water in the pasture areas is very important. Heifers consume more pasture where water is readily available.

Provide heifers on pasture plenty of shade and salt. If any are receiving little or no grain, it is also advisable to provide a good calcium-phosphorus supplement such as steamed bone meal or dicalcium phosphate.

Effects of Over-Conditioning

Keep heifers in a good thrifty condition but not fat. Over-conditioning of heifers may impair their production as mature animals. The reasons for this are not fully understood. It has been theorized that 1) fatty deposits in the udder prevent development of some of the secretory cells; 2) over-conditioning reduces the ability of the cow to produce an adequate supply of the lactogenic hormone (responsible for initiation of production and persistency of production), preventing her from being able to express her true inheritance; and 3) the resulting additional body weight requires a greater amount of feed for maintenance. Some workers have also observed that the udders of cows over-conditioned as calves and heifers have a more meaty texture. As a result, the circulation of blood flow to and from the udder may be somewhat reduced.

Breeding

When to Breed: In general, heifers that have made normal growth may be bred at 15 months of age. Dairymen may want to breed some heifers at an earlier age and others beyond 15 months to attain a balanced calving schedule.

For a guide on size and age to breed herifers, see the following table. Heifers should be bred according to body weight within the range of ages shown. Early breeding of well-grown heifers cobld allow up to an extra lactation, shorten the the "boarding" period and increase the overall efficiency of dairy production.

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Breeding heifers to avoid calving difficulty: Some Ohio dairymen breed heifers to beef bulls in an attempt to reduce difficulty at calving time. The size of the dam appears to have a greater influence on calf size than breed of sire, so this does not seem to be an effective practice. If followed, this practice would further reduce the number of replacements available annually.

The development of genetic rankings for calving ease gives dairymen an effective tool for reducing the incidence of calving difficulty in Holsteins. Rankings may be used to select the bulls with the lowest expected percent of difficult first carvings. Because many factors influence the ease or difficulty of a specific calving, these rankings cannot predict the outcome of each mating.

Feeding and care of the bred heifer: The bred heifer can be fed and handled in the same manner as other yearlings until the last two or three months of pregnancy. The last three months before an animal is due to calve is the period in which the unborn calf makes nearly two-thirds of its growth. Therefore, during this time a bred heifer may need extra nutrients for condition, growth of the fetus and her own growth. Heifers may require as much as 8 to 10 pounds of grain daily a few weeks before calving. On the other hand, they may need very little, if any, grain, depending on the quality of forage fed. The main precaution is to keep them from getting fat.

About four to six weeks before calving, the bred heifer may be housed with the milking herd. This permits her to become accustomed to the other cows and the new premises. Some dairymen run heifers through

the milking parlor for a period before they calve. All these practices are aids in training the heifer in good milking habits.

Life-long milking habits are begun at the first milking. First-calf heifers should be handled gently and properly prepared to encourage rapid milking.

After lactation has begun, first calf heifers are still growing. Therefore, they need an extra allowance of protein and energy (grain) above the requirements for maintenance and milk production. This will allow them to milk to capacity and continue to grow.

Major Expenses

Feed is the major expense in raising dairy herd replacements. Feed costs, on the average, account for 60 to 65 percent of the total cost of raising replacements.

Other expenses included in the total cost are grouped under the following headings: labor, building and equipment costs, interest on investment in replacements, breeding fees, bedding and value of heifers at birth. Additional miscellaneous expenses are veterinary service, medicines, disinfectants, supplies, insurance, registration, telephone and electricity.

Chore labor directly related to raising heifers from birth to first calving ranges from 20 to 35 hours per heifer. When calculating costs, 30 hours is a good average figure to use for the large breeds and 25 hours for the small breeds in figuring labor costs. Labor is the second largest cost, accounting for 15 to 18 percent of the total rearing cost.

Bedding requirements from birth to two years of age (age at first freshening) average about a ton. Breeding. fees range from $10 to S20 per head, and interest on investment per heifer is currently being charged at the rate of 13 percent annually. Interest is calculated on total feed, miscellaneous, breeding and bedding costs. Charges for buildings (depreciation, interest, repairs, taxes and insurance—DIRTI) is calculated at 19 percent per year on an estimated $235 investment per calf (midyear life). Charge for equipment (DIRI) is calculated on an estimated $48 investment per calf (10-year life). If older buildings or those with no other use are used, this cost would be much lower. The same could be true for equipment costs.

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Feeding and care of the bred heifer: The bred heifer can be fed and handled in the same manner as other yearlings until the last two or three months of pregnancy. The last three months before an animal is due to calve is the period in which the unborn calf makes nearly two-thirds of its growth. Therefore, during this time a bred heifer may need extra nutrients for condition, growth of the fetus and her own growth. Heifers may require as much as 8 to 10 pounds of grain daily a few weeks before calving. On the other hand, they may need very little, if any, grain, depending on the quality of forage fed. The main precaution is to keep them from getting fat.

About four to six weeks before calving, the bred heifer may be housed with the milking herd. This permits her to become accustomed to the other cows and the new premises. Some dairymen run heifers through the milking parlor for a period before they calve. All these practices are aids in training the heifer in good milking habits.

Life-long milking habits are begun at the first milking. First-calf heifers should be handled gently and properly prepared to encourage rapid milking.

After lactation has begun, first calf heifers are still growing. Therefore, they need an extra allowance of protein and energy (grain) above the requirements for maintenance and milk production. This will allow them to milk to capacity and continue to grow.

Major Expenses

Feed is the major expense in raising dairy herd replacements. Feed costs, on the average, account for 60 to 65 percent of the total cost of raising replacements.

Other expenses included in the total cost are grouped under the following headings: labor, building and equipment costs, interest on investment in replacements, breeding fees, bedding and value of heifers at birth. Additional miscellaneous expenses are veterinary service, medicines, disinfectants, supplies, insurance, registration, telephone and electricity.

Chore labor directly related to raising heifers from birth to first calving ranges from 20 to 35 hours per heifer. When calculating costs, 30 hours is a good average figure to use for the large breeds and 25 hours for the small breeds in figuring labor costs. Labor is the second largest cost, accounting for 15 to 18 percent of the total rearing cost.

Bedding requirements from birth to two years of age (age at first freshening) average about a ton. Breeding. fees range from $10 to S20 per head, and interest on investment per heifer is currently being charged at the rate of 13 percent annually. Interest is calculated on total feed, miscellaneous, breeding and bedding costs. Charges for buildings (depreciation, interest, repairs, taxes and insurance—DIRTI) is calculated at 19 percent per year on an estimated $235 investment per calf (midyear life). Charge for equipment (DIRI) is calculated on an estimated $48 investment per calf (10-year life). If older buildings or those with no other use are used, this cost would be much lower. The same could be true for equipment costs.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

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Control of Contagious Mastitis

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Mastitis, an inflammation of the mammary gland, is almost always the result of bacterial infection.

Characteristics of Contagious Bacteria

Contagious Bacteria

Simply stated, the term contagious mastitis means that the infection can be transferred from an infected quarter to a non-infected quarter. This may occur either between quarters on the same cow or from one cow to another. **Streptococcus agalactiae** (Strep ag) and **Staphylococcus aureus** *(Staph* aureus) are the two major species of contagious bacteria commonly found in the Midwest.

Several characteristics of Strep ag are very important to understanding attempts to control it in a herd. First, Strep ag is able to live and multiply only when it is in the cow's udder. Once in the udder, Strep ag grows on the tissue surface. These characteristics, and it's sensitivity to penicillin, mean that Strep ag can usually be eliminated from the udder by the proper use of antibiotics.

Staph aureus is also very contagious. However, in addition to living in the udder like Strep ag, *Staph* aureus may also be found colonizing on teat skin surfaces. This is especially true when the teat skin has been damaged. *Staph* aureus does not grow on udder tissue surfaces where it would readily be exposed to antibiotics; instead, it grows deep within the connective tissue where it will form small abcesses. Furthermore, *Staph* aureus tends to develop resistance to antibiotics. These characteristics make *Staph* aureus more difficult than Strep ag to control and/or eliminate in a dairy herd.

Length of Infection:

Once established, contagious bacteria may live in the udder for the

entire life of the cow, unless there is effective intervention. The end result is lowered milk production because bacterial growth in the udder causes damage to milk secreting tissue.

Signs of Contagious Mastitis:

Infection by contagious bacteria usually results in subclinical mastitis, i.e. the milk is visibly normal. Occasionally, there may be mild flare-ups, and on rare occasions, certain strains of *Staph* aureus may result in gangrenous mastitis.

Somatic Cells:

Somatic cells in milk are primarily white blood cells (leukocytes). When bacteria infect a quarter, the cow's immune system responds to fight the infection by increasing the number of somatic cells present in the milk. Because infections caused by contagious bacteria are usually of long duration, milk somatic cell counts in cows infected with these organisms are usually elevated for long periods of time. In fact, the most frequent finding in herds where the somatic cell count exceeds legal standards is a high proportion of quarters infected with contagious bacteria.

Control of Contagious Mastitis

In the 1960s, research indicated that dipping of teats in a germacide after milking was effective in reducing the rate of new mastitis infections by 50 to 90 percent. In addition, researchers demonstrated that the length of an infection could be decreased by intramammary infusion of antibiotics at drying-off time. Such drug therapy has also been shown to reduce the rate of new infections that occur shortly after drying-off.

Postmilking Teat Dipping with a Germacide:

Properly done, immersion of teats after milking in an effective germacide is the most important means available to prevent new mastitis infections caused by contagious bacteria. Apply the dip to at least the lower half of the teat immediately after the milker unit has been removed. Dipping is usually preferable to spraying because, in most cases, better teat-end coverage is achieved. Other points to consider concerning postmilking teat dipping include:

1. Dip-containers should be cleaned daily.
2. All products labelled as teat dips may not be equally effective. At the present time the FDA does not require that teat dips be tested for effectiveness prior to marketing. The best assurance of product effectiveness may be obtained by testing under Protocols B or C of the National Mastitis Council (NMC). These

procedures (Protocol B and C) determine how effective the product is in reducing the number of new cases of mastitis in cows.

3. Avoid teat skin irritation. Chapping or "burning" teat skin can actually allow *Staph aureus* and other bacteria to colonize teats and result in additional new mastitis infections. Mixing products, use of damaged products, or injudicious dipping in extremely cold weather may result in damaged teat skin.

Dry Cow Therapy:

Immediately after the last milking of each lactation, each quarter of a cow should be treated with a single tube of a specifically formulated commercial dry cow product. A suggested procedure is:

1. Immerse teats in postmilking dip
2. Thoroughly clean teat-ends with alcohol and cotton
3. Carefully infuse each quarter
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5. Rinse hands in udder sanitizer and dry between cows.

Caution: Follow label directions to avoid antibiotic residue in meat and milk.

Although postmilking teat dipping in a germacide and dry cow therapy are the principal methods of contagious mastitis control, several additional management procedures merit attention.

Fomites - Contagious bacteria may spread from infected to non-infected quarters by way of contaminated milk droplets. Any object that aids in this transfer of contaminated milk droplets is called a fomite. Fomites considered important in spreading contagious bacteria include:

1. Use of a common udder cloth or sponge among cows. A single-service, individual paper towel is recommended for preparation of each cow.
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Purchased animals - Studies show that about 5 percent of the herds free of *Strep ag* become reinfected each year. This reinfection results primarily from purchasing infected animals. If animals are purchased, it is advisable to isolate them and bacteriologically culture their milk before placing them in the regular milking string.

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Control of Environmental Mastitis

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Control of Environmental Mastitis

Two management practices, postmilking teat dipping and dry-cow treatment, have been effective in the control of mastitis caused by contagious bacteria. These practices, however, have not proven effective in the control of environmental mastitis. Other contrasts exist between environmental and contagious mastitis as shown in Table 1.

Table 1 Contrasting characteristics of environmental and contagious mastitis.

Characteristic	Environmental	Contagious
Major bacterial species	Streptococcus non-ag Coliform	Streptococcus agalactiae Staphylococcus aureus
Primary location of organisms	Animal's environment	Inside udder
Visual signs	Often clinical	Often subclinical
Duration of infection	Short	Long
Bulk tank somatic cell count	Often low	Often high

Somatic Cell Counts

Individual cows, at the time of an environmental mastitis infection, often have elevated somatic cell counts (SCC) similar to those exhibited by cows with contagious mastitis. However, herds with an increased rate of environmental mastitis, unlike those herds experiencing an

increased rate of contagious mastitis, often do not have extremely elevated bulk tank SCC.

Two characteristics of environmental mastitis may be used to explain this observed difference:

1. **Clinical nature of environmental mastitis:** Because milk from cows with environmental mastitis is usually visibly abnormal, it is likely to be excluded from the bulk tank. Also, the clinical nature of environmental infections increases the likelihood of antibiotic therapy, therefore, requiring exclusion of the milk from the tank. By contrast, the milk from cows infected with contagious bacteria is usually put in the bulk tank as it often appears normal to the naked eye.
2. **Duration of infection:** Because environmental infections are of relatively short duration, the number of infected quarters (or prevalence) in a herd at any given time is usually low (e.g. <10%). Even with a similar rate of new infections, herds with contagious mastitis may have 40 to 60 percent of the quarters infected. This is because contagious infections are typically of longer duration. Furthermore, the relatively short duration of environmental infections is the reason that individual cow DHI-SCC may not be a good indicator of environmental mastitis problems within a herd.

Season, Age and Stage of Lactation

Research at The Ohio Agricultural Research and Development Center (OARDC) indicates that season of the year and parity affected the rate of new environmental mastitis infections. Summer, with hot and wet weather, was the season with the highest infection rate. Older cows (2+ lactations) were shown to be more prone to infection than heifers. Furthermore, cows were more likely to become infected shortly after drying-off and near freshening than at other times.

Control Strategies

While contagious bacteria live primarily in the udder and are usually spread during milking, the cow is exposed to environmental bacteria throughout the entire day. Therefore, specifics of environmental mastitis control may vary somewhat from farm-to-farm; however, a basic overall strategy should address the following areas:

1. **Dry Cow Management:** Research has shown that the risk of new environmental mastitis infection is greatest immediately after drying-off and again near freshening. Dry cow medications, as currently marketed, are only partially effective in preventing

new environmental infections; however, dry cow therapy is still recommended because it greatly reduces the number of new environmental streptococcal infections that occur at drying-off. Therefore, a key objective in the prevention of new environmental mastitis infections must be the maintenance of a **clean, dry and well-ventilated** environment for dry cows.

2. **Vitamin E/Selenium:** Rations deficient in vitamin E and selenium increase the risk of environmental mastitis. Current OARDC recommendations include supplementation for large breeds as follows:
    - Dry cows: Feed 1000 IU vitamin E per head per day (when not on green pasture) and 3 mg selenium per head per day; also inject 50 mg selenium 21 days prior to parturition.
    - Lactating cows: Feed 400-600 IU vitamin E per head per day and 6 mg selenium per head per day.
3. **Cow Preparation:** An overall goal of good cow preparation should be the application of a properly functioning milker-unit to a clean, surface-dry teat. Predipping is a relatively new technique that may be helpful in reducing the number of new environmental mastitis infections in certain circumstances. Predipping consists of the application and **removal** of a germacide to the teats before milking. A variety of products and techniques have been used. Dairymen are advised to discuss specifics of the procedure with their veterinarian, fieldman or county agent before implementing the practice. The first rule must be to **"Avoid Residues in Milk."**
4. **Milking Technique and Milking Machine Function:** Proper machine function is described in Dairy Guide Leaflet 504. In addition, recent research indicates that liner slippage during milking is definitely associated with new intramammary infections.
5. **Teat Sphincter Closure:** A simple technique that may be beneficial in the prevention of environmental mastitis is to encourage cows to remain standing for 1 to 2 hours after milking. This allows time for the teat sphincter to close and is best accomplished by providing cows with fresh feed following milking.
6. **Environment:** The number of new mastitis infections is proportional to the number of bacteria to which the teat-end is exposed. Therefore, reduction of bacterial numbers at the teat-end is the goal. Clean, dry, and well-ventilated are key words that describe a proper environment. Proper design and maintenance of free stalls and freshening pens, cleaning of alleys,

parlor holding-pens and barn lots, and fencing cows out of muddy areas are several means by which this goal may be accomplished.

Diagnosis

Environmental mastitis is usually accompanied by clinical signs. Bacteriologic culturing of milk from cows with clinical mastitis cases or high SCC can be used to determine whether contagious or environmental bacteria are involved and also which areas of management might require adjustment.

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6. **Environment:** The number of new mastitis infections is proportional to the number of bacteria to which the teat-end is exposed. Therefore, reduction of bacterial numbers at the teat-end is the goal. Clean, dry, and well-ventilated are key words that describe a proper environment. Proper design and maintenance of free stalls and freshening pens, cleaning of alleys, parlor holding-pens and barn lots, and fencing cows out of muddy areas are several means by which this goal may be accomplished.

Diagnosis

Environmental mastitis is usually accompanied by clinical signs. Bacteriologic culturing of milk from cows with clinical mastitis cases or high SCC can be used to determine whether contagious or environmental bacteria are involved and also which areas of management might require adjustment.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

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Periodicals:

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Somatic Cells in Milk

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Somatic Cells in Milk

The average dairy herd without a mastitis control program has subclinical or nondetectable mastitis in 47 percent of the cows. Three percent of the cows will be clinical at any point in time. The economic losses from both subclinical and clinical mastitis are great. The National Mastitis Council in 1978 estimated the yearly cost per cow from clinical mastitis cases, culling and decreased production to be about $161. Of this amount only about $56 was attributed to the costs of anitbiotics, discarded milk, time in treating and milking separately, veterinary service and culling prematurely. The greatest amount, $105, resulted from reduced milk production and income caused by subclinical mastitis. Infection in just one quarter reduces a cow's milk production 10 to 15 percent! Subclinical mastitis is the great hidden enemy of the dairyman.

The strip cup and visual observations at milking will not detect subclinical mastitis. The normal defense mechanism of the cow responds to subclinical mastitis (bacterial infection) by migrating leukocytes, a type of somatic cell from the blood, into the infected area of the udder. Leucocytes are divided into two types: lymphocytes and polymorphonuclear neutrophils. Macrophages, another type of defense mechanism cell, also migrate to the area of infection. The function of all these cells is to engulf and destroy the invading bacteria.

The level of somatic cells (leucocytes, macrophage and epithelial cells from the secretory tissue) in milk can be measured; therefore, it can become a rough measure of the level of infection in a herd. This can be done on the bulk tank milk sample, the composite milk sample from each cow, or on individual quarter milk samples.

There are three commercial test methods used presently to measure the number of somatic cells in farm milk samples: the California Mastitis

Test (CMT), the Wisconsin Mastitis Test (WMT) and Electronic Cell Counting.

The CMT Test:

This test is commonly used on a composite milk sample taken from each cow. In the DHI program the test is run and read by the testing supervisor. It is also used by dairymen and veterinarians on individual quarters as a "cow-side test" indicator of the infection level in a cow's udder.

To conduct the test, two to three cc of the milk are placed in a four chambered paddle. An equal amount of an alkaline reagent is added to the milk. The reagent interacts with somatic cells in the milk to form a gel. After the paddle is tipped back and forth four or five times, a visual judgment reading of the amount of gel formation is taken.The sample is scored N (negative),T (trace), 1, 2 or 3 depending upon the amount of gel. A score of N or T indicates 500,000 or fewer somatic cells per cc of milk. These are acceptable scores and would indicate very little loss of production due to infection. Scores with higher ratings indicate higher somatic cell numbers and thus greater infection levels and milk losses.

The CMT reading usually increases as a cow moves into her second, third and later lactations. This is because cows usually have a greater amount of udder infection as they become older.

The CMT report is an early warning system that can identify cows with subclinical infections. The somatic cell program and culture results indicate that most cows have fewer than 400,000 somatic cells per cc milk are uninfected.

If a cow's composite milk sample has a CMT reading of two or three, each quarter should be sampled individually to determine if treatment is advisable.

The SCC count

A more accurate somatic cell count can be obtained by direct microscopic count or by electronic cell counting. The direct microscopic count is too slow; therefore, most somatic cell counts are done electronically with the Coulter or the Fossomatic counters. The cell count is expressed as thousands of cells per milliliter, or on a 0-9 scale. The somatic cell count is very important in detecting subclinical mastitis before any clinical mastitis signs are evident.

The WMT Test:

The Wisconsin Mastitis Test is commonly used by milk receiving plants to measure the quality of the farm bulk tank milk sample picked up by the milk hauler. The principle of the WMT is the same as the CMT. Instead of a subjective rating, the amount of gel that forms is measured in millimeters (mm) that remains in a calibrated tube. The WMT test is conducted under more precise procedures and standard temperature conditions. A WMT reading of 8 mm suggests that there are probably very few cows in the herd with subclinical mastitis. If the WMT reading reaches 20 mm or more, most milk plants will run a direct microscopic count to obtain an accurate somatic cell count. If the somatic cell count is 1,500,000 or greater, the dairyman is notified and assistance is provided in correcting the problem. Milking procedures and equipment operation need to be throughly checked.

Do not try to equate the WMT (mm) and the related cell count to the other scoring systems. The bulk tank sample is a composite sample representing the herd, while the other samples are composite samples from individual cows and will have a wider range of cell counts.

The importance of the somatic cell count relates not only to production loss from subclinical mastitis but also to the regulations governing Grade A and Manufacturing milk. The regulation for Grade A milk reads as follows: "Whenever the somatic cell count exceeds 1.5 million, the dairy plant is expected to send written notice to the producer. When two of the last four counts exceed that level, the written notice must come from the regulatory agency. The last notice remains in effect as long as two of the last four tests remain above 1.5 million in count. At the same time an inspection is required, also by the regulatory agency, and at some time between the third and 14th day following this inspection, a sample of milk is taken for further analysis. If this sample proves excessively high in cell count (over 1.5 million), action will be taken to suspend a producer's certificate to sell milk." Interstate milk shippers are required to meet these somatic cell standards. Any milk manufacturing plant that sells products to the U.S.D.A. has to meet similar regulations imposed by the U.S.D.A.

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Factors Affecting the Flavor of Milk

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Factors Affecting the Flavor of Milk

Fresh milk has a mild, pleasing and slightly sweet and rich flavor. The sweet flavor is contributed by the milk sugar and the richness by the fat. On the other hand milk which has been produced under less than ideal conditions or which has been abused during handling may have acquired or developed and undesirable flavor.

Consumer acceptance of milk, and particularly the acceptance by children, is greatly affected by flavor. Therefore, it is important that producers and others associated with the dairy industry have full knowledge of the farm factors which have an adverse effect on milk flavor. Following are common flavor defects encountered in raw milk, the contributing factors and procedures which should be practiced to prevent off-flavors and preserve the delicate flavor of fresh milk.

Feed or Weed Flavor

Distinguishing Characteristics:

The milk tastes unnaturally sweet, aromatic or bitter. Flavor may be similar to cabbage, turnips, and other vegetables or it may suggest wild onions, ragweed, bitterweed, peppergrass, buckhorn, wild dog fennel and other weeds. Feed flavors may be detected by the sense of smell and may disappear rapidly from the mouth, leaving no aftertaste. "Weedy" milk may have a strong odor and leave an aftertaste in the mouth.

Contributing Factors:

Strong-flavored feedstuff consumed prior to milking and/or breathing the odors of feedstuff such as sweet clover, alfalfa or soybean silage produces milk which has feed or weed flavors. Normal quantities of

concentrate feeds such as wheat bran, rolled barley, dried beet pulp, coconut meal, soybean meal, cottonseed meal and wet brewer's grains given at milking time do not influence milk flavor. However, when concentrates are fed in quantities of seven pounds or more one to two hours before milking, milk with a slight feed flavor and aftertaste may result. Table 1 shows the relationship between various feeds and the flavor of milk.

Control Measures:

- Take cows off pastures of grass, sweet clover, alfalfa and other strong-flavored feeds or weeds two to four hours before milking.
- Delay feeding of silage, alfalfa hay and other strong-flavored feedstuffs until milking is completed.
- Remove feed not eaten from mangers and feed bunks.
- Keep loaded silage carts out of the milking area until milking is completed.
- Control weed growth in pastures by pasture renovation or by the use of proper herbicides and allow only dry cows and heifers to graze weedy pastures.
- Avoid feeding vegetable crops such as cabbage or turnips.
- In the spring, pasture cows only a few hours each day at the outset to permit a gradual change from winter to spring feed.
- Provide adequate ventilation in the barn and milking area to prevent the accumulation of strong feed odors.

It has been commonly thought that silage and other feed flavors are caused largely by milk absorbing the odors in the milking area. This view is erroneous. Feed flavor results from ingestion of strong feeds by the cow rather than from the milk absorbing the flavor after it has been drawn. However, milk may absorb odors of some fruits, vegetables, chemicals and other volatile materials.

Table 1: The relationship of various feeds to the flavor of milk.

Feed	Amount fed (lbs)	Time fed before milking (hrs)	Effect on milk flavor
Alfalfa - green hay	5	2	Strong feed flavor
Alfalfa - silage	5	1	Slight feed flavor
Alfalfa - silage	20	1	Strong feed flavor
Alfalfa - pasture	--	6	Very slight feed flavor
Barley	5	1	Very slight feed flavor

Beets - pulp	3-4	1	No off-flavor detected
Beets - tops	20	1	Strong feed flavor, reduced by aeration
Cabbage	14	1	Strong feed flavor, reduced by aeration
Carrots	30	1	Very slight feed flavor
Citrus pulp	3-4	1	No off-flavor detected
Citrus pulp	5	1	Slight feed flavor
Clover - hay	5	1	Slight feed flavor
Clover - hay	10	1	Very strong feed flavor, reduced by aeration
Clover - pasture	--	2	No off-flavor detected
Corn - green	25	1	No off-flavor detected
Corn - silage	1	1	Definite feed flavor
Corn - silage	free choice	5	Slight feed flavor
Cottonseed - meal	--	1	No off-flavor detected to very slight
Cowpeas	15	1	Very slight feed flavor
Grass	--	5	Definite feed flavor
Oats	30	1	Very slight feed flavor
Pumpkin	30	1	No off-flavor detected
Rye - green	30	1	Slight feed flavor
Soybean - silage	5	1	Feed flavor
Soybean - green	30	1	Slight improved flavor

Tankage	50	1	No off-flavor detected
Turnip	15	1	Strong feed flavor

Unclean Cowy-Barney Flavor

Distinguishing Characteristics:

The milk has a rather unpleasant, distinct odor and flavor which resembles the odor of a poorly cleaned and ventilated barn. An unclean aftertaste persists in the mouth.

Contributing Factors:

This objectionable flavor results when cows inhale the odors of a damp, unclean, poorly ventilated barn and dirty cows are milked with improperly cleaned and sanitized milk-handling equipment. The general health of the cow(s) may also be a contributing factor.

Control Measures:

- House and milk cows in clean, dry, well ventilated buildings.
- Keep cows clean and wash and dry udders and teats immediately before milking.
- Use clean, properly sanitized milking equipment.
- Avoid contamination of milk with manure and other dirt.
- Identify cows with ketosis or acetonemia and exclude their milk from the milk supply. Cows afflicted with ketosis and acetonemia should be treated by a veterinarian and kept isolated. The urine from such cows emits an offensive odor which is transmitted to the milk when inhaled by healthy cows.

Rancid Flavor

Distinguishing Characteristics:

The milk has a sharp, unclean, astringent taste that persists in the mouth. Rancid milk is often bitter or soapy and has an odor resembling spoiled nut meats when the flavor is intense.

Contributing Factors:

Milkfat is practically flavorless. Rancid flavor develops when the fat globules in raw milk are disrupted and the milkfat is exposed. The enzyme, lipase, will react with the fat and produce highly flavored free fatty acids. Excessive agitation of warm milk in the presence of air, which causes foaming, and temperature fluctuation such as cooling

milk to 50°F or below, warming it to about 86°F and then cooling it again are conditions which aid rancid flavor developmeet. The off-flavor is encountered most frequently in winter milk when cows are on dry feed and in milk from cows in late lactation. Milk from individual cows varies markedly in susceptibility to become rancid.

Control Measures:

- Select high producing cows and milk rapidly.
- Eliminate as much air as possible from pipelines during milking and periodically check the milking system for leaky fittings.
- Eliminate risers in pipelines where practical, keep the number and height of risers to a minimum, and maintain as high a rate of milk in the presence of air, which causes foaming, and adequate cooling for raw milk and maintain the bulk tank in good working order to insure that milk is cooled rapidly and that the blend temperature does not exceed 50°F when warm milk is added to cold.
- Do not freeze raw milk nor hold it at excessively low temperatures (below 35°F).
- Avoid excessive agitation of milk in centrifugal pumps by proper maintenance of the controls which cause the pump to run only when the pump chamber is full.
- Dry off cows when production drops to 20 pounds per day, or when cows are within six weeks of freshening.
- Feed green succulent feeds when available.
- Cull those cows whose milk is subject to spontaneous rancid flavor development.

Oxidized Flavor

Distinguishing Characteristics:

The milk has a tallowy, metallic or cardboard like off-flavor. The off-flavor may be detected by smell but it is better identified by taste. Oxidized flavor is most prevalent during late winter and early spring after cows have been on a dry ration for a prolonged period.

Contributing Factors:

Contamination of milk with copper, iron, rust, chlorine, exposure to sunlight and excessive incorporation of air are factors known to contribute to the development of oxidized flavor. The milk from some cows becomes oxidized spontaneously.

Control Measures:

- Use only milk handling equipment with milk contact surfaces

constructed of stainless steel, glass, plastic, or rubber. Avoid milk handling equipment constructed of copper-bearing metals such as brass, nickel, "white metal," and poorly tinned or rusty cans, strainers and pails.

- Use water free of copper and iron for cleaning milk contact surfaces.
- Maintain cows in a good state of nutrition.
- Feed green, succulent feeds containing Vitamin E. In many instances oxidized flavor development may be inhibited by feeding cows, in the concentrate, one to two grams of alpha-tocopherol acetate, a stable form of Vitamin E, per cow per day.
- Protect milk in transparent pipelines and receiving jars from sunlight and strong artificial light.
- Avoid excessive agitation and foaming of raw milk.
- Completely drain chlorine sanitizing solutions from all lines and equipment before use.
- Identify and cull cows producing milk susceptible to spontaneous oxidized flavor development.

Malty Flavor

Distinguishing Characteristics:

The milk has a malty or grapenutlike flavor.

Contributing Factors:

Malty flavor results from bacterial growth. Contamination may be from improperly washed or sanitized milking machines and other milk handling equipment, dirty pulsators and air hoses, the cow's teats and the environment. Bacterial growth occurs when milk is cooled slowly and improperly, for example, due to under-sized or malfunctioning equipment.

Control Measures:

- Clean all milk-handling equipment after each use.
- Select the proper cleaning compound based on prevailing water conditions and use according to the manufacturer's recommendations.
- Acidify the rinse water, where water is hard, to prevent the formation of waterstone (white film) on equipment.
- Sanitize all milk contact surfaces of milking machines and milk-handling equipment just prior to milking.
- Protect milk from contamination with soil, bedding and other

extraneous material.

- Have a properly engineered refrigeration system which will cool the total herd output to 40°F or below within two hours after milking during the season of maximum production. The cooling system must also be of such capacity that the temperature of the milk does not exceed 50°F when milk is added at subsequent milkings.
- Have the refrigeration system serviced regularly to assure adequate cooling and continuous operation.
- Avoid delays in milk shipment and prolonged holding of raw milk even at low temperature.

High Acid Flavor

Distinguishing Characteristics:

The milk has an unpleasant, disagreeable odor and an acid or sour taste.

Contributing Factors:

High acid flavor, like malty, results when milk is heavily contaminated with bacteria and the bacteria is permitted to grow.

Control Measures:

See control measures for malty flavor.

Foreign Flavor

Distinguishing Characteristics:

Foreign flavor includes a variety of sensations. The term is generally used to describe the flavor of milk which has absorbed or been contaminated with chemicals.

Contributing Factors:

Cows may have consumed or inhaled fumes from foreign materials, or a foreign material may have directly contaminated the milk. Common sources of contaminatin include medications, disinfectants, sanitizers, fly sprays, gasoline and other petroleum products, and many other materials and compounds commonly used on the farm.

Control Measures:

- Keep foreign materials away from or out of the milk.
- Prevent cows from consuming and inhaling the odor from foreign materials.

- Use medications, insecticides, disinfectants and similar materials with caution and according to directions.

Dairymen who need help in identifying the source or cause of off-flavors in their milk may contact their fieldman or the Department of Food Science and Nutrition, Ohio State University, for assistance.

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Clover - hay	10	1	Very strong feed flavor, reduced by aeration
Clover - pasture	--	2	No off-flavor detected
Corn - green	25	1	No off-flavor detected
Corn - silage	1	1	Definite feed flavor
Corn - silage	free choice	5	Slight feed flavor

Cottonseed - meal	--	1	No off-flavor detected to very slight
Cowpeas	15	1	Very slight feed flavor
Grass	--	5	Definite feed flavor
Oats	30	1	Very slight feed flavor
Pumpkin	30	1	No off-flavor detected
Rye - green	30	1	Slight feed flavor
Soybean - silage	5	1	Feed flavor
Soybean - green	30	1	Slight improved flavor
Tankage	50	1	No off-flavor detected
Turnip	15	1	Strong feed flavor

Unclean Cowy-Barney Flavor

Distinguishing Characteristics:

The milk has a rather unpleasant, distinct odor and flavor which resembles the odor of a poorly cleaned and ventilated barn. An unclean aftertaste persists in the mouth.

Contributing Factors:

This objectionable flavor results when cows inhale the odors of a damp, unclean, poorly ventilated barn and dirty cows are milked with improperly cleaned and sanitized milk-handling equipment. The general health of the cow(s) may also be a contributing factor.

Control Measures:

- House and milk cows in clean, dry, well ventilated buildings.
- Keep cows clean and wash and dry udders and teats immediately before milking.
- Use clean, properly sanitized milking equipment.
- Avoid contamination of milk with manure and other dirt.
- Identify cows with ketosis or acetonemia and exclude their milk from the milk supply. Cows afflicted with ketosis and acetonemia should be treated by a veterinarian and kept isolated. The urine from such cows emits an offensive odor which is transmitted to the milk when inhaled by healthy cows.

Rancid Flavor

Distinguishing Characteristics:

The milk has a sharp, unclean, astringent taste that persists in the mouth. Rancid milk is often bitter or soapy and has an odor resembling spoiled nut meats when the flavor is intense.

Contributing Factors:

Milkfat is practically flavorless. Rancid flavor develops when the fat globules in raw milk are disrupted and the milkfat is exposed. The enzyme, lipase, will react with the fat and produce highly flavored free fatty acids. Excessive agitation of warm milk in the presence of air, which causes foaming, and temperature fluctuation such as cooling milk to 50°F or below, warming it to about 86°F and then cooling it again are conditions which aid rancid flavor developmeet. The off-flavor is encountered most frequently in winter milk when cows are on dry feed and in milk from cows in late lactation. Milk from individual cows varies markedly in susceptibility to become rancid.

Control Measures:

- Select high producing cows and milk rapidly.
- Eliminate as much air as possible from pipelines during milking and periodically check the milking system for leaky fittings.
- Eliminate risers in pipelines where practical, keep the number and height of risers to a minimum, and maintain as high a rate of milk in the presence of air, which causes foaming, and adequate cooling for raw milk and maintain the bulk tank in good working order to insure that milk is cooled rapidly and that the blend temperature does not exceed 50°F when warm milk is added to cold.
- Do not freeze raw milk nor hold it at excessively low temperatures (below 35°F).
- Avoid excessive agitation of milk in centrifugal pumps by proper maintenance of the controls which cause the pump to run only when the pump chamber is full.
- Dry off cows when production drops to 20 pounds per day, or when cows are within six weeks of freshening.
- Feed green succulent feeds when available.
- Cull those cows whose milk is subject to spontaneous rancid flavor development.

Oxidized Flavor

Distinguishing Characteristics:

The milk has a tallowy, metallic or cardboard like off-flavor. The off-flavor may be detected by smell but it is better identified by taste. Oxidized flavor is most prevalent during late winter and early spring after cows have been on a dry ration for a prolonged period.

Contributing Factors:

Contamination of milk with copper, iron, rust, chlorine, exposure to sunlight and excessive incorporation of air are factors known to contribute to the development of oxidized flavor. The milk from some cows becomes oxidized spontaneously.

Control Measures:

- Use only milk handling equipment with milk contact surfaces constructed of stainless steel, glass, plastic, or rubber. Avoid milk handling equipment constructed of copper-bearing

metals such as brass, nickel, "white metal," and poorly tinned or rusty cans, strainers and pails.

- Use water free of copper and iron for cleaning milk contact surfaces.
- Maintain cows in a good state of nutrition.
- Feed green, succulent feeds containing Vitamin E. In many instances oxidized flavor development may be inhibited by feeding cows, in the concentrate, one to two grams of alpha-tocopherol acetate, a stable form of Vitamin E, per cow per day.
- Protect milk in transparent pipelines and receiving jars from sunlight and strong artificial light.
- Avoid excessive agitation and foaming of raw milk.
- Completely drain chlorine sanitizing solutions from all lines and equipment before use.
- Identify and cull cows producing milk susceptible to spontaneous oxidized flavor development.

Malty Flavor

Distinguishing Characteristics:

The milk has a malty or grapenutlike flavor.

Contributing Factors:

Malty flavor results from bacterial growth. Contamination may be from improperly washed or sanitized milking machines and other milk handling equipment, dirty pulsators and air hoses, the cow's teats and the environment. Bacterial growth occurs when milk is cooled slowly and improperly, for example, due to under-sized or malfunctioning equipment.

Control Measures:

- Clean all milk-handling equipment after each use.
- Select the proper cleaning compound based on prevailing water conditions and use according to the manufacturer's recommendations.
- Acidify the rinse water, where water is hard, to prevent the formation of waterstone (white film) on equipment.
- Sanitize all milk contact surfaces of milking machines and milk-handling equipment just prior to milking.
- Protect milk from contamination with soil, bedding and other extraneous material.
- Have a properly engineered refrigeration system which will cool the total herd output to 40°F or below within two hours after milking during the season of maximum production. The cooling system must also be of such capacity that the temperature of the milk does not exceed 50°F when milk is added at subsequent milkings.
- Have the refrigeration system serviced regularly to assure adequate cooling and continuous operation.
- Avoid delays in milk shipment and prolonged holding of raw milk even at low temperature.

High Acid Flavor

Distinguishing Characteristics:

The milk has an unpleasant, disagreeable odor and an acid or sour taste.

Contributing Factors:

High acid flavor, like malty, results when milk is heavily contaminated with bacteria and the bacteria is permitted to grow.

Control Measures:

See control measures for malty flavor.

Foreign Flavor

Distinguishing Characteristics:

Foreign flavor includes a variety of sensations. The term is generally used to describe the flavor of milk which has absorbed or been contaminated with chemicals.

Contributing Factors:

Cows may have consumed or inhaled fumes from foreign materials, or a foreign material may have directly contaminated the milk. Common sources of contaminatin include medications, disinfectants, sanitizers, fly sprays, gasoline and other petroleum products, and many other materials and compounds commonly used on the farm.

Control Measures:

- Keep foreign materials away from or out of the milk.
- Prevent cows from consuming and inhaling the odor from foreign materials.
- Use medications, insecticides, disinfectants and similar materials with caution and according to directions.

Dairymen who need help in identifying the source or cause of off-flavors in their milk may contact their fieldman or the Department of Food Science and Nutrition, Ohio State University, for assistance.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

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Johne's Disease (Paratuberculosis)

Johne's disease, or Paratuberculosis, is a chronic infection of the intestinal tract of ruminants. Infections have been found in cattle, sheep, goats and some species of wild ruminants. Johne's disease is caused by a species of bacteria known as *Mycobacterium Paratuberculosis.*

How is this infection spread?

The major known method of spread is fecal-oral; this means the animal usually ingests the bacteria through feed or water contaminated with infected feces. In calves, this may occur when they first nurse their dam. Apparently, there is an age-related resistance to Johne's Disease. Calves under one year old are most susceptible. Older heifers are less susceptible and adult cows are resistant to infection. Other possible, though less common, routes of infection include semen (via natural service) and pregnant dam to fetus (in utero).

How widespread is Johne's Disease?

The exact answer to this question is unknown. For example, separate slaughter surveys have indicated that as few as 2 percent to as many as 17 percent of culled Ohio cattle may be infected with *Mycobacterium Paratuberculosis*. While many individual herds are undoubtedly free of infection, some herds may harbor the infectious agent in 50 percent of the adult animals.

What are the signs of Johne's Disease?

Following exposure, some animals apparently "clear" the bacteria and

remain totally free of infection. Others may become infected and periodically shed bacteria in their feces but never develop clinical signs of the disease. Some herds, however, may lose 5-10 percent of their adult cattle annually to clinical Johne's.

For those cattle that are exposed and eventually develop clinical signs, Johne's Disease is different than many other diseases. The time from exposure to development of signs is long and may range from 1-13 years. It is common for heifers to develop Johne's signs following the stress of the first or second freshening.

The initial clinical sign is the development of diarrhea. The diarrhea may be either continuous or of an intermittent nature. In addition to diarrhea, there is extreme weight loss and, eventually, death. Some animals may have a low-grade fever and develop edema under the jaw as diarrhea progresses. There is some evidence which indicates that animals with subclinical Johne's (i.e. without diarrhea) may experience reduced milk production and suboptimal fertility.

How do I know if Johne's Disease is in my herd?

Obtaining a rapid, reliable diagnosis is possibly the major problem in controlling Johne's Disease. Basing the diagnosis of a herd entirely on clinical signs could be misleading. Other disease agents can cause a similar type of diarrhea. Furthermore, an animal could be shedding Johne's bacteria (Mycobacterium Paratuberculosis) in its feces, contaminating the environment, yet be visibly normal.

Currently, the most reliable diagnostic test is the bacteriologic culture of feces. A drawback to the fecal culture is that is doesn't allow detection of infected animals that are not shedding bacteria. Another drawback is the time it takes to determine the results, 12-18 weeks.

Two serum tests, AGID and ELISA are available; currently, both have serious shortcomings. The AGID test is very accurate when an animal has clinical Johne's, and many veterinarians use AGID to obtain an early diagnosis on a suspect diarrheic animal. This test has a 48 hour turnaround; an advantage over the 12-18 week time-lag with fecal cultures. For use in herd control programs, AGID is not sensitive when an animal is infected but visibly normal: AGID is likely to misclassify a shedding or non-shedding animal that is still clinically normal as negative.

The ELISA tests currently available falsely classify some noninfected animals as infected and some infected animals as noninfected. Hopefully, improvements in test methods and standardization will enhance the usefulness of the ELISA.

In the future, other improved tests may be developed for practical use in diagnosis. For example, DNA probes for detection of *Mycobacterium Paratuberculosis* in feces have been developed and used experimentally. At this time (September 1988), work is being completed to determine how applicable DNA probes will be for diagnostic use and in herd control programs.

How resistant is *Mycobacterium Paratuberculosis* to treatment?

The Johne's bacteria is very resistant to antibiotics. Treatment of animals with Johne's is not advisable. Generally, the most economically sound decision is to market clinically affected cattle as soon as possible. Johne's infected cattle will usually pass slaughter if they are not severely thin or debilitated.

In the environment, Mycobacterium Paratuberculoses is extremely hardy. It can survive in soil, manure and water for more than a year. It is resistant to many common disinfectants. On clean surfaces, however, it is quickly destroyed by direct sunlight. As with most other infectious diseases, there is no substitute for cleanliness when considering Johne's control.

Is there a vaccine available?

A vaccine is available. In Ohio, it must be administered by an accredited veterinarian. Permission and guidelines for its use on a farm must be obtained from the State Veterinarian. The vaccine helps reduce shedding of bacteria and clinical signs when coupled with good management. The vaccine will not totally prevent infection, however. As with many other diseases, vaccination may be a portion of a disease control or reduction program but not the total answer.

Does Ohio have an eradication or control program?

No official federal or Ohio programs exist at the present time. Several other states do have programs in place. Most programs, in addition to stressing hygiene and management, rely upon periodic fecal culturing to identify shedding animals and subsequent culling of these animals from the herd. Some states allow vaccination; others do not. It is too early to tell how effective these programs will be.

What if Johne's Disease is diagnosed in my herd?

First assess the probability or extent of additional infected animals

present in your herd. For example, was the affected cow purchased as a springing heifer or raised as a natural addition to your herd? If she was home-raised, given the fact that infection occurs early in life, there is a likelihood that additional herd mates have been exposed. If she was purchased as a springer and not exposed to your farm's young stock it is possible that spread may not have occurred. Your veterinarian may or may not recommend additional herd testing at the time of the initial diagnosis depending on the circumstances.

Total eradication of Johne's, given currently available diagnostic tests and knowledge, may not be economically feasible in commercial herds. However, a more intensive intervention program may be warranted in herds that merchandise breeding stock. Herds that can demonstrate test-negative status may command premiums on animals offered for sale or export. Regardless of your herd's present infection status, institution of a control or prevention program does make economic sense in all dairy herds.

Reduce exposure of susceptible animals. In any Johne's control or eradication program, complete commitment and cooperation between herd owners, managers, caretakers and veterinarians is vital.

Management Recommendations for Control of Johne's Disease in a Dairy Herd.

1. To reduce environmental contamination, identify and remove from the herd those adults that are shedding *Mycobacterium Paratuberculosis.* Fecal culture, although not perfect, is the diagnostic test favored at this time as it is the only test that identifies shedders. The extent and pattern of culturing in a herd is best determined by consultation with your veterinarian.
2. Freshen in a sanitary area—outside is best, weather permitting. Remove the calf from its dam as soon as possible. Don't let the calf nurse. Hand feed colostrum obtained from a thoroughly cleaned udder. Using milk replacer may lower the exposure of young calves in infected herds. Alternatively, some large herds have installed pasteurizers to use on discard milk for feeding calves.
3. Raise young stock away from adults. Remember that adults are possible carriers of infective bacteria and that animals less than 12 months old are susceptible. Have a separate person care for the calves or feed them before handling the adult animals. Break the habit of feeding calves after the morning milking.
4. The bacteria that causes Johne's is hardy and is spread through manure from adult cattle. Do not spread manure on pastures or graze heifers on pastures previously used by adults. Watch drainage from adult barnyards to heifer lots or heifer water

supplies. Fence off ponds that have become contaminated by barnyard drainage.

5. Isolate unthrifty animals or animals showing diarrhea. Work closely with your veterinarian to obtain an accurate diagnosis of all diseases.
6. High risk animals. Progeny from infected cows should be regarded at greater risk of being infected themselves and considered for potential culling or at least for greater surveillance. Exposure during the birth process is likely and the possibility of intrauterine infection of the fetus exists. The consequences of fetal infection are not yet known.
7. If you don't have Johne's Disease in your herd DON'T BUY IT. For the prevention of Johne's and other contagious diseases it makes good sense to use Artificial Insemination. If you do purchase bulls or replacement females, know as much about the source as possible. At least two national breed organizations have instituted programs designed to reduce the chances of purchasing an infected animal. In other cases, screen testing of the seller's herd prior to purchase has been advocated by some experts. However, if you do purchase stock, maintain these animals away from your own young stock and institute recommendations 1-5 above.

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Milk Heat Recovery

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Milk Heat Recovery

Warm water for washing the udders of dairy cows and hot water for washing and sanitizing milk handling equipment are required for the operation of a modern, commercial dairy farm. Heating the water for these purposes requires about one-third of the electrical energy that is used in a dairy operation. A significant portion of this expense can be economically eliminated through the use of waste heat recovery from the milk refrigeration system. At the same time, valuable energy can be saved.

Basic Facts

Milk contains valuable energy: In this country, the most common unit of thermal energy (heat) is the the BTU (British Thermal Unit). A BTU is the amount of energy needed to heat one pound of water (or milk) by one degree Fahrenheit. This energy also becomes available as milk is cooled. A cow produces milk at about 102° F. When this milk is cooled to about 37°F for storage (a difference of 65°F), 65 BTUs of heat per pound of milk must be removed. Thus, if a cow produces 50 pounds of milk a day, 3250 BTUs of energy are available per day per animal.

A refrigerator transfers heat from a cold area to a warm one: All refrigeration units operate by pumping a special fluid around in a loop. This loop has a hot end and a cold end. At the cold end, the refrigeration fluid is at a low pressure and evaporates as it absorbs heat. It is then compressed to a hot, high pressure state and condenses as it gives off heat. In this way, heat taken from the milk is transferred to room air and often wasted.

Refrigeration Heat Recovery

While refrigeration heat must be removed from the condenser, there is no need to waste it. Commercial equipment is available that economically recovers part of this heat. This equipment falls into two basic categories: Desuperheating units and fully condensing units.

Desuperheating Units

Desuperheating units can be inexpensively added to existing refrigeration equipment: In order to recover part of the heat in the refrigeration fluid, the hot vapor must be passed through a coil in a heat exchanger before it goes through the condenser. At the same time, cold water must be pumped through an adjoining coil in the heat exchanger so that heat is conducted from the hot refrigeration fluid to the cold water. This produces warm water, typically 95 to 105°F, that is stored until it is needed. Thus, the system is very simple. The heat exchanger pump operates only when the refrigeration unit operates, and all the refrigeration control functions remain connected to the condenser fan. However, this system can use only part of the available heat, typically 40 to 50 percent, to warm process water.

Fully Condensing units

Fully condensing units replace the condenser of an ordinary refrigeration system: A fully condensing unit is completely water cooled and eliminates the need for an ordinary, air cooled condenser. Nearly 100 percent of the available refrigeration heat is recovered from such a unit as hot water, typically at 120°F to 140°F. However, this heat recovery equipment must be properly adjusted to the requirements of the refrigeration system. It probably should be adapted only as an integral part of a new or replacement refrigeration unit.

A valve controls the flow of cold water through the heat exchanger so that this flow meets the requirements of the refrigeration system. This cold water, either from the bottom of the storage tank or from the cold water inlet, is needed to condense the hot vapor into cooler liquid refrigerant while absorbing and carrying away the heat of condensation. If this doesn't occur, the pressure and temperature of the refrigeration fluid will rise and the compressor will soon become damaged. As long as there is cool water in the bottom of the storage tank, the pump will circulate this water through the heat exchanger and the warmed water is stored for future use. However, once the storage tank is fully heated, another valve opens and excess warm water is discharged from the system while additional cold water is drawn into it to supply the needed cooling. This excess warm water can be used in the home, given to the cows as drinking water in the winter or put to other use on the farm. It does not have to be wasted.

Economics of Refrigeration Heat Recovery

The value of heat recovery depends on the size of the herd being milked and on the cost of the energy being replaced. It is convenient to express energy costs in terms of the amount that must be paid for a million BTUs (MBTU) of energy used to heat water.

Electricity is the most expensive way to heat water. However, it is frequently the only convenient method available to a dairy operator.

The amount of heat used for hot water on a dairy farm and the amount of heat that can be recovered from the refrigeration system both depend on the number of cows being milked. A large herd requires more energy input and produces more milk output than a small one. Consequently, a large dairy operation has more expense for energy to heat water and greater potential for saving on this expense.

Equipment Available

Most dairy equipment companies now supply refrigeration heat recovery equipment. Typically, this equipment is of the add-on, desuperheating type that can be adopted at any time. As noted previously, such equipment is generally economical and its adoption is recommended. In addition, some dairy equipment companies supply fully condensing refrigeration systems. Such equipment is more efficient in energy collection than the desuperheating units and can save more money. However, such equipment is considerably more expensive and will only be economical if a new refrigeration system is required for other than energy conservation reasons. In either case, you should consult your dairy equipment supplier to find out what equipment will best fit your needs.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Dairy Development in Sub-Saharan Africa : A Study of Issues and Options (World Bank Technical Paper, Africa Technical Department Series, No 135) - by Michael J. Walshe - Publication Date: March 1991 - List: $7.95 + $1.35 special surcharge
- Milk Quotas : European Community and United Kingdom Law - by Michael Cardwell - Publication Date: July, 1996 - List: $82.00
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Milk Heat Recovery

Warm water for washing the udders of dairy cows and hot water for washing and sanitizing milk handling equipment are required for the operation of a modern, commercial dairy farm. Heating the water for these purposes requires about one-third of the electrical energy that is used in a dairy operation. A significant portion of this expense can be economically eliminated through the use of waste heat recovery from the milk refrigeration system. At the same time, valuable energy can be saved.

Basic Facts

Milk contains valuable energy: In this country, the most common unit of thermal energy (heat) is the the BTU (British Thermal Unit). A BTU is the amount of energy needed to heat one pound of water (or milk) by one degree Fahrenheit. This energy also becomes available as milk is cooled. A cow produces milk at about 102° F. When this milk is cooled to about 37°F for storage (a difference of 65°F), 65 BTUs of heat per pound of milk must be removed. Thus, if a cow produces 50 pounds of milk a day, 3250 BTUs of energy are available per day per animal.

A refrigerator transfers heat from a cold area to a warm one: All refrigeration units operate by pumping a special fluid around in a loop. This loop has a hot end and a cold end. At the cold end, the refrigeration fluid is at a low pressure and evaporates as it absorbs heat. It is then compressed to a hot, high pressure state and condenses as it gives off heat. In this way, heat taken from the milk is transferred to room air and often wasted.

Refrigeration Heat Recovery

While refrigeration heat must be removed from the condenser, there is no need to waste it. Commercial equipment is available that economically recovers part of this heat. This equipment falls into two basic categories: Desuperheating units and fully condensing units.

Desuperheating Units

Desuperheating units can be inexpensively added to existing refrigeration equipment: In order to recover part of the heat in the refrigeration fluid, the hot vapor must be passed through a coil in a heat exchanger before it goes through the condenser. At the same time, cold water must be pumped through an adjoining coil in the heat exchanger so that heat is conducted from the hot refrigeration fluid to the cold water. This produces warm water, typically 95 to 105°F, that is stored until it is needed. Thus, the system is very simple. The heat exchanger pump operates only when the

refrigeration unit operates, and all the refrigeration control functions remain connected to the condenser fan. However, this system can use only part of the available heat, typically 40 to 50 percent, to warm process water.

Fully Condensing units

Fully condensing units replace the condenser of an ordinary refrigeration system: A fully condensing unit is completely water cooled and eliminates the need for an ordinary, air cooled condenser. Nearly 100 percent of the available refrigeration heat is recovered from such a unit as hot water, typically at 120°F to 140°F. However, this heat recovery equipment must be properly adjusted to the requirements of the refrigeration system. It probably should be adapted only as an integral part of a new or replacement refrigeration unit.

A valve controls the flow of cold water through the heat exchanger so that this flow meets the requirements of the refrigeration system. This cold water, either from the bottom of the storage tank or from the cold water inlet, is needed to condense the hot vapor into cooler liquid refrigerant while absorbing and carrying away the heat of condensation. If this doesn't occur, the pressure and temperature of the refrigeration fluid will rise and the compressor will soon become damaged. As long as there is cool water in the bottom of the storage tank, the pump will circulate this water through the heat exchanger and the warmed water is stored for future use. However, once the storage tank is fully heated, another valve opens and excess warm water is discharged from the system while additional cold water is drawn into it to supply the needed cooling. This excess warm water can be used in the home, given to the cows as drinking water in the winter or put to other use on the farm. It does not have to be wasted.

Economics of Refrigeration Heat Recovery

The value of heat recovery depends on the size of the herd being milked and on the cost of the energy being replaced. It is convenient to express energy costs in terms of the amount that must be paid for a million BTUs (MBTU) of energy used to heat water.

Electricity is the most expensive way to heat water. However, it is frequently the only convenient method available to a dairy operator.

The amount of heat used for hot water on a dairy farm and the amount of heat that can be recovered from the refrigeration system both depend on the number of cows being milked. A large herd requires more energy input and produces more milk output than a small one. Consequently, a large dairy operation has more expense for energy to heat water and greater potential for saving on this expense.

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Frequently Asked Questions:

Other Information Sources:

Milking Equipment

Frequently Asked Questions Other Information Sources Return to Dairy Contents

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Milking Equipment

The milking machine is the most important piece of equipment on the dairy farm. It is used more often and more hours per year than any other piece of equipment, including the farm tractor.

Machine Components

There are five basic components of the milking machine: the vacuum pump, vacuum controller or regulator, pulsator, teat cup shell and teat cup liner or inflation. Other parts of the system such as the balance tank, lines, vacuum gauge, sanitary trap, etc. are accessories to these main components.

Vacuum pump:

The function of the vacuum pump is to remove air from a closed system, thereby creating a partial vacuum. Atmospheric air creates a pressure on all surfaces, and when measured with a manometer will cause mercury to rise in a column to 29.92 inches at sea level. This is called barometric pressure. The vacuum pump creates a partial vacuum by removing most of the air from a closed system, thus reducing the pressure of the air. The difference between the almost 30 inches of mercury at atmospheric pressure and the reduced air pressure is the vacuum created and is expressed in inches of mercury.

The size of the vacuum pump is usually expressed in terms of cubic feet of air removed from the system per minute (CFM). The CFM rating of vacuum pumps is measured in one of two ways: The ASME Standard (the pump ratings designated by the American Society of Mechanical Engineers and adopted by the Milting Machine Manufacturers' Council of the Farm Equipment Institute); and The New Zealand Standard.

The two methods measure the volume of air at different pressures. The American Standard is based upon the volumetric delivery rate at normal atmospheric pressure of about 30 inches of mercury, while the New Zealand Standard is based upon the volume of air delivered at the reduced pressure of 15 inches of mercury. Two volume units of air at 15 inches of vacuum (1/2 an atmosphere) equal one volume unit of air at atmospheric pressure. Thus, 1 CFM ASME Standard = 2 CFM New Zealand Standard. Boumatic and Surge pumps are rated by the New Zealand Standard, while the ASME standard is used to rate the pumps of most other companies.

The CFM required to operate a milking installation depends upon the amount of air introduced into the vacuum system, which in turn depends on the number of milker units used, the size of the milk and vacuum lines, the number and sizes of auxiliary milking equipment such as weigh jars and milk metering devices, the amount of air leakage into the system, and the efficiency of the operator. If there are vacuum operated accessories such as doors and gates, a separate system should operate them.

Current recommendations for vacuum pump size needed are based upon research in Pennsylvania and New York. They are shown in the following tables:

For stall barns with pipelines and parlors with swing units.

Number of Units	Pump CFM (ASME) Capacity
2	36
4	42
6	52
8	66
10	80

For parlors with milker units at each stall.

Number of Units	Pump CFM (ASME) Capacity
6	48
8	56
12	78
16	100
20	112
24	120

While these tables are helpful in determining vacuum pump size needed, the critical value needed in a system is the reserve air capacity. With all the equipment set-up ready to milk, there should be between 3 and 5 cfm (ASME) reserve air per milker unit.

The vacuum pump and the power unit should be installed as close as possible and practicable to the milking area. Such locations as a feed

room or near a haymow chute should be avoided. The exhaust from the pump should be piped to the outside of the building through a pipe whose diameter is at least as great as that of the pump's intake port. Mufflers or silencers should not be used, since they reduce effective pumping capacity. On some pumps, mufflers may perform other functions such as filtering or reducing theoil film, which may be exhausted with the air. Since oil is present in most exhausts, the exhaust should be directed downward and away from the side of the building. This prevents rain water from entering the exhaust pipe and pump, and also prevents accumulation of oil and dirt on the side of the building.

Servicing the pump should be performed as directed in the service manual. Maintaining the oil level in the pump or supply cup and checking the belt for proper alignment and tension are the two most important maintenance procedures. These should be done every two weeks. Recommended annual or semi-annual service checks will vary with the pump and the manufacturer's specifications.

Vacuum controller (regulator):

The vacuum controller admits air into the milking system to maintain a set maximum vacuum on the pulsator and milk lines. The CFM rating of the controller must be equal to or greater than the vacuum pump capacity. A controller that is too small may result in an excessively high vacuum level which could cause damage to the teats.

Weight-type regulators usually do not provide the vacuum stability desired. They should be replaced with the newer style regulators available.

Controllers should be installed in a clean area where moisture and dirt will not affect their proper operation, and where they will not freeze in cold weather if condensation accumulates in them.

Vacuum controllers should be located between the cow and the pump. In the bucket milking system the controllers should be placed between the pump and the first stall cock opening. In the pipeline system the controllers should be placed between the vacuum pump and the trap. Controllers are often located near or on the vacuum reserve tank. Some people think controllers should be located as close to the cow as possible. By Ohio Health Department regulation, the closest point the controller can be located to the milk line side is at the sanitary trap. For this reason, locate the trap and receiving jar as close to the cow as possible. Locate controllers where the air admitted into them is relatively clean. Easy accessibility is important for routine observation and maintenance.

Controllers are not needed on the pulsator line, if the pulsator line is

fully looped to the balance tank and the controllers are mounted on the tank. If there is a controller on the pulsator line, it should control the vacuum level at the same level as the controllers on the milk line. Different vacuum levels on the two lines is an imbalance that should be avoided.

Check and clean the controller at least every two weeks. Accumulation of dirt in the valve is one of the primary causes of malfunction. The manufacturer's recommendations for maintenance and service should be closely followed.

Pulsator:

The function of pulsators is to alternate the space between the teat cup shell and teat cup liner between a partial vacuum (milking phase) and atmospheric air pressure (rest phase). During the milking phase, the space between the inflation and shell, and the space inside the inflation have the same partial vacuum. This causes the inflation to open and milk to flow from the teat. Milk flows from the teat because the pressure inside the udder is greater than that outside the teat end.

During the rest phase, air at normal atmospheric pressure,enters between the shell and inflation. Due to the partial vacuum inside the inflation, the inflation collapses around the teat. The pressure of the collapsed inflation helps massage the teat, preventing congestion of blood and body fluids in the teat skin and tissue.

The number of times per minute that the pulsator alternates between the milking and rest phase is called the **pulsation rate.** Rates vary from about 40 to 80 pulsations per minute, depending upon the manufacturer. A rate between 50 to 60 is recommended.

The ratio of time the inflation is in the milking phase to the time it is in the rest phase is called the **pulsation ratio.** Ratios vary by manufacturer, from 50:50 to about 70:30. Cows will usually milk slightly faster with a wider ratio. However, the longer milk phase and shorter rest phase may cause teat end trauma and damage if the milking equipment is not working properly and good milking practices are not followed. Ratios closer to 60:40 are less likely to contribute to problem situations.

The closing patterns of the inflations varies by manufacturer. Some have all four inflations of a claw closing at once (simultaneous), while others have an alternating pattern (only two inflations close at a time). The alternating pattern results in less claw flooding in units with a small claw. In units with larger claws that do not flood, alternating pulsation is not as important. Claw flooding (filling) is not desired, for it causes vacuum fluctuation at the teat end. This, in turn, can result in teat end

injury and the back flushing of milk into the teat. The introduction of mastitis causing organisms into the udder can occur in such a situation.

Pulsators are controlled either by electricity or air (pneumatically) or a combination of the two. Electrically controlled units are preferred because of their more consistent action. Pneumatically operated units are more unreliable and require more maintenance. It is recommended that when four or more units are being used, the electric pulsators be wired on two or more circuits to prevent them from being in the same phase. This can help prevent cyclic vacuum fluctuations on the pulsator line.

A new type of milking unit from New Zealand has the pulsator mounted directly on top of the claw. It operates by vacuum and not by air or electricity. At this time, research studies evaluating the units are lacking.

Teat cup shell and teat cup liner (inflation):

These two components form the pulsating chamber which allows milk to be removed from the teat. The shell size used should correspond to the inflation size. Most companies recommend the use of narrow bore liners (3/4 inch or less in internal diameter). They have less tendency to climb the teats, especially towards the end of milking, which can shut off milk flow from the udder into the teats and can also cause udder trauma at the base of the teats. Special types of inflations having features such as being square, having ribbed sides, or special kinds of tops have not been evaluated in controlled experiments. Many dairymen have used them successfully.

Air inlets are available to admit air into the tail piece of the liner (vented inflation). This is done in an attempt to avoid claw and tail piece flooding with milk. Most manufacturers have attempted to control claw flooding by admitting air into the claw. Vented inflations may cause problems in systems that have inadequate reserve air flow. Observations also indicate that inlets are not satisfactory when used in liners with a high collapse differential. While many dairymen are successfully using vented inflations, objective information for recommending their use is lacking. If they are used, the air inlet in the claw should be closed.

Research in New Zealand and Germany is in progress to design and develop a milking claw without inflations. Perhaps such a unit will be perfected and available in the future.

Interconnecting Parts and Their Relationship to Machine Function

Claws: Claws should be of adequate size to avoid flooding. Most claws admit air to aid in preventing flooding. Claws or breaker cups should not have filters. Be sure the ferrules (tubes where the liners are attached to the claw) are not bent or damaged. If they are, blockage of milk flow from the teat cup can occur, resulting in slow milking and teat irritation.

Long Milk Hose: Be sure the long milk hose is in good condition, does not leak, is not too long and does not contain a filter. Do not let it hang lower than the cows udder before elevating it, or do not elevate it before dropping into a low line or weigh jar.

Milk Inlets: Place milk inlets on the upper half of the line. This prevents them from being covered with milk, which can cause undesired vacuum fluctuation.

Milk Line: Place milk lines below the cows udder so that milk is not elevated. If weigh jars are used, a low line is not necessary. Low-lines allow for less claw and milk hose flooding during peak milk flow. This in turn reduces vacuum fluctuation, which can cause teat-end erosion, slow milking and perhaps predispose cows to mastitis. The line should be of adequate size for the number of units and the number of inlets into the receiving jar. Loop all milk lines to the receiver jar. Recommended line sizes are as follows:

Size of Milk Line	Number of Units Single Slope	Number of Units Double Slope
11/2 inches	2	4
2 inches	4	8
21/2 inches	6	12
3 inches	9	18

All milk lines should be sloped 11/2 inches per 10 feet to the receiver jar. Milk lines of three inches or larger may be difficult to clean properly. Therefore, a looped double sloped line of smaller diameter is often preferred. Milk lines can either be glass or stainless steel. Stainless steel is preferred because of its durability. Most stainless steel lines are welded on the job and joined with sanitary connections or clamps and gaskets.

Pulsator or Vacuum Line: The pulsator line should be of adequate size and looped into the balance tank. It should be cleaned regularly. Galvanized or PVC pipe can be used. The PVC pipe creates less friction and is preferred. Line sizes recommended are as follows:

Number of Milking Units	Pipe Size
2-12	2 inches
more than 12	3 inches

Receiving Jar: Install receiving jars with an adequate number of ports. For example, a double slope system will have two ports. Some

installations use a "T" to allow milk from two lines to enter through a single port. This is not recommended. The valve between the receiving jar and the milk pump should not admit air. If a bubbling action occurs in the receiver jar, air is leaking past the valve and it should be replaced.

Vacuum Balance Tank: The balance tank is sometimes referred to as a vacuum reserve, air distribution, or a header tank. It is used for several purposes. First, it is a point of entry for header pipes leading to the pump(s), to the trap and to the pulsator line. In this regard, it is a distribution tank. It also represents a volume which when evacuated has a cushioning effect on vacuum levels when small amounts of air and milk are admitted. In this regard, it is a cushion tank. If oversized it may be used as a reserve tank to compensate for inadequate pump capacity. This, however, leads to slow recovery time and irregular fluctuations. A tank size of five gallons per milking unit is commonly used. If air is admitted to a container under vacuum, vacuum level will fall unless air is removed. Thus, adequate pump capacity and reserve air flow are important in maintaining a stable vacuum. A properly installed balance tank is the best site for locating regulators to avoid unequal vacuum levels in the milk and pulsator lines.

Traditionally, the balance tank has been located directly under or right next to the vacuum pump. This has been and continues to be satisfactory for smaller installations, providing the pump is not too far from the milking area. For larger installations (double-8 herringbone or larger), it is recommended that the balance tank be located as near the milking units as possible. This location gives the most stable vacuum to systems requiring large amounts of air movement. Locating the tank horizontally over the receiver jar and sanitary trap or over the parlor gets the vacuum reserve as close to the milkers as is practically possible. The vacuum regulators should be placed on the top or side of the balance tank.

Rubber Components: All rubber components need to be replaced at regular intervals. With inflations and milk hoses, this is essential for sanitation. Replacement is essential for all rubber parts if small leaks with a large cumulative effect on fluctuation are to be avoided.

Weigh Jars: Weigh jars are glass jars calibrated to weigh the volume of milk accurately. They are used in milking parlors by some dairymen for the following reasons:

1. Abnormal milk secreted by some cows can be isolated and discarded.
2. The daily production level of each cow can be checked.
3. They assist in stabilizing the vacuum on the teat end.

This is especially true where the milk line is located above the level of

the udder. Weight jars should be placed so the milk inlet ports are about the same height as the cows' udders. This reduces the lifting of milk from the udder which can cause teat end vacuum fluctuation.

Weigh jars also have certain disadvantages:

1. Emptying the weigh jar after each cow can slow down the efficiency of the parlor.
2. They tend to congest a parlor pit and reduce ease of operator movement.
3. They are fairly expensive to purchase and replace if broken.

Most weigh jars are approved for use in the DHIA production testing programs.

Sanitary Trap: The sanitary trap is usually located close to the milk receiver jar. Its purpose is to trap any milk or wash water that goes past the receiver jar so it doesn't enter the vacuum balance tank or pump. The pipes connecting the trap with the balance tank and receiver jar should be the same size as the milk line, and should slope toward the trap.

Machine Function Guidelines

Vacuum Fluctuation: Vacuum fluctuations at the teat end should be minimal. However, no one has definitely established this minimum figure. McDonald from the National Animal Disease Lab suggests that the vacuum fluctuation at the teat end should never exceed two inches of mercury.

Fluctuations can occur in both a cyclic and irregular pattern. A cyclic pattern of fluctuation is related to pulsation and milk flow. This cyclic pattern may be affected by other forces, but the predominant effect is produced within the machine. Rapid flow of milk and flooding at the teat end cause most of this type of fluctuation. Irregular fluctuations are unrelated to pulsation. They are mainly caused by inadequate air movement or transporting milk with air, as is necessary in a high line system or in a system with a riser. Milk lines of inadequate size, or with inadequate slope, can flood and cause irregular vacuum fluctuation. They may also be related to poor milking technique in attaching and removing milkers. Vacuum fluctuations have been demonstrated to increase the rate of new intramammary infections (mastitis). There still remains some speculation about the way this happens, but from a practical standpoint, eliminating fluctuations can be beneficial to mastitis control. The following is a list of factors involved in vacuum fluctuation.

1. Inadequate pump capacity.

2. Inadequate reserve air flow (vacuum reserve).
3. Flooding.
4. Other obstruction to air flow.
5. Leaks in the system.
6. Simultaneous pulsation in machines with minimal claw capacity.
7. Use of milking vacuum to elevate and transport milk.
8. Inadequate regulator function.

Vacuum Level: Most milking machines operate with 11 to 15 inches of vacuum. Many knowledgeable workers in the field recommend a vacuum level of between 11 and 13 inches of mercury. It is common to find systems that operate at much higher vacuum levels than originally designed. Farmers often interfere with regulators to achieve a higher vacuum level, which compensates, in an adverse way, for inadequate vacuum reserve. Inadequate vacuum reserve occurs commonly with inadequate pump capacity, ageing of the system with development of leaks and when additional units are added.

Vacuum guages may lose their accuracy with time. They should be recalibrated or replaced yearly. It is recommended that a mercury column, which measures vacuum level of the milking system, also be installed. Mercury columns are available from all milking equipment manufacturers.

Adequate Massage: Although it is commonly accepted that a milking machine must adequately massage the teat end, it is not clear what constitutes adequate massage. With this lack of precise information, general recommendations are to keep the pulsators in good operating condition, minimize flooding of the teat cup liners, and have the same vacuum level on the inside and outside of the teat cup liners. McDonald has suggested that the massage force range from 6 to 11 inches of mercury vacuum.

Flooding: When milk completely fills any tube or line between the teat end and the vacuum pump, the system is said to be flooded. Placing a solid column of milk in the air column slows its movement. If air is being admitted to the system behind the column of milk, the vacuum level will lower. Some researchers feel that flooding alone is detrimental and vacuum fluctuation is secondary in causing new udder infections. Their opinion is based on the possibility of milk from an infected quarter mixing in the flooded claw and then contaminating the teat end of an uninfected quarter. This is a possibility. One researcher showed that impact forces on a teat end do occur when the liner opens. The following is a list of factors involved in flooding.

1. Fast milking cows.
2. Fast milking machines.

3. Liner tail piece of inadequate capacity.
4. Small Claws and wide ratios.
5. Elevating milk with milking vacuum.
6. Milk line too small for number of milkers.
7. Inadequate milk line slope.
8. Risers.
9. In line milk filters.
10. Elbows in milk line.
11. Improperly placed milk inlets.

Machine and Equipment Maintenance

Because the milking system is used daily, it needs to be serviced and maintained in proper working condition. Some items need to be checked more often than others. An example of a maintenance check list to use follows:

Daily maintenance checks to make (at each milking)

1. vacuum regulator operating properly
2. vacuum level at desired level
3. no breaks in inflations and hoses
4. vacuum pump oil level satisfactory
5. pulsators operating properly
6. air inlets into claw or inflation tailpiece are open
7. bulk tank turned on and operating properly

Checks to make every few weeks

1. clean vacuum regulator
2. check belt tension on vacuum pump
3. disassemble pulsators and check for wear
4. cheek lines, couplings and inlets for leaks
5. inspect, rotate or change inflations if needed
6. inspect CIP system for proper cleaning
7. check water temperature **after** circulating through system—it should be above 110° F

Checks to make every six months to one year

1. reserve air capacity of system
2. graph pulsator action
3. vacuum gauge for accuracy
4. all electrical connections

5. replace hoses and rubber parts as needed
6. valve in receiver jar for air leak
7. stray voltage level while milking
8. water quality and chemicals used for cleaning
9. all other service checks as specified by the manufacturer

By following a regular maintenance schedule, the dairyman can milk efficiently and can reduce the role of the milking machine as a factor in predisposing cows to udder infections.

Machine Malfunction Checklist

Even with routine maintenance of the milking equipment by the dairyman and the machine company serviceman, machine malfunction can occur. Listed below are some common problems that may occur and suggested corrective action.

Inadequate vacuum or vacuum fluctuation

Pump too small -- Replace (reserve should be 50% of pump capacity).

Plugged line -- Clean with lye once a month.

Sticky vacuum regulator -- Clean and oil, adjust if necessary.

Worn belt -- Replace.

Worn pump -- Repair or replace.

Air leaks -- Tighten couplings, repair or replace gaskets or stallcocks.

Broken vacuum line -- Replace.

Vacuum or milk lines too small -- Replace.

Pump running too slow -- Have serviceman check voltage and pulley sizes.

Too many milking units -- Eliminate units or get larger system.

High Vacuum

Sticky or dirty vacuum regulator -- Clean and oil regularly.

Too much weight on regulator -- Remove and adjust weights.

Pulsators too fast or too slow

Poor adjustment -- Correct to manufacturer's recommended rate.

High or low vacuum -- Adjust to manufacturer's recommended pressure.

Dirty pulsators -- Clean at least once a month.

Worn pulsators -- Repair.

Teat cup inflations

Ballooned, cracked or blistered -- replace entire set of four.

Rough -- Clean thoroughly.

Teat cups drop off

Pipeline couplings may leak, valves not properly seated, or poor air tube or hose -- Tighten couplings or replace gaskets, valves or hose.

Plugged air-bleeder vents -- Clean daily.

Inadequate vacuum -- See above.

Too many milking units -- See above.

Milk line too high -- See above.

Slow milking

Inflations in poor condition -- Replace.

Air tubes contain holes -- Replace.

Plugged air-bleeder vent -- Clean daily.

Inadequate vacuum -- See above.

Poor pulsation -- Clean and service pulsator.

Pipeline not washing

Water may not be hot enough -- Check hot water heater and water pressure.

Washing detergent solution too weak -- Add more detergent to washing cycle, use recommended amount.

Wrong type of cleaner -- Use total program with one manufacturer's products and use as recommended.

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The function of the vacuum pump is to remove air from a closed system, thereby creating a partial vacuum. Atmospheric air creates a pressure on all surfaces, and when measured with a manometer will cause mercury to rise in a column to 29.92 inches at sea level. This is called barometric pressure. The vacuum pump creates a partial vacuum by removing most of the air from a closed system, thus reducing the pressure of the air. The difference between the almost 30 inches of mercury at atmospheric pressure and the reduced air pressure is the vacuum created and is expressed in inches of mercury.

The size of the vacuum pump is usually expressed in terms of cubic feet of air removed from the system per minute (CFM). The CFM rating of vacuum pumps is measured in one of two ways: The ASME Standard (the pump ratings designated by the American Society of Mechanical Engineers and adopted by the Milting Machine Manufacturers' Council of the Farm Equipment Institute); and The New Zealand Standard.

The two methods measure the volume of air at different pressures. The American Standard is based upon the volumetric delivery rate at normal atmospheric pressure of about 30 inches of mercury, while the New Zealand Standard is based upon the volume of air delivered at the reduced pressure of 15 inches of mercury. Two volume units of air at 15 inches of vacuum (1/2 an atmosphere) equal one volume unit of air at atmospheric pressure. Thus, 1 CFM ASME Standard = 2 CFM New Zealand Standard. Boumatic and Surge pumps are rated by the New Zealand Standard, while the ASME standard is used to rate the pumps of most other companies.

The CFM required to operate a milking installation depends upon the amount of air introduced into the vacuum system, which in turn depends on the number of milker units used, the size of the milk and vacuum lines, the number and sizes of auxiliary milking equipment such as weigh jars and

milk metering devices, the amount of air leakage into the system, and the efficiency of the operator. If there are vacuum operated accessories such as doors and gates, a separate system should operate them.

Current recommendations for vacuum pump size needed are based upon research in Pennsylvania and New York. They are shown in the following tables:

For stall barns with pipelines and parlors with swing units.

Number of Units	Pump CFM (ASME) Capacity
2	36
4	42
6	52
8	66
10	80

For parlors with milker units at each stall.

Number of Units	Pump CFM (ASME) Capacity
6	48
8	56
12	78
16	100
20	112
24	120

While these tables are helpful in determining vacuum pump size needed, the critical value needed in a system is the reserve air capacity. With all the equipment set-up ready to milk, there should be between 3 and 5 cfm (ASME) reserve air per milker unit.

The vacuum pump and the power unit should be installed as close as possible and practicable to the milking area. Such locations as a feed room or near a haymow chute should be avoided. The exhaust from the pump should be piped to the outside of the building through a pipe whose diameter is at least as great as that of the pump's intake port. Mufflers or silencers should not be used, since they reduce effective pumping capacity. On some pumps, mufflers may perform other functions such as filtering or reducing theoil film, which may be exhausted with the air. Since oil is present in most exhausts, the exhaust should be directed downward and away from the side of the building. This prevents rain water from entering the exhaust pipe and pump, and also prevents accumulation of oil and dirt on the side of the building.

Servicing the pump should be performed as directed in the service manual. Maintaining the oil level in the pump or supply cup and checking the belt for proper alignment and tension are the two most important maintenance procedures. These should be done every two weeks. Recommended annual or semi-annual service checks will vary with the pump and the manufacturer's specifications.

Vacuum controller (regulator):

The vacuum controller admits air into the milking system to maintain a set maximum vacuum on the pulsator and milk lines. The CFM rating of the controller must be equal to or greater than the vacuum pump capacity. A controller that is too small may result in an excessively high vacuum level which could cause damage to the teats.

Weight-type regulators usually do not provide the vacuum stability desired. They should be replaced with the newer style regulators available.

Controllers should be installed in a clean area where moisture and dirt will not affect their proper operation, and where they will not freeze in cold weather if condensation accumulates in them.

Vacuum controllers should be located between the cow and the pump. In the bucket milking system the controllers should be placed between the pump and the first stall cock opening. In the pipeline system the controllers should be placed between the vacuum pump and the trap. Controllers are often located near or on the vacuum reserve tank. Some people think controllers should be located as close to the cow as possible. By Ohio Health Department regulation, the closest point the controller can be located to the milk line side is at the sanitary trap. For this reason, locate the trap and receiving jar as close to the cow as possible. Locate controllers where the air admitted into them is relatively clean. Easy accessibility is important for routine observation and maintenance.

Controllers are not needed on the pulsator line, if the pulsator line is fully looped to the balance tank and the controllers are mounted on the tank. If there is a controller on the pulsator line, it should control the vacuum level at the same level as the controllers on the milk line. Different vacuum levels on the two lines is an imbalance that should be avoided.

Check and clean the controller at least every two weeks. Accumulation of dirt in the valve is one of the primary causes of malfunction. The manufacturer's recommendations for maintenance and service should be closely followed.

Pulsator:

The function of pulsators is to alternate the space between the teat cup shell and teat cup liner between a partial vacuum (milking phase) and atmospheric air pressure (rest phase). During the milking phase, the space between the inflation and shell, and the space inside the inflation have the same partial vacuum. This causes the inflation to open and milk to flow from the teat. Milk flows from the teat because the pressure inside the udder is greater than that outside the teat end.

During the rest phase, air at normal atmospheric pressure,enters between the shell and inflation. Due to the partial vacuum inside the inflation, the inflation collapses around the teat. The pressure of the collapsed inflation helps massage the teat, preventing congestion of blood and body fluids in the teat skin and tissue.

The number of times per minute that the pulsator alternates between the milking and rest phase is called the **pulsation rate.** Rates vary from about 40 to 80 pulsations per minute, depending upon the manufacturer. A rate between 50 to 60 is recommended.

The ratio of time the inflation is in the milking phase to the time it is in the rest phase is called the

pulsation ratio. Ratios vary by manufacturer, from 50:50 to about 70:30. Cows will usually milk slightly faster with a wider ratio. However, the longer milk phase and shorter rest phase may cause teat end trauma and damage if the milking equipment is not working properly and good milking practices are not followed. Ratios closer to 60:40 are less likely to contribute to problem situations.

The closing patterns of the inflations varies by manufacturer. Some have all four inflations of a claw closing at once (simultaneous), while others have an alternating pattern (only two inflations close at a time). The alternating pattern results in less claw flooding in units with a small claw. In units with larger claws that do not flood, alternating pulsation is not as important. Claw flooding (filling) is not desired, for it causes vacuum fluctuation at the teat end. This, in turn, can result in teat end injury and the back flushing of milk into the teat. The introduction of mastitis causing organisms into the udder can occur in such a situation.

Pulsators are controlled either by electricity or air (pneumatically) or a combination of the two. Electrically controlled units are preferred because of their more consistent action. Pneumatically operated units are more unreliable and require more maintenance. It is recommended that when four or more units are being used, the electric pulsators be wired on two or more circuits to prevent them from being in the same phase. This can help prevent cyclic vacuum fluctuations on the pulsator line.

A new type of milking unit from New Zealand has the pulsator mounted directly on top of the claw. It operates by vacuum and not by air or electricity. At this time, research studies evaluating the units are lacking.

Teat cup shell and teat cup liner (inflation):

These two components form the pulsating chamber which allows milk to be removed from the teat. The shell size used should correspond to the inflation size. Most companies recommend the use of narrow bore liners (3/4 inch or less in internal diameter). They have less tendency to climb the teats, especially towards the end of milking, which can shut off milk flow from the udder into the teats and can also cause udder trauma at the base of the teats. Special types of inflations having features such as being square, having ribbed sides, or special kinds of tops have not been evaluated in controlled experiments. Many dairymen have used them successfully.

Air inlets are available to admit air into the tail piece of the liner (vented inflation). This is done in an attempt to avoid claw and tail piece flooding with milk. Most manufacturers have attempted to control claw flooding by admitting air into the claw. Vented inflations may cause problems in systems that have inadequate reserve air flow. Observations also indicate that inlets are not satisfactory when used in liners with a high collapse differential. While many dairymen are successfully using vented inflations, objective information for recommending their use is lacking. If they are used, the air inlet in the claw should be closed.

Research in New Zealand and Germany is in progress to design and develop a milking claw without inflations. Perhaps such a unit will be perfected and available in the future.

Interconnecting Parts and Their Relationship to Machine Function

Claws: Claws should be of adequate size to avoid flooding. Most claws admit air to aid in preventing flooding. Claws or breaker cups should not have filters. Be sure the ferrules (tubes where the liners are attached to the claw) are not bent or damaged. If they are, blockage of milk flow from the teat cup can occur, resulting in slow milking and teat irritation.

Long Milk Hose: Be sure the long milk hose is in good condition, does not leak, is not too long and does not contain a filter. Do not let it hang lower than the cows udder before elevating it, or do not elevate it before dropping into a low line or weigh jar.

Milk Inlets: Place milk inlets on the upper half of the line. This prevents them from being covered with milk, which can cause undesired vacuum fluctuation.

Milk Line: Place milk lines below the cows udder so that milk is not elevated. If weigh jars are used, a low line is not necessary. Low-lines allow for less claw and milk hose flooding during peak milk flow. This in turn reduces vacuum fluctuation, which can cause teat-end erosion, slow milking and perhaps predispose cows to mastitis. The line should be of adequate size for the number of units and the number of inlets into the receiving jar. Loop all milk lines to the receiver jar. Recommended line sizes are as follows:

Size of Milk Line	Number of Units Single Slope	Number of Units Double Slope
11/2 inches	2	4
2 inches	4	8
21/2 inches	6	12
3 inches	9	18

All milk lines should be sloped 11/2 inches per 10 feet to the receiver jar. Milk lines of three inches or larger may be difficult to clean properly. Therefore, a looped double sloped line of smaller diameter is often preferred. Milk lines can either be glass or stainless steel. Stainless steel is preferred because of its durability. Most stainless steel lines are welded on the job and joined with sanitary connections or clamps and gaskets.

Pulsator or Vacuum Line: The pulsator line should be of adequate size and looped into the balance tank. It should be cleaned regularly. Galvanized or PVC pipe can be used. The PVC pipe creates less friction and is preferred. Line sizes recommended are as follows:

Number of Milking Units	Pipe Size
2-12	2 inches
more than 12	3 inches

Receiving Jar: Install receiving jars with an adequate number of ports. For example, a double slope system will have two ports. Some installations use a "T" to allow milk from two lines to enter through a single port. This is not recommended. The valve between the receiving jar and the milk pump should not admit air. If a bubbling action occurs in the receiver jar, air is leaking past the valve and it should be replaced.

Vacuum Balance Tank: The balance tank is sometimes referred to as a vacuum reserve, air distribution, or a header tank. It is used for several purposes. First, it is a point of entry for header pipes leading to the pump(s), to the trap and to the pulsator line. In this regard, it is a distribution

tank. It also represents a volume which when evacuated has a cushioning effect on vacuum levels when small amounts of air and milk are admitted. In this regard, it is a cushion tank. If oversized it may be used as a reserve tank to compensate for inadequate pump capacity. This, however, leads to slow recovery time and irregular fluctuations. A tank size of five gallons per milking unit is commonly used. If air is admitted to a container under vacuum, vacuum level will fall unless air is removed. Thus, adequate pump capacity and reserve air flow are important in maintaining a stable vacuum. A properly installed balance tank is the best site for locating regulators to avoid unequal vacuum levels in the milk and pulsator lines.

Traditionally, the balance tank has been located directly under or right next to the vacuum pump. This has been and continues to be satisfactory for smaller installations, providing the pump is not too far from the milking area. For larger installations (double-8 herringbone or larger), it is recommended that the balance tank be located as near the milking units as possible. This location gives the most stable vacuum to systems requiring large amounts of air movement. Locating the tank horizontally over the receiver jar and sanitary trap or over the parlor gets the vacuum reserve as close to the milkers as is practically possible. The vacuum regulators should be placed on the top or side of the balance tank.

Rubber Components: All rubber components need to be replaced at regular intervals. With inflations and milk hoses, this is essential for sanitation. Replacement is essential for all rubber parts if small leaks with a large cumulative effect on fluctuation are to be avoided.

Weigh Jars: Weigh jars are glass jars calibrated to weigh the volume of milk accurately. They are used in milking parlors by some dairymen for the following reasons:

1. Abnormal milk secreted by some cows can be isolated and discarded.
2. The daily production level of each cow can be checked.
3. They assist in stabilizing the vacuum on the teat end.

This is especially true where the milk line is located above the level of the udder. Weight jars should be placed so the milk inlet ports are about the same height as the cows' udders. This reduces the lifting of milk from the udder which can cause teat end vacuum fluctuation.

Weigh jars also have certain disadvantages:

1. Emptying the weigh jar after each cow can slow down the efficiency of the parlor.
2. They tend to congest a parlor pit and reduce ease of operator movement.
3. They are fairly expensive to purchase and replace if broken.

Most weigh jars are approved for use in the DHIA production testing programs.

Sanitary Trap: The sanitary trap is usually located close to the milk receiver jar. Its purpose is to trap any milk or wash water that goes past the receiver jar so it doesn't enter the vacuum balance tank or pump. The pipes connecting the trap with the balance tank and receiver jar should be the same size as the milk line, and should slope toward the trap.

Machine Function Guidelines

Vacuum Fluctuation: Vacuum fluctuations at the teat end should be minimal. However, no one has definitely established this minimum figure. McDonald from the National Animal Disease Lab suggests that the vacuum fluctuation at the teat end should never exceed two inches of mercury.

Fluctuations can occur in both a cyclic and irregular pattern. A cyclic pattern of fluctuation is related to pulsation and milk flow. This cyclic pattern may be affected by other forces, but the predominant effect is produced within the machine. Rapid flow of milk and flooding at the teat end cause most of this type of fluctuation. Irregular fluctuations are unrelated to pulsation. They are mainly caused by inadequate air movement or transporting milk with air, as is necessary in a high line system or in a system with a riser. Milk lines of inadequate size, or with inadequate slope, can flood and cause irregular vacuum fluctuation. They may also be related to poor milking technique in attaching and removing milkers. Vacuum fluctuations have been demonstrated to increase the rate of new intramammary infections (mastitis). There still remains some speculation about the way this happens, but from a practical standpoint, eliminating fluctuations can be beneficial to mastitis control. The following is a list of factors involved in vacuum fluctuation.

1. Inadequate pump capacity.
2. Inadequate reserve air flow (vacuum reserve).
3. Flooding.
4. Other obstruction to air flow.
5. Leaks in the system.
6. Simultaneous pulsation in machines with minimal claw capacity.
7. Use of milking vacuum to elevate and transport milk.
8. Inadequate regulator function.

Vacuum Level: Most milking machines operate with 11 to 15 inches of vacuum. Many knowledgeable workers in the field recommend a vacuum level of between 11 and 13 inches of mercury. It is common to find systems that operate at much higher vacuum levels than originally designed. Farmers often interfere with regulators to achieve a higher vacuum level, which compensates, in an adverse way, for inadequate vacuum reserve. Inadequate vacuum reserve occurs commonly with inadequate pump capacity, ageing of the system with development of leaks and when additional units are added.

Vacuum guages may lose their accuracy with time. They should be recalibrated or replaced yearly. It is recommended that a mercury column, which measures vacuum level of the milking system, also be installed. Mercury columns are available from all milking equipment manufacturers.

Adequate Massage: Although it is commonly accepted that a milking machine must adequately massage the teat end, it is not clear what constitutes adequate massage. With this lack of precise information, general recommendations are to keep the pulsators in good operating condition, minimize flooding of the teat cup liners, and have the same vacuum level on the inside and outside of the teat cup liners. McDonald has suggested that the massage force range from 6 to 11 inches of mercury vacuum.

Flooding: When milk completely fills any tube or line between the teat end and the vacuum pump, the system is said to be flooded. Placing a solid column of milk in the air column slows its

movement. If air is being admitted to the system behind the column of milk, the vacuum level will lower. Some researchers feel that flooding alone is detrimental and vacuum fluctuation is secondary in causing new udder infections. Their opinion is based on the possibility of milk from an infected quarter mixing in the flooded claw and then contaminating the teat end of an uninfected quarter. This is a possibility. One researcher showed that impact forces on a teat end do occur when the liner opens. The following is a list of factors involved in flooding.

1. Fast milking cows.
2. Fast milking machines.
3. Liner tail piece of inadequate capacity.
4. Small Claws and wide ratios.
5. Elevating milk with milking vacuum.
6. Milk line too small for number of milkers.
7. Inadequate milk line slope.
8. Risers.
9. In line milk filters.
10. Elbows in milk line.
11. Improperly placed milk inlets.

Machine and Equipment Maintenance

Because the milking system is used daily, it needs to be serviced and maintained in proper working condition. Some items need to be checked more often than others. An example of a maintenance check list to use follows:

Daily maintenance checks to make (at each milking)

1. vacuum regulator operating properly
2. vacuum level at desired level
3. no breaks in inflations and hoses
4. vacuum pump oil level satisfactory
5. pulsators operating properly
6. air inlets into claw or inflation tailpiece are open
7. bulk tank turned on and operating properly

Checks to make every few weeks

1. clean vacuum regulator
2. check belt tension on vacuum pump
3. disassemble pulsators and check for wear
4. cheek lines, couplings and inlets for leaks
5. inspect, rotate or change inflations if needed
6. inspect CIP system for proper cleaning

7. check water temperature **after** circulating through system—it should be above 110° F

Checks to make every six months to one year

1. reserve air capacity of system
2. graph pulsator action
3. vacuum gauge for accuracy
4. all electrical connections
5. replace hoses and rubber parts as needed
6. valve in receiver jar for air leak
7. stray voltage level while milking
8. water quality and chemicals used for cleaning
9. all other service checks as specified by the manufacturer

By following a regular maintenance schedule, the dairyman can milk efficiently and can reduce the role of the milking machine as a factor in predisposing cows to udder infections.

Machine Malfunction Checklist

Even with routine maintenance of the milking equipment by the dairyman and the machine company serviceman, machine malfunction can occur. Listed below are some common problems that may occur and suggested corrective action.

Inadequate vacuum or vacuum fluctuation

Pump too small -- Replace (reserve should be 50% of pump capacity).

Plugged line -- Clean with lye once a month.

Sticky vacuum regulator -- Clean and oil, adjust if necessary.

Worn belt -- Replace.

Worn pump -- Repair or replace.

Air leaks -- Tighten couplings, repair or replace gaskets or stallcocks.

Broken vacuum line -- Replace.

Vacuum or milk lines too small -- Replace.

Pump running too slow -- Have serviceman check voltage and pulley sizes.

Too many milking units -- Eliminate units or get larger system.

High Vacuum

Sticky or dirty vacuum regulator -- Clean and oil regularly.

Too much weight on regulator -- Remove and adjust weights.

Pulsators too fast or too slow

Poor adjustment -- Correct to manufacturer's recommended rate.

High or low vacuum -- Adjust to manufacturer's recommended pressure.

Dirty pulsators -- Clean at least once a month.

Worn pulsators -- Repair.

Teat cup inflations

Ballooned, cracked or blistered -- replace entire set of four.

Rough -- Clean thoroughly.

Teat cups drop off

Pipeline couplings may leak, valves not properly seated, or poor air tube or hose -- Tighten couplings or replace gaskets, valves or hose.

Plugged air-bleeder vents -- Clean daily.

Inadequate vacuum -- See above.

Too many milking units -- See above.

Milk line too high -- See above.

Slow milking

Inflations in poor condition -- Replace.

Air tubes contain holes -- Replace.

Plugged air-bleeder vent -- Clean daily.

Inadequate vacuum -- See above.

Poor pulsation -- Clean and service pulsator.

Pipeline not washing

Water may not be hot enough -- Check hot water heater and water pressure.

Washing detergent solution too weak -- Add more detergent to washing cycle, use recommended amount.

Wrong type of cleaner -- Use total program with one manufacturer's products and use as recommended.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Dairy Development in Sub-Saharan Africa : A Study of Issues and Options (World Bank Technical Paper, Africa Technical Department Series, No 135) - by Michael J. Walshe - Publication Date: March 1991 - List: $7.95 + $1.35 special surcharge
- Milk Quotas : European Community and United Kingdom Law - by Michael Cardwell - Publication Date: July, 1996 - List: $82.00
- The Family Cow - by Dirk Van Loon - Publication Date: August, 1983 - List: $14.95
- The Behaviour of Cattle - by J. L. Albright, Clive Wendell Arave, C.A.B. International - Publication Date: October 1997 - List: $90.00

Periodicals:

- None identified.

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Raising Goats

Frequently Asked Questions Other Information Sources Return to Livestock Index

Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Goats

The goat is one of the smallest domesticated ruminants which has served mankind earlier and longer than cattle and sheep. It is managed for the production of milk, meat and wool, particularly in arid, semitropical or mountainous countries. In temperate zones, goats are kept often rather as supplementary animals by small holders, while commercially cows or buffaloes are kept for milk, cheese and meat, and sheep for wool and meat production. Nonetheless, there are more than 460 million goats worldwide presently producing more than 4.5 million tons of milk and 1.2 million tons of meat besides mohair, cashmere, leather and dung; and more people consume milk and milk products from goats worldwide than from any other animal. Cheese production from goat milk, even in France, Greece, Norway and Italy, is of economic importance. Goat herds, on the other hand low producing though, are an expression of capital assets and wealth in Africa and Asia where they are found in large numbers. In the United States, there are between 2 and 4 million head; with Texas leading in Angora, meat and bush goats; and California leading in dairy goats.

Goats can survive on bushes, trees, desert scrub and aromatic herbs when sheep and cattle would starve to death. Goat herders often have neglected a rational numerical balance between goat numbers and sparse vegetation. Over-grazing has destroyed many tree and woodland areas which was blamed then on goats rather than man, and this has caused widespread ecological and political concerns, erosion, desertification and even ban on freely grazing goats in some areas. On the other hand, goats are valued by cattle and sheepmen in the fight against brush encroachment on millions of acres of open rangeland.

Swiss goat breeds are the world's leaders in milk production. Indian and Nubian derived goat breeds are dual-purpose meat and milk producers.

Spanish and South African goats are best known for meat producing ability. The Turkish Angora, Asian Cashmere and the Russian Don goats are kept for mohair and cashmere wool production. In addition, there are Pygmy goats from Western Africa of increasing interest as laboratory and pet animals.

Goat milk casein and goat milk fat are more easily digested than from cow milk. Goat milk is valued for the elderly, sick, babies, children with cow milk allergies, patients with ulcers, and even preferred for raising orphan foals or puppies. Fat globules in goat milk are smaller than in cow milk and remain dispersed longer. Goat milk is higher in vitamin A, niacin, choline and inositol than cow milk, but it is lower in vitamin B6, B12, C and carotenoids. The shorter chain fatty acids (C6, C8, C10, C12) are characteristically higher in goat milk than in cow milk. Otherwise milk gross composition from goats or cows is similar except for differences due to breeds, climate, stage of lactation and feeds.

Breeds of goats vary from as little as 20 lb mature female bodyweight and 18 inches female withers for dwarf goats for meat production up to 250 lb and 42 inches withers height for Indian Jamnapari, Swiss Saanen, Alpine and AngloNubian for milk production. Some Jamnapari males may be as tall as 50 inches at withers. Angora goats weigh between 70 to 110 lb for mature females and are approximately 25 inches tall. Birthweights of female singles are between 3 and 9 lb; twins being often a pound lighter and males 1/2 lb heavier. Twinning is normal in goats with a high percentage of triplets thus giving several breeds an average annual litter size above 2 per doe and more than 200 reproduction rate. Females are called doe, young are kids, males are bucks; one speaks of buck and doe kids, and doelings, and of wethers or castrates.

Differentiation Morphologically, goats may have horns of the scimitar or corkscrew types, but many are dehorned in early age with a heated iron, caustic or later on with a rubber band or surgical saw. Goats may also be hornless genetically. They can be short haired, long haired, have curled hair, are silky or coarse wooled. They may have wattles on the neck and beards. Some breeds, particularly the European, have straight noses, others have convex noses, e.g., the Jamnapari and Nubian breeds or slightly dished noses (Swiss). Swiss and other European breeds have erect ears, while pendulous, drooping, large ears characterize Indian and Nubian goats. The American LaMancha breed has no external ear. A "gopher" ear rudiment in LaMancha is less than 1 inch long with little or no cartilage; an "elf" ear is less than 2 inches long, but bucks can be registered only with gopher ears. The responsible gene for rudimentary ears is dominant, thus sires with gopher ears will always have gopher or elf-eared offspring, no matter what the genotype of the dam is to which he was mated.

Goats come in almost any color, solid black, white, red, brown, spotted, two and three colored, blended shades, distinct facial stripes, black and white saddles, depending on breeds.

Teeth in goats are a good guide to age. Six lower incisors are found at birth and a set of 20 "milk teeth" are complete at 4 weeks of age consisting of the eight incisors in the front of the lower jaw, and 12 molars, three on each side in each jaw. Instead of incisors in the upper jaw there is a hard dental pad against which the lower incisors bite and cut. Some goats have an undesirable inherited recessive condition of "parrot" (overshot upper jaw) or "carp" mouth (undershot upper jaw) which does not interfere with barn feeding conditions but handicaps the goat severely in pasturing and browsing, because the lower incisor teeth cannot cut correctly against the upper dental pad. With progressing age, the permanent teeth wear down from the rectangular crossectional shape and cores to the round stem which is a further distinguishing mark of age. Furthermore, there are pregnancy rings marking horns and telling age.

The digestive tract of the goat after nursing has the typical four stomach compartments of ruminants consisting of the rumen (paunch) (4-6 gallon), the reticulum (honeycomb) (1-2 liters), the omasum (maniply) (1 liter), and the abomasum (true stomach) (3.5 liters). The intestinal canal is about 100 feet long (11 liters), or 25 times the length of a goat. The total blood volume of the goat approximates 1/12-1/13 of bodyweight; it takes about 14 seconds for goat blood to complete one circulation.

Among diseases, goats are not too different from cattle and sheep in the same regions. Goats tend to have more internal parasites than dairy cows, especially in confined management. They tend to have less tuberculosis, milk fever, post partum ketosis and brucellosis than dairy cows and their milk tends to be of lower bacteria counts than cow milk. They have more prepartum pregnancy toxemia than dairy cows, and are known to have laminitis, infectious arthritis, Johne's disease, listeriosis, pneumonia, coccidiosis, scours, scabies, pediculosis, liver fluke disease and mastitis.

Reproduction:

The skin of the goat has sebaceous and sweat glands besides growing the hair cover, horns, hooves and the two compartmented mammary gland (udder). Before the first pregnancy, the udder is underdeveloped, but with sustained repeated gentle massaging, a small, normal milk producing gland can be stimulated in virgin does and even in goat bucks. In contrast to sheep, the teats of goat's udders are conveniently long and large for hand milking.

Tails, scent and horns distinguish goats easily from sheep and cattle. The goat tail is short, bare underneath and usually carried upright. Major scent glands are located around the horn base. They function in stimulating estrus in male and female goats, improving conception. The goat odor is, however, a detriment to goat keeping and milk consumption if not properly controlled. Many goat breeds are seasonal breeders, being influenced by the length of daylight. Artificial insemination is commercially practiced in regions where numbers of females make it economical. Goats are in puberty at 1/2 year of age and can be bred if of sufficient size. Does come into estrus in 21 day cycles normally, lasting approximately 1 to 2 days.

In temperate zones, goats breed normally from August through February. Nearer the equator, goats come into estrus throughout the year. Thus more than one litter per year is possible, considering the length of pregnancy of 150 days. Five days after ovulation one or several corpus luteum form to protect the conceptus from abortion. The goat pregnancy is corpus luteum dependant in contrast to cattle. If no conception occurred, the corpus luteum disappears and new ovulation takes place. A buck ejaculates normally 3/4 - 1 1/2 ml of semen with 2-3 billion spermatozoa each. The life of an ovum after ovulation is about 8-10 hours. As the ovum travels down the goat's oviduct, it is fertilized by semen which traveled up through the uterus. The fertilized embryo becomes firmly attached to the uterine walls and surrounds itself with a nourishing placenta starting at 52 days after conception. Semen of goat bucks freezes as well as that of bulls and may be stored for years in 1 ml ampules or 1/2 ml straws in liquid nitrogen tanks for artificial insemination use.

Origin

Wild goats or escaped feral goats are found in many countries and islands and can be harmful to the vegetation if numbers are left uncontrolled. Truly wild goats are found on Creta, other Greek islands, in Turkey, Iran, Turkmenia, Pakistan; in the Alps, Siberia, Sudan, Caucasus; the Pyrenees, the Himalayan, Central Asian, Russian and Tibetan mountain ranges, and prefer rocky, precipitous mountains and cliffs. Goats can not be herded as well with dogs as sheep; instead they tend to disperse or face strangers and dogs headon. Relatives of true goats are the Rocky Mountain goat, the Chamois of the Alps and Carpathian, and the muskox.

Goats belong, scientifically, to the Bovidae family within the suborder of ruminants (chevrotain, deer, elk, caribou, moose, giraffe, okapi, antelope), who besides the other suborders of camels, swine and hippopotamuses make up the order of eventoed hoofed animals called artiodactyla. They have evolved 20 million years ago in the Miocene

Age, much later than horses, donkeys, zebras, tapirs, rhinoceroses, who make up the order of uneventoed hoofed animals; and the hyrax, elephants, manatees who make up the ancient near-hoofed animals. All these are herbivorous mammals, i.e., they live from plants and nurse their young with milk from an external gland after the young is born, having been carried in pregnancy to term relatively long in an internal uterus with a complex, nourishing placenta.

Goats and sheep make up a tribe within the Bovidae family called Caprini that include six goat, six sheep and five related species. Goats have a 2n chromosome set number of 60 while domestic sheep have a 2n set of 54; yet living hybrids of the two genera have been reported. The six species of goats can be distinguished by their horn shapes:

- Capra aegagrus, the wild (or bezoar) goat of Near East Asia has scimitar-shaped horns with a sharp anterior keel and a few knobs in- terrupting it.
- Capra ibex, the ibex of the Alps, Siberia and Nubia has scimitar shaped horns with a flatter front and many transverse ridges.
- Capra falconeri, the markhor of Central Asia has sharpkeeled horns that are twisted into open or tight spirals.
- Capra pyrenaica, the Spanish goat has outward-upward curving horns with a sharp posterior keel.
- Capra cylindricornis, the Dagestan tur of the Caucasus mountains as round outward-back inward curving horns.
- Capra hircus, the domestic goat evolved principally from capra aegagrus, except for Angora, Cashmere goats, and Damascus types who descended from capra falconeri.

Breeds

Domestic goat breeds are many. Swiss breeds are distinguished in milk producing ability and have influenced significantly milk production from goats around the world, especially in Europe, North America, Australia and New Zealand. A few breeds kept mostly for meat are the South African boer goat, the Indian beetal, black Bengal, the Latin American criollo, the US "Spanish" goats and most of the small or nondescript goats. Fiber producing goat breeds are the Angora in Turkey, USA, South Africa; the Cashmere in Afghanistan, Iran, Australia and China; and Don breed in Russia.

The major breeds of US goats are:

- **Saanen** originate from Switzerland (Saanen Valley), are totally white, with or without horns. The white color is dominant over other colors. They are mostly short haired. The "Appenzell" is a similar breed, but partially related to the Toggenburg from

Northern Switzerland, longhaired, white and hornless. Saanen have been exported around the world as leading milk producers. An Australian Saanen doe holds the world record milk production of 7,714 lbs in 365 days. Saanen had been bred in Switzerland for odorfree milk long ago.

- **Toggenburg**, brown with white facial, ear and leg stripes, another straight nosed, horned or hornless, mostly shorthaired, erect eared goat, as all Swiss are, has been very popular in the USA, comes from N.E. Switzerland, but is 4 inches shorter in height and 18 lb lighter in average than the Saanen. They have been bred pure for over 300 years, longer than many of our other domestic breeds of livestock. They are reliable milk producers summer and winter, in temperate and tropical zones. Mrs. Carl Sandburg, wife of the famous US poet had several world record Toggenburg does on official USDA tests.
- **Alpine** (including French, Rock and British), another Swiss breed (French Switzerland), horned or hornless, shorthaired, as tall and strong as the Saanen, with usually faded shades of white into black, with white facial stripes on black. They are second in milk production to Saanen and Toggenburg.
- **LaMancha** is a new, young breed developed in California from Spanish Murciana origin and Swiss and Nubian crossings. They are known for excellent adaptability and good winter production. They are also producing fleshier kids than the Swiss, but are not milking as much. They have straight noses, short hair, hornless or horns, and no external ear due to a dominant gene. They are more the size of Toggenburg. Their milk fat content is higher than that of the Swiss breeds.
- **(Anglo)-Nubian** is a breed developed in England from native goats and crossed with Indian and Nubian which have heavy arched "Roman" noses and long, drooping, pendulous ears, spiral horns and are shorthaired. They are leggy and as tall as Saanen, but produce less milk, though higher milk fat levels and are more fleshy. They are less tolerant of cold but do well in hot climates. They "talk" a lot, and are in numbers the most popular breed in USA and Canada. They have a tendency for triplets and quadruplets. They are horned or hornless and have many colors that may be "Appaloosa"-like spotted.
- **Oberhasli**, a western Swiss breed, usually solid red or black, horned or hornless, erect ears, not as tall as Saanen, very well adapted for high altitude mountain grazing and long hours of marching; popular in Switzerland, but milk production is variable. They are also called Swiss Alpine, Chamoisie or Brienz.
- **Angora** originated in the Near East. The long upper coat (mohair) is the valuable product in the Angora in contrast to the

Cashmere, where the fine underwool is the valuable product. Head has a straight or concave nose, thin, not very long; pendulous ears and twisted horns, in both sexes. It is a small breed, usually white. The haircoat is long with undulating locks and ringlets of fine, silky hair. The top quality fleece of purebreds may be 1-2 lbs, but slightly more in males and wethers. They are bearded. Spring moult is natural and shearing occurs just before. They are not very prolific and twinning is less frequent than in other breeds.

- **Pygmy** are dwarf, short legged goats from West and Central Africa and the Caribbean. Their growth rates and milk production are relatively respectable, although low, twinning is frequent and they are breeding all year usually. They are adaptable to humid tropics and resistant to trypanosoma.
- **Others**. There is little known about the so-called Spanish or bush goats that are kept on the open range in the Southwest mostly. Also, a few minor breeds exist in this country, e.g. the Sables, which are a colored variety of the Saanen. It would be profitable to know more about the other at least 60 goat breeds in the world and their comparative values under US conditions.

Adjustment Factors for Milk Records

Lactation records of milk and fat production provide important information for managing a dairy goat herd and for breeding better goats. Environmental factors such as length of lactation, age of doe, and season of kidding should be standardized through appropriate adjustment factors to make genetic evaluations more accurate.

A lactation length of 305 days has been defined as the standard for dairy cattle and also is used for goats. This standard assumes a 365-day interval between parturitions, which includes a 60-day dry period. However, many goats do not milk 305 days. A recent study shows that only one-third of all does with official records ending with a dry date milked 305 days. One reason for shorter records is that production of many does declines sharply with the onset of seasonal estrus and the does then are dried off. A standard lactation length of less than 305 days might be more useful for comparisons among does; however, the 305-day standard allows for reduced computing costs because doe and cow records can be computed the same way.

If a doe's lactation ends on or before 305 days because her production declined to the point at which continued milking was not worthwhile, then her record is considered complete. Such records are not projected to 305 days but are treated as complete 305-day records. If a lactation ends before 305 days for any reason other than going dry, such as the

doe's being sold or the herd's discontinuing testing, the record is considered incomplete and is adjusted. If a doe is still milking and has fewer than 305 days in milk, the record is considered incomplete, adjusted, and referred to as a record in progress. If a doe milks for more than 305 days, the production for only the first 305 days is included in the 305-day record.

A method to adjust incomplete records and records in progress uses the USDA projection factors in Table 1. Different categories of factors are required to adjust records because of variations in the lactation curve, particularly in the rate of decline of production after the peak and the number of days milked. To select the appropriate factor, the following information is necessary: breed, herd average production, month of kidding, days in milk, and age of doe at kidding. An adjusted or projected record is the incomplete record plus an estimate of production for the rest of the lactation. That estimate is the projection factor times the last sample-day production times the number of days from the end of the incomplete record through 305 days.

Suppose a Nubian doe freshens in March at 25 months of age. She has an incomplete record at 130 days of 800 lb milk and 27 lb fat. Her last sampleday production is 5 lb milk with 3.4 The herd average is 1,725 lb. Then, her projected record would be 800+0.69(5) (305-130) =1,404 lb milk and 27+0.76(5) (0.034) (305-130) =50 lb fat.

Age-Season Lactation production increases with age until maturity and then declines. Month or season of kidding also influences lactation production. For example, does kidding in the early spring produce more milk than those kidding later in the year. Lactation records can be adjusted to a common age and season of kidding to standardize the effects of age and season. The factors in Table 2 standardize production to that expected from a doe kidding from January through March at 36 months of age.

The adjustment factors vary by breed, age, and season of kidding. Records are adjusted for age and season by multiplying production by the appropriate factor from Table 2. To illustrate, consider the Nubian doe from the previous example: Adjusted milk=1.07(1,404)=1,502 lb Adjusted fat=1.08(50)=54 lb.

The factors in Table 2 were computed by assuming a smooth change by age and by ignoring lactation number. Recent results, however, suggest that lactation number should be considered, particularly for does kidding about 24 months of age. Equations recently developed at the University of California in Davis provide factors that vary by parity. These factors may be more accurate; however, the factors reported here should contribute to improved comparisons among does.

Artificial Insemination

If you have a few backyard does that you enjoy as a hobby, with little concern for genetic improvements of their offspring, then artificial insemination (AI) is probably not for you, assuming a suitable buck can be located for servicing the does. The expense of purchasing the necessary equipment and learning to do AI are likely not worthwhile. However, if there is an experienced inseminator in the area who is willing to work with your goats, then this may prove to be a viable alternative and certainly is much simpler than hauling your does in heat to the buck's home.

AI has some key advantages over natural breeding.

- It eliminates the necessity of keeping one or several bucks on the farm (depending on herd size). Costs of feeding, housing, separate fencing and labor are eliminated. However, heat detection may be more difficult in the absence of a buck.
- AI can increase the rate of genetic improvement in an herd, as long as superior bucks are consistently selected. In natural service, the prospective breeder has only the buck's pedigree to rely on, whereas AI bucks should be progeny tested for their transmitting ability of milk and fat percentage, weight gain, type conformation, etc.
- AI allows breeding of different portions of the herd to different bucks. Young does may be bred to not yet proven but high potential bucks, while the majority of the herd can be bred to proven high quality bucks.
- AI permits breeding of many does on one day when synchronization is practiced. No long drives to top bucks are involved.
- The danger of transmission of diseases or parasites is greatly reduced. (The transmission of diseases through frozen semen needs further study.)
- The time of breeding can be more carefully regulated, and the owner knows exactly when the doe was bred, as opposed to pasture servicing by a buck that is allowed to run with the herd.
- AI induces good recordkeeping of dates of heat, breeding, pedigrees, etc. This will aid in herd improvements and enable the owner to make better culling decisions.

Once the decision to use AI has been made, the next step is to determine whether to do the inseminating yourself or pay someone else to do it. If there are only a few does in your herd, and an experienced inseminator of goats is available, then it may be more practical to pay to have the service done. However, if the number of does in the herd is rather large, or an experienced inseminator is nowhere to be found, then

its probably time to learn how to practice AI techniques yourself.

AI technicians of the cattle industry may not necessarily be of much help when it comes to inseminating goats, for the modern method of inseminating cattle (rectal palpation) differs from that of breeding goats (speculum method) considerably. The speculum was used on cattle early in AI history, and some cattle inseminators may be capable of teaching goat insemination.

The cost of getting started in AI, not including semen purchases, will generally run around $500, of which $400 to $450 is tied up in the liquid nitrogen tank, which is necessary for storing semen any length of time. Temperatures must be kept at -320F (-196C) for sperm survival to be maximized at breeding time. It may be possible to share the cost of the tank with neighboring goat owners or dairy farmers, thus alleviating some initial costs of an AI program.

If AI is to be used with any hope of achieving a good level of success, much must be known and well understood by the prospective inseminator.

- basic knowledge of the doe's reproductive organs and their functions
- understanding of storage and handling of semen
- ability to use, in a proper and sanitary manner, the equipment required for inseminating goats
- ability to accurately detect heat at an early stage
- necessity of keeping accurate, up to date records of heat cycles, breeding, kidding, reproductive problems, treatments, and any other pertinent information that may reflect on the goat's reproductive patterns.

Reproductive Organs and Functions

The two ovaries are the sites of egg formation. They produce estrogens and progesterone, and as such are determining factors of heat cycle, ovulation and pregnancy. Basically the estrus (heat) cycle in goats operates as follows:

- Proestrus is the time of follicle growth. As an egg (ovum) begins to mature in an ovary, it becomes surrounded by a fluid filled sac on the outside of the ovary, much like a blister forms on the skin. This growth is accompanied by increasing levels of estrogen in the blood.
- Estrus - As estrogen levels peak, the doe will come into heat. This can be observed by changes in behavior (increased bleating and restlessness), willingness to be bred, and the swelling of the external genital area. The period of "standing heat" (acceptance of the buck) will generally last for 24 to 36 hours.

- Ovulation, or the release of the egg, is accomplished by the rupturing of the follicle, expelling the egg from the ovary, and receiving it into the oviduct via the fimbria funnel. This occurs very near, or soon after, the end of standing heat (6 hours before to 12 hours after). Egg life is 12 to 24 hours, while the sperm lasts 24 to 48 hours.
- Metaestrus - in this stage, the ruptured follicle is undergoing cellular differentation to form a functionally important tissue mass, the corpus luteum (yellow body). This structure is responsible for the secretion of progesterone, a hormone which prevents the development of another follicle and prepares the uterus to receive a fertilized egg.
- Diestrus - is the longest period of the estrous cycle in does. During this period of corpus luteum influence, two events may happen. If fertilization of the egg occurred, the corpus luteum will persist for the entire gestation period, preventing follicular development and keeping estrogen levels low. If no fertilization took place, the progesterone secretions of the corpus luteum gradually lessen, allowing a new cycle of follicular development to begin, with a corresponding increase in estrogen levels. The length of time required for one estrous cycle without fertilization, ranges from 17 to 24 days in goats, with the majority taking 21 days. Shorter cycles are not uncommon (5-10 days).
- The egg, after being expelled from the ovary, passes into the oviduct via the infundibulum, and toward the cornua (horns) of the uterus. This movement is produced by wave-like motions of the ciliated (hair-like projections) cells of the oviduct. Sperm and eggs meet in the oviduct and fertilization occurs in the middle to upper one third of the duct.
- The egg continues into the horn of the uterus, where, if it has been fertilized and undergone several cellular divisions, it will become attached to the uterine wall. If no fertilization has occurred, the egg will degenerate and the cycle goes on.
- The cervix of the uterus plays a key role in artificial insemination, as it is the external entrance to the uterus which must be located and penetrated with the inseminating instrument. The cervix is normally tightly closed, except during periods of heat or kidding. Semen is deposited on the vaginal side of the cervix in natural services, but AI requires the deposition of semen in the uterine side of the cervix. This is because of the greatly reduced volume of semen that is used in AI. If the 0.5 to 1 cc of semen in AI were deposited on the vaginal side of the cervix, there is a good chance that none of the sperm would reach the egg.
- The vagina serves as the connecting tube between the uterus and

the outside opening, the vulva. It is part of the birth canal, and also contains the urethral opening, from which urine will pass during emptying of the bladder.

Purchase and Preparation of Semen

In most cases, the inseminator will acquire the semen needed by direct purchase from a commercial operation, in which case it will be shipped to the inseminator. It is of the greatest importance that the semen be transferred to permanent storage (the liquid nitrogen tank) without exposing it to anything approaching air temperature. Generally, this means transferring the container element which houses the semen directly to the liquid nitrogen tank. Here it can be safely stored for long periods of time, since biological activity practically stops at liquid nitrogen temperatures (-320F). Semen is generally to be used within 6 months, but conceptions have resulted from semen stored for several years, although sperm survival is decreased, resulting in lower conception rates.

Semen Collection Bucks are handled basically the same way as bulls for semen collection. Three basic methods may be employed, but all three require an artificial vagina, a double walled device with an opening at one end and collection tube at the other. The inner lining holding warm water should be coated with a light application of water soluble lubricating jelly.

The three methods of semen collection are:

- A buck may be allowed to mount a doe, with the semen collector manually diverting the buck's penis into the artificial vagina (ram or dog size). Don't touch the penis directly, instead direct the penis into the artificial vagina by grasping the buck's sheath. After ejaculation (usually 0.5 to 1.0 cc) has occurred, remove the artificial vagina and tip it so that the semen will all run into the collection tube. This method may require practice and adjustment by both the buck and the collector before good samples are collected.
- A buck is trained to mount a dummy instead of a live doe. The same procedures are followed for sample collection. Mounting may be facilitated by applying vaginal mucus scrapings of a doe that is in heat to the dummy, at least during the training process.
- Use of electro-ejaculation. The buck is not required to mount an object, although an artificial vagina should still be used for semen collection. An electrode unit, which has a number of contact rings, is inserted into the buck's rectum. Slight electric stimulation brings on ejaculation. This technique generally results in good samples in quantity and quality. However, the sperm concentration of the sample will be lower. This method does not require extensive training, and will allow collections

from bucks that may refuse or are unable to mount and serve an artificial vagina.

Semen, once collected, may be used in one of three different ways:

- As liquid semen, directly or on the same day one ejaculate can serve 3 to 5 does. If kept at body temperature, the semen may be good for three hours.
- Semen may be stored 24 to 48 hours by placing the collection tube in a container of water and putting this unit in a refrigerator. No diluter is needed, although plain egg yolk can serve as simple extender to double the number of does that can be served.
- Semen that is to be stored for longer periods of time must be mixed with a diluter and very carefully frozen. A commercially prepared diluter extender, such as Ortho Semen Diluter is desirable, although plain milk can be used successfully also.

Following are steps in semen extending:

1. With a commercial preparation, use a diluter to semen ratio of 19:1, adding the semen to the diluter, and rolling the bottle gently to achieve a thorough mixing. The semen and diluter should be at the same temperature. This mixture can be stored in the refrigerator and used for a week, or slowly cooled and stepwise frozen for storage in a liquid nitrogen tank for later insemination.
2. For a homemade milk diluter, it is best to use fresh 3.5 pasteurized, homogenized whole milk. It must be heated and held at 210F for 10 minutes in a glass boiler, keep the lid in place so that no moisture is lost. Next, the milk is cooled in a water bath with the lid on. When the milk is in equilibrium temperature with the water bath, the water condensation on the inside of the lid is shaken back into the milk. To every 400 cc of milk, add 100,000 units of potassium G crystalline penicillin and 500 mg crystallin di-hydrostreptomycin sulfate, mixing well. Warm this diluter to about body temperature before adding the fresh semen at 19:1 ratio. Place the diluted semen in a water bath at body temperature of 101F and allow to cool slowly. Semen may be frozen, if the extender contains an antifreeze compound, slowly, stepwise for storage on dry ice or in liquid nitrogen.
3. A microscope, capable of 900x magnification is an essential tool when doing your own semen collection in order to determine semen quantity and quality. First, place a semen sample on a clean slide and cover with a coverslip or another slide. Set the magnification to 400x and observe the appearance of dark patches or spots thru the scope; four dark areas or more per microscope field represent high concentrations of sperm, a really good sample. Three dark areas is somewhat chancy for use at a diluted service, but is good enough for natural service. Two dark

areas should be used only for natural services and one dark area means that the concentration of sperm is too low for even natural service. Switching to 900x, the sperm cells can be individually observed for normal structures. Diluting in warm saline is helpful. Coiled tails, broken tails, absence of tails and abnormal shapes all constitute deficient sperm cells. Sixty to 70% good motility before freezing should be observed in a good sample, with a minimum of 30% motility after freezing and thawing.

Any insemination program, no matter how carefully carried out, will yield poor results if the concentration and quality of the collected sperm is not of high standards. Sophisticated techniques of washing the sperm free of seminal plasma before extending and freezing will improve post-thaw viability.

The concentration of a buck semen ejaculate can be determined accurately by using a red blood cell diluting pipette and standard hemocytometer techniques. Typical results during the breeding season are 3 to 5 billion sperm per cc. Optical density can also be used to estimate sperm concentration if the photometer has been calibrated for buck semen. A simpler technique involves the determination of a spermatocrit using microhematocrit pipettes. The aliquot of semen is centrifuged for 10 minutes; for each percentage point of packed sperm, approximately 200 million sperm cells per cc are present. Correction is made for the percent motile sperm, after which the ejaculate can be diluted appropriately to supply a minimum of 125 million motile sperm in each breeding dose. It is often difficult to introduce more than 0.2 ml of semen into the cervix, so dilution to a final concentration of 600 million to 1.2 billion live sperm per cc has been recommended. When no laboratory support is available, fresh semen for immediate use may be diluted up to 5 times in extender if it is yellowish and 10 times if the ejaculate is white. A straw holding 0.5 cc of this diluted semen will provide adequate sperm if excessive reflux does not occur.

Storage and Removal of Semen from the Liquid Nitrogen Tank

A liquid nitrogen tank is basically a very large thermos-bottle in which liquid nitrogen is placed to keep the inner temperature near -320F (-196C). The spacing between the inner and outer walls is insulated and under vacuum. The temperature in the tank is maintained uniformly at -320F up to the bottom of the tank neck until the liquid nitrogen level gets down to around 5". To measure liquid nitrogen, use a piece of black metal rod that is long enough to hold and touch the bottom of the tank. Dip the rod to the tank bottom and remove after 30 seconds. By waving it in the air, a white frost line will appear on the rod. This line indicates the liquid nitrogen depth of the tank. Levels nearing 5" require a refill. The only real differences between tanks is their storage capacity (number of ampules or straws that they will hold) and their length of

holding time (liquid nitrogen evaporation rate). The neck diameter varies somewhat also, with wider openings being easier to work with, but an increased evaporation rate usually results.

When working with semen in the liquid nitrogen tank, it is important to keep the racks below the frost line in the neck of the tank. Removal of semen from the tank for periods as brief as 10 seconds, such as for identification, before replacing it to the tank will often result in lowered fertility levels. If the right rack can't be located in 5 seconds, lower the canister back to the bottom of the tank for at least 30 seconds before trying again. Also, when handling semen, try to stay out of any direct sunlight, as ultraviolet light has a spermicidial effect.

The semen comes in two basic types of packaging: ampules (1 ml) and straws (0.5 or 0.25 ml). The ampule is the most common type of packaging for buck sperm. Both ampules and straws are stored in racks (canes), which are aluminum pieces that hold a vertical row of ampules, usually six.

A few key reminders concerning semen storage:

- Always keep the liquid nitrogen level above 5".
- Never lift a canister above the frost line of the tank.
- When the semen is removed with a forceps from the tank it should be placed immediately in the thaw box.
- Never expose semen to direct ultraviolet light.
- Never refreeze semen that has been thawed as it will be destroyed.
- Check for proper identification on ampule or straw.
- A defective ampule may blow up after it is removed from the tank. This is due to a small leak that allows nitrogen to enter the ampule. When removed from the tank, the gas expands too rapidly to vent back out the hole and it explodes the glass. A hissing sound is usually audible when it is removed. Keep your hand between the ampule and your face when putting it into thaw box.
- Always wear gloves and goggles for your own protection when working inside a liquid nitrogen tank.

Thawing Procedures

Methods for semen thawing vary among manufacturers, and it is best to follow their recommendation. The thawing procedure for 1cc ampules, the most common for goat semen, is generally the ice water bath.

Ice water (38-42F) is placed in a styrofoam box long enough before-hand to allow temperature to equilibrate. Remove the ampule from tank and place immediately into thaw box. Ampule may be placed

in a small plastic cup with holes in the bottom. This prevents ice from coming into direct contact with ampule. Ampule should thaw in 3 to 5 minutes. Check for slushiness and allow more time if needed. Ampule may sit in ice water for as long as 30 minutes with no damage. Once removed, the semen must be used right away. The layer of ice on the ampule must be peeled off before opening to avoid possible contamination. The ice water thaw method is especially good during winter breeding of does because of low risk of cold shock to thawed and exposed semen. Thawing of semen can be done from -320F rapidly, but any subsequent exposure to lower temperatures after thawing will kill many or all of the sperm.

The warm water method of thawing is more exact than the ice water method, but probably will not work in cold weather, although it may give somewhat better results the rest of the year. The procedure is basically the same as for the ice water thaw except that the water must be maintained at 92 to 98F. This requires a source of warm water and an accurate thermometer. Thawing will be complete in about 1 minute with no ice layer formation of the ampule. Ampules thawed with the warm water method should be used within 5 minutes.

Straws (0.5 or 0.25 ml) can be thawed by either of the previous two methods. A given amount of semen in a straw will take about one half as long to thaw as an equal amount in an ampule. Many inseminators simply thaw straws by placing them into their shirt or pants pocket.

Inseminating Procedures

All the care in handling, storage and preparation of semen will be useless if the inseminating process is not done carefully and cleanly. Hygienic practices at this point cannot be over-emphasized. All reusable items such as inseminating guns (for straws), scissors for cutting straws, scribe for cutting ampules, etc. must be wiped clean with 70 0sopropyl alcohol and allowed to dry before reuse. Disposable items should be kept in their sealed packages until they are to be used. The speculum should be sterilized after each use (this is one reason why the cattle industry discontinued the speculum method; the inseminator would have to carry a few dozen specula on his daily rounds, sterilizing them each night). This is best accomplished by boiling for 10 minutes, allowing to air dry. Then place inside a sterile container or wrapping, such as a new plastic AI glove. Disposable plastic type specula for goats can be obtained from mail order companies, eliminating the need for constant resterilization.

Materials needed for artificial insemination:

- Speculum, Pyrex 22 x 175 mm for doelings; 25 x 200 mm for adult does; or stainless steel human vaginal speculum; or plastic disposables; with a small clip-on flashlight.

- Sterile lubricating jelly (K-Y)
- Thaw box
- Inseminating pipette with bulb or syringe (ampules only) or Inseminating gun (straws only)
- Paper towels
- Facility for securing doe (stanchion, fence, rope hoist)
- Recording journal for breeding dates, buck's name, etc.

Preparing Ampules:

1. Partially remove an inseminating pipette from its plastic bag.
2. Place bulb or syringe on exposed end.
3. Thaw ampule according to the described methods.
4. Dry ampule after thawing, hold in paper towel and scribe (with proper tool) one side of ampule collar. Some ampule types do not need to be scribed, but can be snapped open.
5. Pull syringe back 1/2 cc on plunger or squeeze bulb closed before placing pipette into ampule. Tip ampule to slight angle and maintain constant suction on pipette while it is slowly inserted into the ampule. Try to get all the semen into the pipette, keeping the semen column down near the end of the pipette.
6. When filled, the pipette should have a semen column with no air spaces, with the bottom of the column being 1 to 2" from the pipette tip. Do not draw semen into the syringe or bulb.
7. Keep the ampule for information to complete breeding records.
8. Keep the pipette away from sunlight or cover with paper towels.
9. The semen is now ready to be placed into the doe in estrus.

Preparing Straws:

1. An inseminating gun, designed for your type of straw is needed, obtainable thru farm supply houses or the local cattle AI technician. Have cover sheath available, sealed until needed.
2. Place straw in thaw box.
3. Remove when thawed, wipe dry. Check buck information.
4. Pull plunger on gun back 4 to 6" and insert straw into gun, cotton plug end first (towards plunger).
5. Hold gun in upright position, allowing air bubble to rise to the sealed end.
6. Cut sealed end of straw with scissors. Take care to cut straw squarely for proper seating.
7. Install the sheath over the gun, fastening it down with the provided O-ring. Install it so that the wider side of the ring faces the straw, with the narrower side facing the syringe end.

Insemination:

Assuming that the doe has been observed in heat, has been suitably restrained (i.e. in stanchion) and the steps for preparing the ampule or straw have been followed. The next steps are:

- Position doe on milk stand. The inseminator places his left foot on the stand and drapes the hindquarters of the goat across his horizontally positioned thigh. The goat is allowed to stand as long as she does not struggle or collapse. The vulva is cleaned.
- Hold pipette or inseminating gun, wrapped in a paper towel, in your mouth; or let someone else hold it if extra hands are available.
- Turn head light on and insert lubricated speculum in a slow and gentle manner. Begin entrance at a somewhat upward angle for the first several inches. This is to prevent the speculum from scraping across the vaginal floor, possibly doing damage to the urethral opening.
- Complete insertion of speculum and locate cervix. Center the end of the speculum over the os uteri (entrance to cervical canal).
- Cervix should be of a red-purple coloration with a viscous whitish mucus present if doe is truly in heat.
- Insert pipette or inseminating gun into speculum to the cervix. Gently manipulate the instrument through the cervical canal (cervix is 1 to 2" long) to the 4th or 5th annular ring.
- Deposit semen near the uterine end of the cervix or just inside the uterus. Do not enter too far into the uterus as the semen will then tend to be dumped into one horn or the other. If the semen is pushed into the wrong horn (i.e. egg produced in left ovary, semen dumped into right horn) then fertilization may not occur.
- Deposit semen slowly, taking at least five seconds.
- Slowly withdraw instrument without release of syringe or depressed bulb, then carefully remove the speculum.
- Record all pertinent breeding information.
- Carefully discard all disposable materials. Arrange to sanitize reuseable items and sterilize the speculum (if it is a non-disposable type).

Frequently, the pipette cannot be passed all the way through the cervix even though the doe is in heat. If it has penetrated deeply into the cervix (3 to 4 cm, as determined by laying another pipette alongside the first and observing the distance by which the outer ends are offset), cervical insemination will provide a conception rate almost equal to that of intrauterine semen deposition. The conception rate expected from intra-vaginal insemination, however, is less than 30. If semen is very valuable, it may be advisable to pass a trial pipette to determine patency

of the cervix before thawing the semen unit.

In France, a doe is usually restrained by a second person who straddles the doe's neck and elevates the hindquarters to a vertical position while holding the hind limbs tightly flexed. The inseminator is free to stand in a comfortable position. He holds the speculum and the goat's tail in one hand and the pipette or straw gun in the other hand. If excess mucus is a problem, the assistant lowers the goat's hindquarters almost to the ground; if the mucus does not run out of the speculum, the latter is removed and shaken to clear it. The goat is then lifted to its former position. If many goats are to be bred, the assistant may tire using this technique. If the doe is not held in a vertical position, it is often impossible to adequately visualize and penetrate the cervix. Various slings have been devised to suspend the goat in the appropriate position.

Angora Goats

Angora goats may be the most efficient fiber producers on earth. These makers of mohair came from and were named after Ankara (Angora prior to 1930), the Turkish province where they have thrived for centuries. Turkey guarded these goats against exportation until 1849 when seven does and two bucks were imported into the United States. Later, more were imported from Turkey and South Africa, the two principal mohair producers in the 19th century. But now, the United States has become one of the two biggest producers (along with South Africa) of mohair - the long, lustrous, wavy hair that goes into fine garments. The other primary fiber from goats is cashmere. Never the twain should meet! To cross Angora with cashmere goats results in a fiber called cashgora, with very limited uses and characteristics of neither fine fiber. The two goat types differ in temperaments, too. The Angoras are pretty laid back and docile, while cashmere and/or Spanish meatgoats are often flighty and high strung. (Incidentally, Angora goats, which do produce mohair, do not produce Angora hair; only rabbits can produce that.)

Although Angora goats are somewhat delicate, they grow their fleeces year-round. This puts considerable strain on the animal and probably contributes to their lack of hardiness. About 90 percent of the U.S. mohair clip originates in Texas, but the goats are raised over wide areas of the United States. They adapt well to many conditions, but are particularly suited to the arid southwestern states. Central and southwestern Texas have all the major mohair warehouses.

Shear twice a year

Angora goats are sheared twice a year, before breeding and before kidding. The hair grows about 3/4 of an inch a month, and adult hair should be 4-6 inches long at shearing. Shearing most often follows the

method developed by the Mexicans, with the goats lying down with legs tied. Shearing should be done on a clean-swept floor or sheet of plywood. Care should be give to keep mohair clean and free from contaminants-weeds, grass seeds, or urine. Buyers severely discount unclean hair and hair showing second cuts. Fleeces should be bagged separately in 6-foot burlap bags. Not acceptable are polyethylene bags or poly twine. Each bag should show the grower's name marked with a permanent-type felt-tip pen, be tagged, and contain only one fleecetype clearly marked: Kid, yearling, young adult, adult, buck and stained with spring or fall clip. Special problems, such as burns or coarse, extra long, or short fleece, should also be listed. Buyers slit the bag's side when inspecting before buying; sellers must present a uniform product. An adult goat usually will produce 8-16 pounds of mohair ayear. Kid mohair should be 4 inches long, is finer, and may yield 3-5 pounds a year. Mohair fiber diameter ranges from 20 to 40 microns. If kemp fiber (long, straight, hollow and brittle) shows up on any goats, especially along the backbone and thighs, such "kempy"animals should be culled, as suggested by the U.S. Mohair Marketing Board. Kemp fiber breaks easily and does not readily accept dye. The U.S. Government has a direct-payment program for mohair producers which helps maintain a viable industry. The direct payment through the U.S. Department of Agriculture's (USDA) Agricultural Stabilization and Conservation Service (ASCS) is based on thedifference between the national average market price and a support price. In one recent year, producers received an average of @2.475 for every dollar's worth of mohair marketed. Details can be found at ASCS offices in many counties.

Selecting Bucks

Bucks should be chosen for body conformation and fine hair. Preferred are open-faced bucks not blinded by hair. Bucks should be left with does for 6 weeks. Angora goats are seasonally in estrus. The normal breeding season is from late September into December. The gestation period for goats is usually 150 days, but it can vary several days each way. Kids are usually dropped from late February through April or early May. Twins may account for 40 percent of births, with a much lower percentage being triplets.

Fiber Comes First

Angora goats have high nutrient requirements and give nutritional advantage to fiber growth at the expense of other demands. Meeting nutritional needs should be the producer's main concern. Range forage of browse and forbs, protein supplements, grain and crop residues, and cereal crop pastures can help supply needed nutrients for growth and reproduction. Goats, browsing animals, can be pastured with sheep and cattle; each species prefers different plants. Goats prefer brush, tree leaves, and rough plants. They can improve pasture, clear reforestation

areas, control leafy spurge and destroy multifloraroses, red cedars, sand burs, knapweed, hound's tongue, Canadian thistle, sagebrush, backbrush, giant ragweed, sunflowers, and many other weeds. When growing plants are not available, Angora goats need supplemental hay and perhaps grain. While gaining at breeding time, young does should weigh at least 55 pounds (sheared weight) and mature does at least 75. Does need extra feed before and after breeding so fetuses can develop hair follicles. During pregnancy and lactation, does need almost 1/2 pound of crude protein daily. Supplement feeding must start as soon as does begin to lose weight and condition. Improved nutrition brings more and better big growth kids and heavier fleeces. Poor nutrition is the leading cause of abortion and poor mothering. Young or lighter-weight goats are most subject to abortion. Stress from disease, moving long distances, or cold wet weather also cause abortions. Goats should be given adequate nutrition before and after shearing.

Angora goats must be able to take shelter from wet and cold; great death loss can occur without shelter for 4 to 6 weeks after shearing. Goats to not carry layers of body fat, unlike sheep.

Kidding on the Range

Due to lack of labor and facilities, large herds are usually kidded on the range, while many smaller herds use a more intensive confinement system. For open-range kidding, small pastures with shelter, centrally located watering and supplement feeding areas, and bedding spots reduce numbers of lost kids. Angora does and kids should be undisturbed for several weeks, since does may abandon their kids. When goats are moved, pastures should be rechecked for kids. An even more intensive kidding system uses buildings, small individual stalls, heat lamps, and feeder space. This "system kidding" can be done earlier in the year but is much more labor intensive and therefore more expensive. But a larger kid crop can be realized with good management. Before kidding, does should be outdoors except in cold or wet weather or at night; this helps keep bedding cleaned and dry and encourages needed exercise. As does kid, they should be moved into stalls and kids' navels treated with 7 percent iodine. C and D antitoxin should be given. Cold kids will not try to suck and may need a heat lamp. When warm, they will usually suck by themselves but may need help to begin. Angora kids, very sensitive to cold, can die within a short time if too chilled. Immersion in warm water to speed restorationof body temperature and then thorough drying may save severely chilled kids. After identification with matching paint or ear tags, well fed does and kids can be moved to group pens or holding areas. Twins and triplets should not be grouped with singles since stronger kids often rob milk from usually smaller multiple-birth kids. Groups should contain kids of similar age.

Parasites Trouble Goats

Among goats, major health problems are internal and external parasites, coccidiosis (in kids before and after weaning), and pneumonia. A good health care program includes vaccination for most diseases and should be established between a grower and a veterinarian. Goats' hooves may need to be trimmed, depending upon walking conditions. Rocky ground may take care of that problem.

Goats may need special 4-foot-high fencing to keep them in and predators out. Goats like to go under or through obstacles. Five wire electric fences, with three wires hot and two grounded, make a good system. Woven wire fences may be used with the addition of a 12 inch "outrigger" electric wire about 12 inches above ground. Small-mesh fencing also may be used. Horns caught in the fence or the crotch of a tree become life-threatening, not only from predators but also from other goats. While most goats are not aggressive toward humans, they are not always kind to other goats and in seconds can do serious or lethal damage with their horns. A goat raiser may find horns useful-as handles. For safety, both for the handler and for other animals, horns' sharp points may be clipped, using a bolt cutter or similar device.

Angora Goat Production

Angora goats are an important enterprise for ranch operators in certain areas of Texas, mostly, but also in New Mexico and a few other Western states. Angoras produce income from the sale of mohair and meat. They also are used for biological control of brush and weeds in range improvement programs. Production costs have increased in recent years. This places a heavier burden on the ranch manager for decision making for greater efficiency in production and higher economic returns.

Goats require the same major production resources as other species of livestock. These include land, labor, capital and management. Goats often are grazed on forage land less suited for other livestock. They prefer browse, thus are not totally competitive with cattle and sheep for limited land resources. However, goats must convert forage into salable products to justify their presence in most multi-species operations. Since land is a costly resource in ranching operations, goats should recover their share of the costs.

The total annual cost of maintaining an Angora goat varies by area and from ranch to ranch. This is influenced by the productivity of the land resource and by the level of management. Annual income per goat also varies for the same reasons.

Type of Production

Doe and kid operation should consist of a flock of healthy animals of productive age, three to six years of age.

- Raise replacements to make improvements in flock.
- Keep Spanish or meat-type animals separate.
- Sell all crossbred kids so they do not become mixed in the Angora flock.
- Replace wether goats for mohair production when the mohair becomes coarse and loses its character.
- Stock goats at a rate that will insure maximum mohair production with a minimum of supplemental feed.

Range Management

Use stocking rates consistant with the area of production. Practice mixed grazing of livestock consistent with the area of production. Practice rotation grazing for pasture improvement and internal parasite control. Follow range improvement practices recommended for the area and consistent with ranch economics. Make use of supplemental grazing when available.

Breeding Practices

Flush does by supplying 1/4 to 1/3 lb of supplemental feed daily or move to a fresh, rested pasture about two weeks before turning bucks out. Protein blocks may be used in flushing when range conditions are not too severe. When ranges are extremely dry, it may pay to give does vitamins A, D and E two weeks before breeding.

Follow a good selective breeding program. Mate best does to best bucks, second best does to second best bucks, etc. Save replacement does from top two groups. Adaptability to the area of production is probably the most important single point. Good bucks are essential to a good selective breeding program. Purchase bucks from one breeder whose goats possess the desired characteristics to produce a uniform flock. Select animals for quantity and quality of mohair but do not sacrifice size and vigor. Fleeces also should be uniform in quality and length over the body of the goat

Use three to four bucks per 100 does, depending upon the size, brushiness and roughness of the pastures. Avoid using one buck per pasture in commercial goat production. Condition bucks by supplemental feeding about two weeks before turning them out. Breed does in September and October for February and March kids. It is not good management to run does and kids in the same pasture with wether goats. Wether goats travel too much.

Supplemental Feeding

Angora goats respond to supplemental feeding more than other livestock. They reflect this through heavier fleece weights. Feed goats during dry periods and especially during the winter months. Feed 1/4 to 1/2 lb of cottonseed cake, 1/2 to 1 lb of yellow corn or 1/2 to 3/4 lb of goat cubes per head daily depending upon the condition of the pastures and the does. Pregnant does require larger amounts of feed than dry animals. Abortion often can be prevented by supplemental feeding.

Self-feeding, using salt as an inhibitor, may be used in large, rough or brushy pastures. Keep salt as low as possible and place the feeders 3/4 to 1 mile from water. Move feeders for better pasture utilization. A popular mixture is three parts of ground milo, one part cottonseed meal and one part salt. Salt-controlled feeding is not recommended unless all other methods are impractical.

Feed kids during winter months to insure good growth and development. This will improve the kid crop on two-year-old does. Cull undeveloped kids that do not learn to eat. Protein blocks may be fed during kidding season. This method of feeding prevents kids from becoming lost from their mothers.

Kidding

Use rested pastures for kidding and do not disturb does during the kidding season. Kid in a small pasture, confine kids and let does out to graze until kids are large enough to follow mothers.

Marking

Vaccinate kids for soremouth and earmark for identification when most of the kids are large enough to travel. Plastic ear tabs are a practical way of identification. Castrate kids the following December or January or when the kids are about nine to ten months old. This produces a heavier horn on wether goats that buyers prefer.

Shearing

Spring shearing time is January through March depending on the area of production. Goats may be shedded during this period. Goats may be caped. Caping is the practice of leaving a strip of unsheared mohair about eight inches wide down the neck and back of the goat. This should be sheared after a month or six weeks. If capes are not sheared, they should be taken out and packed separately at shearing. Goats may be sheared with special goat combs. These combs leave about 1/4 inch of stubble on the goat and give him about two weeks start over goats sheared with regular combs. Producers usually supply the special combs and pay a small premium for shearers using them. Goats are sensitive to weather changes for a month to six weeks following shearing.

Fall shearing runs from July through September. Most producers shear with regular combs in the fall but some prefer the special combs. The responsibilities of the producers are to:

- Provide a clean place to shear.
- Instruct the shearing crew so they know what is expected.
- Separate kids and third shearing goats from older goats so they can be sheared separately.
- See that goats are dry and not too full for shearing.
- Supervise the shearing pen or provide a supervisor other than himself.
- Register complaints with shearing crew captain.
- Caution shearing crew about cutting off teats of does.
- When mohair contamination ("vegetable matter") is a severe problem, a change in shearing dates may be advisable.
- Do not pack mohair in plastic bags.

The responsibilities of the shearer are to:

- Keep fleeces clean and remove each fleece in one piece.
- Avoid double cutting.
- Avoid injury to animals.

Spraying

Spray goats out of the shearing pen and again in twelve to eighteen days for best control of external parasites. Change sprays occasionally to get best control. Spray so goats will dry before dark. Use only recommended sprays or dips in strengths advocated by the Food and Drug Administration. Follow guidelines for spraying or dipping animals to go to slaughter. Do not spray under a shed or barn. Spray with the wind, not against it. Do not mix solutions with your hands. Spray or dip animals at a time of day when you will be able to bathe and change clothes. Do not mix chemicals.

Drenching

Watch animals closely for signs of internal parasitism and drench as necessary. Drench out of the shearing pen using one of the recognized drenches. Change drenches occasionally so that parasites do not build up resistance to any specific drench. Move animals to a fresh pasture following drenching. Phenothiazine salt is not recommended for goats because it stains the mohair. Use care in drenching animals so that the linings of the mouth and throat are not injured.

Weaning Kids

Leave kids in the pasture and move does. Kids are familiar with the

pasture and know where to water and rest. Wean in the drylot. This practice gentles kids, teaches them to eat and builds up their strength. Do not wean in an overgrazed, internal parasite-infested pasture. When weaning in a different pasture, move kids to a rested pasture along with a few gentle does who can lead them to water.

Marketing

Some producers sell kids out of the hair after first shearing. Most producers prefer to market as yearlings after the second shearing. Sell through a reputable commission man or through an auction that specializes in handling goats. Market mohair through one of the recognized wool and mohair warehouses. Select one that provides service to meet your requirements. If the bulk of your clip is finer than 24s, it may pay to have your clip graded. Follow the recommendations of your warehouseman in preparing and marketing your mohair. Do not artificially oil goats.

Defect Control

Rearrange shearing dates so that a minimum of plant matter is in the fleece. Use supplemental pastures to avoid vegetable contamination. Provide for control of burr-producing plants in your pasture improvement program.

Records

Keep accurate records of percentage of kid crop, fleece weight by age group and staple length to assist with the breeding program. Keep records of costs and returns to aid with income tax returns and planning business program of the ranch.

Angora Goat Selection

The Angora goat has been selected almost exclusively for fiber (mohair) production, and as such can be considered one of the outstanding success stories in animal breeding. Many Angora goats produce up to 20-25% of their body weight annually in fiber. In terms of growth rate of mohair fiber, they produce approximately double the rate of most types of sheep. Expressed as a function of body weight or feed intake, their rate of fiber production is about four times that of most sheep. However, since a high proportion of their nutrient intake is expended for fiber production, Angora goats are relatively poor meat or milk producers. Of course, slaughter of cull breeding stock provides some meat. It may be possible to develop dual-purpose meat and fiber producers, but only under conditions of better nutrition than that where most are run at the present time. Thus, for this discussion it is assumed that Angoras are bred primarily for fiber. The possibility is recognized

that Angoras are kept for their usefulness in clearing brush and weeds on the farm or ranch also and that some are simply pets.

In selecting for fiber, one is interested in both quantity (weight) and quality of fiber (length, fineness, style, character, absence of kemp, etc). In addition to fiber, one must be concerned with traits that contribute to the survival or viability (soundness, fertility, etc.) of the individual and flocks.

Selection for quantity of fiber is accomplished efficiently by using fleece weights of those Angoras (mostly young males or young females) which are being considered for use as breeding animals. However, history indicates that most producers practice visual selection. In this case the predicting indicators of fleece weight are: size of the animal, completeness of cover, length of fiber, diameter of fiber and differences in density. The amount of grease (oil) or dirt in the fleece contributes to overall fleece weight, but not to fiber weight. It is preferable to emphasize fiber weight over total fleece weight. Environmentally (i.e. phenotypically), the two tend to be positively correlated, but genetically they are negatively related since the oil production requires a substantial amount of feed-energy. Similarly, one should not overemphasize the size of Angoras as a means of obtaining fleece weight.

Phenotypically, size and fleece weight are positively related but genetically they tend to be negatively correlated. For assessing efficiency of production, the genetic correlation is the more accurate term since it is not possible to produce meat and fiber from the same units of feed-energy. Fiber diameter is phenotypically and genetically positively related to fleece weight, but negatively to fleece quality since the finer fiber is more desirable. Completeness of cover includes mostly head, neck, belly and legs. They are genetically related to fiber production. Face cover, however, can interfer with vision and have serious effects on the animal's welfare. This is even more true with range goats where reduced vision can interfer with their ability to graze selectively. The amount of mohair cover on the face contributes little to total fleece weight, but is genetically linked to total cover at other points. The amounts of fiber on neck and belly make important contributions to fleece weight, but the value of fiber grown on the legs (below the knee or hock) is rather low. Therefore, selection for body cover should be limited to the neck and belly, primarily the former. Animals with extensive cover in the face should be eliminated.

Selection for mohair quality includes primarily fiber diameter (finer fibers preferred), length (four inches minimum), freedom from kemp (coarse, brittle, chalky white hair mixed in the fleece), and desirable lock formation. There is little technological support for selecting for a specific lock type or formation, but in the absence of detailed studies it

seems undesirable to allow the fleece to become straight or without some more appealing lock character.

Limited research indicates that all the desirable economic traits of Angora goats are moderately to highly heritable and can thus be changed through selection. Some strong negative relationships exist. Also, problems may be encountered due to genetic, environmental interactions. For example, selection for high level of fiber production tends to make the animal poorly adaptable to the range conditions under which most are produced presently.

Age of selection deserves some discussion. Weaning or first shearing is a poor time to select Angora goats. The second and third shearing (one year and 18 months) provide a much better age to appraise the fiber production potential. Angora goats tend to have high longevity. Thus, culling of Angoras with advancing age can be based on fiber production and less on teeth wear as practiced with sheep. Fleece weights tend to deteriorate (quantitatively and qualitatively) with advancing age. Removing Angoras with deteriorating fleece production can improve directly the evaluation of fleece traits and long-term selection.

Arthritis

The limb joints of animals are designed for mobility. In conjunction with the muscles and tendons, the joints allow for flexion and extension of the legs and permits a wide range of motion and activity. Normal joint function is essential for good health, particularly in grazing animals such as goats which may have to cover large areas over varying terrain in search of food. Normal joint function also allows flight from predators and is important for breeding success in active bucks. In addition, lameness or swellings over joints may reduce an animal's chances in the show ring.

Normal limb joints are comprised of several structures. First are the bone ends, covered with cartilage and shaped to interlock for increased stability. The cartilage is quite smooth, for reducing friction and wear in the joint. A space exists between the cartilage surfaces called the joint cavity. This space is filled with joint (or synovial) fluid which lubricates the joint and acts as a shock absorber to reduce the trauma associated with movement. The fluid is held in place by a fibrous joint capsule which is lined with a synovial membrane that produces the joint fluid. Outside the joint capsule are numerous ligaments, muscles and tendons which add further strength and stability to the joint. The tendons are also surrounded by sheaths containing fluid known as bursae. Inflammation of the tendon sheaths is known as bursitis. Inflammation of the joint from any cause is known as arthritis. Any or all of the structures comprising the joint may be damaged in arthritic

conditions.

Recognizing Joint Disease

Arthritis may result from a variety of infectious and noninfectious causes. A single joint may be affected or multiple joints involved (polyarthritis). Depending on the cause, signs of arthritis may vary. For example, in bacterial or traumatic arthritis, the affected joint may be swollen and warm to the touch. In early viral or nutritional arthritis, no visible change may be detected in the joint. In these cases, the presence of arthritis is suggested by observation of signs such as reluctance or difficulty in rising, slowed return to the barn at milking time, inability of bucks to mount does at breeding time, limping or uneven gait, or complete disuse of a single limb. Even when these signs are noted, other conditions which might result in abnormal motion should be considered. These would include fractures, laminitis or founder, foot rot, and white muscle disease (vitamin E/selenium deficiency). In addition, various neurological problems may be misinterpreted as musculoskeletal disease.

Several diagnostic procedures may be employed to identify the cause of arthritis. Examination of the joint fluid obtained by aseptically tapping the joint may be useful. Large numbers of neutrophils in the fluid are suggestive of bacterial arthritis. Large numbers of mononuclear cells are more indicative of viral arthritis. Little change in the fluid composition may be observed in traumatic or nutritional arthritis. In the case of bacterial arthritis, joint fluid may be cultured to identify the causative organism and to select the appropriate antibiotic therapy.

In cases of nutritional or traumatic arthritis, radiographs may be helpful in establishing a diagnosis and prognosis for recovery. Serological testing may be required for the diagnosis of arthritis due to virus or mycoplasma. Successful treatment of individual cases of arthritis and control and prevention of additional cases depends on accurate and specific diagnosis.

Specific Causes of Caprine Arthritis Bacterial Arthritis

Lacerations or puncture wounds over joints can lead to bacterial infection. Injuries such as these should be cared for immediately. The affected area should be cared for immediately. The affected area should be cleaned thoroughly with soap and water. If the joint has been opened, suturing may be indicated. Antibiotic therapy should be initiated to prevent infection. In young kids, bacterial polyarthritis can occur. The organisms involved are usually E. coli, Corynebacterium pyogenes, or staphylococci. The condition is recognized by lameness and swelling in one or more joints, particularly the front knees (carpi), hocks and stifles. This condition is secondary to bacterial infection elsewhere in the body, usually the navel or digestive tract. The bacteria

are carried to the joints via the bloodstream. Therapy is often ineffective and prevention is the preferred method of control. Unclean environment and improper kid care promote the incidence of polyarthritis. Improved management practices will reduce the occurrence of this disease. Maternity pens should be used for kidding, and kept clean and dry with bedding changed between births. Navels of newborns should be dipped in iodine immediately after birth. Kids should receive adequate colostrum within six hours after kidding. They should be housed in warm, dry quarters, and not overcrowded.

Mycoplasma Arthritis

Mycoplasmas are small microorganisms which differ from bacteria in that they do not have a cell wall. They are difficult to culture in the laboratory and much confusion exits with regard to the species of mycoplasma responsible for caprine arthritis in the United States. Several species of goat mycoplasmas are known in the US but Mycoplasma mycoides subspecies mycoides, large colony type, appears to be most responsible for cases of mycoplasmal arthritis. The prevalence and distribution of caprine mycoplasma arthritis is unclear, and sporadic reports from several regions of the US have appeared in the veterinary literature, most notably from California.

Mycoplasma infection produces a severe systematic disease in which arthritis may be the only sign or may be accompanied by high fevers, inappetence, pneumonia, diarrhea, keratoconjunctivitis (pink eye), or sudden death. All animals in a herd may be affected, but the more dramatic signs are seen in kids and younger adults. Outbreaks are often preceded by some stress such as dehorning. The infection may be carried unnoticed in a herd for extended periods.

Whenever several animals in a group are suddenly affected with arthritis along with signs of illness elsewhere in the body, mycoplasma should be suspected. Any dead animals should be submitted to a diagnostic laboratory for specific diagnosis. Blood samples from living animals should also be taken for evaluation of titers to mycoplasma infection. Correct diagnosis is important since few antibiotics are effective against mycoplasma. Tylosin and tetracyclines may be useful in controlling herd outbreaks although losses may be high.

Viral Arthritis

(CAE) A recently discovered retrovirus has been identified as a cause of chronic arthritis in goats. It is very likely that many previously unexplained cases of caprine arthritis were the result of this slow virus infection. The caprine arthritis encaphalitis virus (CAEV) was first recognized as a cause of progressive paralysis in two of four month old kids resulting from infection of the brain (encephalitis). Later it was demonstrated that the same virus also produces a progressive chronic

arthritis in older goats. The presence of this virus in the US goat production is believed to be very high.

Nutritional Arthritis

One specific syndrome of arthritis related to feeding deserves mention. It involves the excessive consumption of calcium in the ration by mature bucks. Lactating does and young growing animals may require supplemental calcium in the diet. However, mature bucks fed in similar ration are likely to develop arthritis due to excessive deposition of calcium in the bone (osteopetrosis). Proliferative calcification (osteophytes) forming on the margin of joints disrupts normal joint architecture and may impair mobility and breeding effectiveness. Osteophytes may be visible radiographically. To prevent this problem, mature bucks should be fed either grass hay or not more than two pounds of alfalfa hay daily.

Traumatic Arthritis

Because goats are prone to fighting, traumatic joint injuries (sprains, dislocations, torn ligaments) are not uncommon. Sudden lameness and swelling of a single joint without fever is suggestive of traumatic injury. Affected goats should be isolated and confined with exercise restricted. The joint may be wrapped with an elastic bandage and cold compresses applied to minimize swelling. The animal may be placed on aspirin to reduce pain and inflammation. The degree of recovery is dependent on the extent of the injury.

Other Causes of Arthritis

Herd outbreaks of polyarthritis in lambs due to Chlamydia sp., a virus-like organism, are known to occur in the United States. It has been suggested that chlamydial arthritis in goats also occurs, especially in herds which have experienced outbreaks of chlamydial abortion. As interest in and recognition of caprine diseases continues to develop in the United States, chlamydia as well as other organisms may be identified as causes of arthritis in goats.

Avoid Residues in Goat Meat and Milk

The wholesomeness of American food is a cherished goal for all involved in the production and processing of edible goods. In cooperation with producers, federal regulations ensure that food is safe and free from objectionable levels of residues. All persons involved in the daily production of meat and milk are constantly aware of the necessity to closely monitor their management practices to assure that their products, whether used on the family table or sold for processing, meet accepted standards.

Occasionally, animals become ill and require medication. Goats are no exception. However, the owner has little guidance in the use of medication because few drugs are labeled for goats and professional advice often is not available. As a result, treatment of an ailing animal may require a more cautious approach when deciding on the method of drug application and dosage. There is a greater chance for error and the possibility that goat meat and milk could contain unwanted chemical residues for an extended period of time.

A survey conducted among goat breeders in Pennsylvania as part of the USDA Residue Avoidance Program found that many goat owners subscribe to the organic method of food production. An awareness of situations that could induce residue problems in any food supply appears to be foremost in their management programs. Even so, there are numerous instances where medication of an animal for various ailments, infections, and parasite problems is a necessity. In nearly all cases, when animals were given medication there has been extreme caution in the use of milk and meat from the treated animal. Withholding products several days beyond the recommended period is an
accepted practice among goat owners. This type of concern and caution has sponsored a supply of meat, milk and milk products for use in the home or for sale, that meets federal standards. One packing house that slaughters approximately 1,000 goats each year has yet to find a carcass with a residue violation. This would support the observation that goat raisers are thoroughly conscious of potential problems and are taking steps to assure a wholesome product. The industry is to be commended.

There appears to be an ever increasing number of persons practicing goat husbandry. The homesteading movement with its agrarian intent, but often limited to small acreage, finds the dairy goat a perfect animal to meet home food production needs. Many newcomers to the business are not agriculturally trained. The lack of knowledge about adequate ventilation in goat housing and uncertainty about sanitation procedures could lead to a greater incidence of pneumonia, diarrhea,
and parasite problems. This, coupled with a scarcity of drugs labeled for use on goats, and in some areas, no access to veterinary care, increases the risk of accidental medical application. Those raising goats for a long period of time find it difficult to make treatment decisions. It is doubly difficult for the newcomer.

Let's examine the route that drugs and chemicals take to get into meat and milk. Medication may be given orally, injected subcutaneously (under the skin) or into the muscle, infused into the udder or reproductive tract, or applied to the skin as a salve or a powder. Regardless of the treatment method, the medication may be absorbed

into the blood stream and carried to all parts of the body. Therefore, a drug injected into the muscle to treat pneumonia symptoms or fed to the animal to control internal parasites will eventually find its way to the milk secretory cells and all body tissues. Body tissues may retain detectable levels of drug residues longer than body fluids such as milk. It is not uncommon to find labels stating a longer withholding time before it is safe to send the animal for slaughter as compared to using the milk. Withholding times vary! When you treat an animal, be sure to follow directions when administering the drugs. If it calls for intramuscular
injection and you inject subcutaneously, the stated withholding time on the label may be rendered inaccurate. Unusually large doses of medication will require longer withholding times, so stay with the recommended dosage if you expect the label to be an accurate guide.

Mastitis medication formulated for dry treatment generally has a long meat and milk withdrawal time because the drugs are mixed in a slow release, long acting vehicle. Treatment over several days can extend the withdrawal period because of the additive effect. Therefore, depending on the drug you use, the dose given, the length of the treatment, and the drug vehicle (substance used to mix
with or dissolve the drug), you may need to extend the withholding time to allow the body to eliminate the drug residue.

Residues may occur from sources other than medication. Forages, such as hay, weeds, and browse that may have grown on or near roadsides or right of ways that have been sprayed with herbicides or pesticides can become polluted by spray or spray drift. If eaten by the goat, they can be the cause of residues in meat and milk. The browsing nature of goats can lead them to eat both dead and living forage that another species of animal might shun. In addition, if you spray or dust your sweet corn, cabbage, turnips and other garden vegetables to control disease or insects, do not permit the goats to eat any of the garden plants.

Be careful when purchasing a grain mix, especially one not formulated for a ruminant. Read the feed tag. If it says medicated on the tag be sure you read further to find what limitations may be recommended. Also, some milk replacers may contain a medicated ingredient that could pose a problem in the sale of a kid consuming the replacer in its daily ration.

If you have treated a milking doe for mastitis, milk her last and discard all the milk even though you may have treated only one side of the udder. By milking her last, you prevent possible contamination of milk from other does. As little as a teaspoon of milk left in a pail or in a milk line can contaminate the milk from the next doe. Don't take chances. Mark a treated animal with a paint stick or a dye to remind you and anyone else doing the milking that the milk from that doe must be

discarded.

Testing for Residues

Modern-day testing methods make it easier for officials to test for trace levels of residues. Levels that once went undetected now are found in both meat and milk. In addition, procedures have been developed to permit the tracking of a carcass in a slaughter plant back to an auction or buyer and finally to the person who sold the animal. Not only are the tests becoming more accurate and refined, it is now easier to identify the person who committed the error.

Several tests have been developed to assist the producer in checking for the possibility of residues present in the animal or the milk. The Live Animal Swab Test (LAST) developed by scientists in the USDA's Food Safety and Inspection Service (FSIS), is the first tool available for on-the-farm use in checking animals for antibiotic residues before they are shipped for slaughter. LAST is an adaption of a test used since 1979 by FSIS, called STOP (Swab Test on Premises). STOP has been used in slaughter houses to check presence of antibiotics and other antimicrobial substances in the killed carcass. Now producers and/or their veterinarians can perform the LAST on live animals at the farm simply by testing the urine of any suspect animal. Test kits are available for purchase and anyone wishing to learn more about the test and how to perform it may write to Publications Office, FSIS-ILA, Room 1163-S, USDA, Washington, DC 20250.

The DELVO test has been used for several years by milk plants and sanitarians and more recently by dairymen to check for levels of antibiotics in milk. More and more farmers are routinely running this test on milk from any treated, mastitic cow prior to including her milk with that of the herd. It is also used on milk in the bulk tank prior to shipping. Contact any dairy sanitarian, milk plant, veterinarian or Extension agent for information on purchasing this test kit. Or, write to G. B. Fermentation Industries, Inc., 555077 Centre Drive, Charlotte, North Carolina 28224. Other test kits are being developed for on-farm use. LAST, STOP and DELVO tests are all designed to detect the presence of antibiotics and sulfas. They will not detect other chemicals such as wormers or insecticides. Federal meat inspectors use other methods to detect these chemicals.

Today, there is little reason to use or sell residue-contaminated products. You can test a product to be sure it is residue free. This should be especially good news to the goat producer since most of the goat products are used by the family. Rather than to waste several days milk or hold a live animal an extra couple weeks just to be sure the medicine has been eliminated from the body, you can now test and know when the product is safe to place on the family table.

Avoid Residues

- Provide a clean, well bedded, dry area for the does at kidding time.
- Be sure kids receive colostrum; 4 ounces (1/2 cup) within 2 hours following birth. Co lostrum contains protective antibodies and helps keep kids from getting sick.
- Provide kids and adult animals with clean, dry bedding and good ventilation to reduce incidence of scours and pneumonia.
- Feed hay in a hayrack or keyhole feeder; protect grain boxes and watering devices from manure contamination to reduce parasite problems.
- Dip teats in an approved germicidal dip after each milking.
- Clean and sanitize all feeding equipment.
- Fence animals away from chemically sprayed areas and don't feed forages or garden refuse that contain chemical residues.

Ask your veterinarian's advice regarding:

- Proper use of medication.
- Withholding times before slaughtering treated animals or milk offered for sale and/or used at home.
- Oral electrolyte mixtures--unmedicated but effective therapy for scouring kids.

Ask your county extension agent's advice regarding:

- Ventilating requirements and proper fan size to provide draft-free fresh air in stable area.
- How to build hayracks and keyhole feeders.
- Management programs that increase the potential for growth and production and reduce risks of disease.

Don't rely on memory:

- Always read label directions and check withdrawal times. They vary with each medication used.
- Identify with a chalk marker any treated animal. Keep a record of the medication used and date treated.

Use drugs wisely:

- Drugs are not a substitute for good management.
- Permit only one person to administer drugs.
- Limit access to drugs to competent and responsible people.

- When possible, avoid treatment of lactating does.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- Goats, an email list for goat issues. To join, send to listserv@wsuvm1.wsu.edu with message "subscribe goats-l Your Name".
- **GOATS: Discussion List for Goat Managers and Lovers**

  Subscription address: listproc@listproc.wsu.edu

  Topics:

  Subscribe to GOATS. Type "subscribe GOATS Your Name" in the message body. (Not supported by all browsers.)

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- Goat Husbandry - 5th Edition - Paperback - Publication date: July 1993
  List: $16.95
  Contents include: prospects for goat farming, principles of goat feeding, selection of breeding stock, and diseases.
- Goat Medicine - by Mary C. Smith, David M. Sherman - Hardcover - Publication date: April 1994 - List: $79.00
  Book News, Inc., 08/01/94: A comprehensive veterinary text addressing health and disease issues of goats raised under varying conditions around the world. The authors' primary experiences are with intensively managed dairy and fiber goats in temperate zones, but, because most of the world's goats live in

tropical and subtropical regions, disease entities and production constraints in those areas are also fully covered. Annotation copyright Book News, Inc. Portland, Or.

- Goat Nutrition (European Association for Animal Production Publications, No 46) - by P. Morand-Fehr (Editor) - *NR Edition - Hardcover - Publication date: September 1990 - List: $83.00
- Goats : A Guide to Management - by Patricia Ross - Paperback - Publication date: August 1995 - List: $22.95
- Maedi-Visna and Related Diseases (Developments in Veterinary Virology) - by G. Petursson, R. Hoff-Jorgensen (Editor) - Hardcover - Publication date: January 1990 - List: $105.00
- Nutrient Requirements of Goats : Angora, Dairy, and Meat Goats in Temperate and Tropical Countries - by National Research Council Commission on Natural Resources Volume 15 - Paperback, 91 pages - Publication date: December 1981 - List: $24.95
- Raising Milk Goats Successfully - by Gail Luttmann, Gail Luttman - Paperback, 172 pages Publication date: November 1986 - List: $9.95
- Raising Milk Goats the Modern Way - by Jerry Belanger - Revised & Updated Edition Paperback, 200 pages - Publication date: March 1990 - List: $18.95
- The New Goat Handbook : Housing, Care, Feeding, Sickness, and Breeding With a Special Chapter on Using the Milk, Meat, and Hair - by Ulrich Jaudas, Matthew M. Vriends - Paperback, 93 pages - Publication date: March 1, 1989 - List: $9.95
- Your Goats : A Kid's Guide to Raising and Showing - by Gail Damerow - Paperback, 172 pages - Publication date: August 1, 1993 - List: $12.95
  Explores the fun of raising goats, discussing selection, purchase, housing, feeding, health, behavior, breeding, and showing.

Periodicals:

- None identified.

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Frequently Asked Questions:

Other Information Sources:

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Goats

The goat is one of the smallest domesticated ruminants which has served mankind earlier and longer than cattle and sheep. It is managed for the production of milk, meat and wool, particularly in arid, semitropical or mountainous countries. In temperate zones, goats are kept often rather as supplementary animals by small holders, while commercially cows or buffaloes are kept for milk, cheese and meat, and sheep for wool and meat production. Nonetheless, there are more than 460 million goats worldwide presently producing more than 4.5 million tons of milk and 1.2 million tons of meat besides mohair, cashmere, leather and dung; and more people consume milk and milk products from goats worldwide than from any other animal. Cheese production from goat milk, even in France, Greece, Norway and Italy, is of economic importance. Goat herds, on the other hand low producing though, are an expression of capital assets and wealth in Africa and Asia where they are found in large numbers. In the United States, there are between 2 and 4 million head; with Texas leading in Angora, meat and bush goats; and California leading in dairy goats.

Goats can survive on bushes, trees, desert scrub and aromatic herbs when sheep and cattle would starve to death. Goat herders often have neglected a rational numerical balance between goat numbers and sparse vegetation. Over-grazing has destroyed many tree and woodland areas which was blamed then on goats rather than man, and this has caused widespread ecological and political concerns, erosion, desertification and even ban on freely grazing goats in some areas. On the other hand, goats are valued by cattle and sheepmen in the fight against brush encroachment on millions of acres of open rangeland.

Swiss goat breeds are the world's leaders in milk production. Indian and Nubian derived goat breeds are dual-purpose meat and milk producers. Spanish and South African goats are best known for meat producing ability. The Turkish Angora, Asian Cashmere and the Russian Don goats are kept for mohair and cashmere wool production. In addition, there are Pygmy goats from Western Africa of increasing interest as laboratory and pet animals.

Goat milk casein and goat milk fat are more easily digested than from cow milk. Goat milk is valued for the elderly, sick, babies, children with cow milk allergies, patients with ulcers, and even preferred for raising orphan foals or puppies. Fat globules in goat milk are smaller than in cow milk and remain dispersed longer. Goat milk is higher in vitamin A, niacin, choline and inositol than cow milk, but it is lower in vitamin B6, B12, C and carotenoids. The shorter chain fatty acids (C6, C8, C10, C12) are characteristically higher in goat milk than in cow milk. Otherwise milk gross composition from goats or cows is similar except for differences due to breeds, climate, stage of lactation and feeds.

Breeds of goats vary from as little as 20 lb mature female bodyweight and 18 inches female

withers for dwarf goats for meat production up to 250 lb and 42 inches withers height for Indian Jamnapari, Swiss Saanen, Alpine and AngloNubian for milk production. Some Jamnapari males may be as tall as 50 inches at withers. Angora goats weigh between 70 to 110 lb for mature females and are approximately 25 inches tall. Birthweights of female singles are between 3 and 9 lb; twins being often a pound lighter and males 1/2 lb heavier. Twinning is normal in goats with a high percentage of triplets thus giving several breeds an average annual litter size above 2 per doe and more than 200 reproduction rate. Females are called doe, young are kids, males are bucks; one speaks of buck and doe kids, and doelings, and of wethers or castrates.

Differentiation Morphologically, goats may have horns of the scimitar or corkscrew types, but many are dehorned in early age with a heated iron, caustic or later on with a rubber band or surgical saw. Goats may also be hornless genetically. They can be short haired, long haired, have curled hair, are silky or coarse wooled. They may have wattles on the neck and beards. Some breeds, particularly the European, have straight noses, others have convex noses, e.g., the Jamnapari and Nubian breeds or slightly dished noses (Swiss). Swiss and other European breeds have erect ears, while pendulous, drooping, large ears characterize Indian and Nubian goats. The American LaMancha breed has no external ear. A "gopher" ear rudiment in LaMancha is less than 1 inch long with little or no cartilage; an "elf" ear is less than 2 inches long, but bucks can be registered only with gopher ears. The responsible gene for rudimentary ears is dominant, thus sires with gopher ears will always have gopher or elf-eared offspring, no matter what the genotype of the dam is to which he was mated.

Goats come in almost any color, solid black, white, red, brown, spotted, two and three colored, blended shades, distinct facial stripes, black and white saddles, depending on breeds.

Teeth in goats are a good guide to age. Six lower incisors are found at birth and a set of 20 "milk teeth" are complete at 4 weeks of age consisting of the eight incisors in the front of the lower jaw, and 12 molars, three on each side in each jaw. Instead of incisors in the upper jaw there is a hard dental pad against which the lower incisors bite and cut. Some goats have an undesirable inherited recessive condition of "parrot" (overshot upper jaw) or "carp" mouth (undershot upper jaw) which does not interfere with barn feeding conditions but handicaps the goat severely in pasturing and browsing, because the lower incisor teeth cannot cut correctly against the upper dental pad. With progressing age, the permanent teeth wear down from the rectangular crossectional shape and cores to the round stem which is a further distinguishing mark of age. Furthermore, there are pregnancy rings marking horns and telling age.

The digestive tract of the goat after nursing has the typical four stomach compartments of ruminants consisting of the rumen (paunch) (4-6 gallon), the reticulum (honeycomb) (1-2 liters), the omasum (maniply) (1 liter), and the abomasum (true stomach) (3.5 liters). The intestinal canal is about 100 feet long (11 liters), or 25 times the length of a goat. The total blood volume of the goat approximates 1/12-1/13 of bodyweight; it takes about 14 seconds for goat blood to complete one circulation.

Among diseases, goats are not too different from cattle and sheep in the same regions. Goats tend to have more internal parasites than dairy cows, especially in confined management. They tend to have less tuberculosis, milk fever, post partum ketosis and brucellosis than dairy cows and their milk tends to be of lower bacteria counts than cow milk. They have more prepartum pregnancy

toxemia than dairy cows, and are known to have laminitis, infectious arthritis, Johne's disease, listeriosis, pneumonia, coccidiosis, scours, scabies, pediculosis, liver fluke disease and mastitis.

Reproduction:

The skin of the goat has sebaceous and sweat glands besides growing the hair cover, horns, hooves and the two compartmented mammary gland (udder). Before the first pregnancy, the udder is underdeveloped, but with sustained repeated gentle massaging, a small, normal milk producing gland can be stimulated in virgin does and even in goat bucks. In contrast to sheep, the teats of goat's udders are conveniently long and large for hand milking.

Tails, scent and horns distinguish goats easily from sheep and cattle. The goat tail is short, bare underneath and usually carried upright. Major scent glands are located around the horn base. They function in stimulating estrus in male and female goats, improving conception. The goat odor is, however, a detriment to goat keeping and milk consumption if not properly controlled. Many goat breeds are seasonal breeders, being influenced by the length of daylight. Artificial insemination is commercially practiced in regions where numbers of females make it economical. Goats are in puberty at 1/2 year of age and can be bred if of sufficient size. Does come into estrus in 21 day cycles normally, lasting approximately 1 to 2 days.

In temperate zones, goats breed normally from August through February. Nearer the equator, goats come into estrus throughout the year. Thus more than one litter per year is possible, considering the length of pregnancy of 150 days. Five days after ovulation one or several corpus luteum form to protect the conceptus from abortion. The goat pregnancy is corpus luteum dependant in contrast to cattle. If no conception occurred, the corpus luteum disappears and new ovulation takes place. A buck ejaculates normally 3/4 - 1 1/2 ml of semen with 2-3 billion spermatozoa each. The life of an ovum after ovulation is about 8-10 hours. As the ovum travels down the goat's oviduct, it is fertilized by semen which traveled up through the uterus. The fertilized embryo becomes firmly attached to the uterine walls and surrounds itself with a nourishing placenta starting at 52 days after conception. Semen of goat bucks freezes as well as that of bulls and may be stored for years in 1 ml ampules or 1/2 ml straws in liquid nitrogen tanks for artificial insemination use.

Origin

Wild goats or escaped feral goats are found in many countries and islands and can be harmful to the vegetation if numbers are left uncontrolled. Truly wild goats are found on Creta, other Greek islands, in Turkey, Iran, Turkmenia, Pakistan; in the Alps, Siberia, Sudan, Caucasus; the Pyrenees, the Himalayan, Central Asian, Russian and Tibetan mountain ranges, and prefer rocky, precipitous mountains and cliffs. Goats can not be herded as well with dogs as sheep; instead they tend to disperse or face strangers and dogs headon. Relatives of true goats are the Rocky Mountain goat, the Chamois of the Alps and Carpathian, and the muskox.

Goats belong, scientifically, to the Bovidae family within the suborder of ruminants (chevrotain, deer, elk, caribou, moose, giraffe, okapi, antelope), who besides the other suborders of camels, swine and hippopotamuses make up the order of eventoed hoofed animals called artiodactyla.

They have evolved 20 million years ago in the Miocene Age, much later than horses, donkeys, zebras, tapirs, rhinoceroses, who make up the order of uneventoed hoofed animals; and the hyrax, elephants, manatees who make up the ancient near-hoofed animals. All these are herbivorous mammals, i.e., they live from plants and nurse their young with milk from an external gland after the young is born, having been carried in pregnancy to term relatively long in an internal uterus with a complex, nourishing placenta.

Goats and sheep make up a tribe within the Bovidae family called Caprini that include six goat, six sheep and five related species. Goats have a 2n chromosome set number of 60 while domestic sheep have a 2n set of 54; yet living hybrids of the two genera have been reported. The six species of goats can be distinguished by their horn shapes:

- Capra aegagrus, the wild (or bezoar) goat of Near East Asia has scimitar-shaped horns with a sharp anterior keel and a few knobs in- terrupting it.
- Capra ibex, the ibex of the Alps, Siberia and Nubia has scimitar shaped horns with a flatter front and many transverse ridges.
- Capra falconeri, the markhor of Central Asia has sharpkeeled horns that are twisted into open or tight spirals.
- Capra pyrenaica, the Spanish goat has outward-upward curving horns with a sharp posterior keel.
- Capra cylindricornis, the Dagestan tur of the Caucasus mountains as round outward-back inward curving horns.
- Capra hircus, the domestic goat evolved principally from capra aegagrus, except for Angora, Cashmere goats, and Damascus types who descended from capra falconeri.

Breeds

Domestic goat breeds are many. Swiss breeds are distinguished in milk producing ability and have influenced significantly milk production from goats around the world, especially in Europe, North America, Australia and New Zealand. A few breeds kept mostly for meat are the South African boer goat, the Indian beetal, black Bengal, the Latin American criollo, the US "Spanish" goats and most of the small or nondescript goats. Fiber producing goat breeds are the Angora in Turkey, USA, South Africa; the Cashmere in Afghanistan, Iran, Australia and China; and Don breed in Russia.

The major breeds of US goats are:

- **Saanen** originate from Switzerland (Saanen Valley), are totally white, with or without horns. The white color is dominant over other colors. They are mostly short haired. The "Appenzell" is a similar breed, but partially related to the Toggenburg from Northern Switzerland, longhaired, white and hornless. Saanen have been exported around the world as leading milk producers. An Australian Saanen doe holds the world record milk production of 7,714 lbs in 365 days. Saanen had been bred in Switzerland for odorfree milk long ago.
- **Toggenburg**, brown with white facial, ear and leg stripes, another straight nosed, horned or hornless, mostly shorthaired, erect eared goat, as all Swiss are, has been very popular in the USA, comes from N.E. Switzerland, but is 4 inches shorter in height and 18 lb lighter in

average than the Saanen. They have been bred pure for over 300 years, longer than many of our other domestic breeds of livestock. They are reliable milk producers summer and winter, in temperate and tropical zones. Mrs. Carl Sandburg, wife of the famous US poet had several world record Toggenburg does on official USDA tests.

- **Alpine** (including French, Rock and British), another Swiss breed (French Switzerland), horned or hornless, shorthaired, as tall and strong as the Saanen, with usually faded shades of white into black, with white facial stripes on black. They are second in milk production to Saanen and Toggenburg.
- **LaMancha** is a new, young breed developed in California from Spanish Murciana origin and Swiss and Nubian crossings. They are known for excellent adaptability and good winter production. They are also producing fleshier kids than the Swiss, but are not milking as much. They have straight noses, short hair, hornless or horns, and no external ear due to a dominant gene. They are more the size of Toggenburg. Their milk fat content is higher than that of the Swiss breeds.
- **(Anglo)-Nubian** is a breed developed in England from native goats and crossed with Indian and Nubian which have heavy arched "Roman" noses and long, drooping, pendulous ears, spiral horns and are shorthaired. They are leggy and as tall as Saanen, but produce less milk, though higher milk fat levels and are more fleshy. They are less tolerant of cold but do well in hot climates. They "talk" a lot, and are in numbers the most popular breed in USA and Canada. They have a tendency for triplets and quadruplets. They are horned or hornless and have many colors that may be "Appaloosa"-like spotted.
- **Oberhasli**, a western Swiss breed, usually solid red or black, horned or hornless, erect ears, not as tall as Saanen, very well adapted for high altitude mountain grazing and long hours of marching; popular in Switzerland, but milk production is variable. They are also called Swiss Alpine, Chamoisie or Brienz.
- **Angora** originated in the Near East. The long upper coat (mohair) is the valuable product in the Angora in contrast to the Cashmere, where the fine underwool is the valuable product. Head has a straight or concave nose, thin, not very long; pendulous ears and twisted horns, in both sexes. It is a small breed, usually white. The haircoat is long with undulating locks and ringlets of fine, silky hair. The top quality fleece of purebreds may be 1-2 lbs, but slightly more in males and wethers. They are bearded. Spring moult is natural and shearing occurs just before. They are not very prolific and twinning is less frequent than in other breeds.
- **Pygmy** are dwarf, short legged goats from West and Central Africa and the Caribbean. Their growth rates and milk production are relatively respectable, although low, twinning is frequent and they are breeding all year usually. They are adaptable to humid tropics and resistant to trypanosoma.
- **Others**. There is little known about the so-called Spanish or bush goats that are kept on the open range in the Southwest mostly. Also, a few minor breeds exist in this country, e.g. the Sables, which are a colored variety of the Saanen. It would be profitable to know more about the other at least 60 goat breeds in the world and their comparative values under US conditions.

Adjustment Factors for Milk Records

Lactation records of milk and fat production provide important information for managing a dairy goat herd and for breeding better goats. Environmental factors such as length of lactation, age of doe, and season of kidding should be standardized through appropriate adjustment factors to make genetic evaluations more accurate.

A lactation length of 305 days has been defined as the standard for dairy cattle and also is used for goats. This standard assumes a 365-day interval between parturitions, which includes a 60-day dry period. However, many goats do not milk 305 days. A recent study shows that only one-third of all does with official records ending with a dry date milked 305 days. One reason for shorter records is that production of many does declines sharply with the onset of seasonal estrus and the does then are dried off. A standard lactation length of less than 305 days might be more useful for comparisons among does; however, the 305-day standard allows for reduced computing costs because doe and cow records can be computed the same way.

If a doe's lactation ends on or before 305 days because her production declined to the point at which continued milking was not worthwhile, then her record is considered complete. Such records are not projected to 305 days but are treated as complete 305-day records. If a lactation ends before 305 days for any reason other than going dry, such as the doe's being sold or the herd's discontinuing testing, the record is considered incomplete and is adjusted. If a doe is still milking and has fewer than 305 days in milk, the record is considered incomplete, adjusted, and referred to as a record in progress. If a doe milks for more than 305 days, the production for only the first 305 days is included in the 305-day record.

A method to adjust incomplete records and records in progress uses the USDA projection factors in Table 1. Different categories of factors are required to adjust records because of variations in the lactation curve, particularly in the rate of decline of production after the peak and the number of days milked. To select the appropriate factor, the following information is necessary: breed, herd average production, month of kidding, days in milk, and age of doe at kidding. An adjusted or projected record is the incomplete record plus an estimate of production for the rest of the lactation. That estimate is the projection factor times the last sample-day production times the number of days from the end of the incomplete record through 305 days.

Suppose a Nubian doe freshens in March at 25 months of age. She has an incomplete record at 130 days of 800 lb milk and 27 lb fat. Her last sampleday production is 5 lb milk with 3.4 The herd average is 1,725 lb. Then, her projected record would be 800+0.69(5) (305-130) =1,404 lb milk and 27+0.76(5) (0.034) (305-130) =50 lb fat.

Age-Season Lactation production increases with age until maturity and then declines. Month or season of kidding also influences lactation production. For example, does kidding in the early spring produce more milk than those kidding later in the year. Lactation records can be adjusted to a common age and season of kidding to standardize the effects of age and season. The factors in Table 2 standardize production to that expected from a doe kidding from January through March at 36 months of age.

The adjustment factors vary by breed, age, and season of kidding. Records are adjusted for age and season by multiplying production by the appropriate factor from Table 2. To illustrate, consider

the Nubian doe from the previous example: Adjusted milk=1.07(1,404)=1,502 lb Adjusted fat=1.08(50)=54 lb.

The factors in Table 2 were computed by assuming a smooth change by age and by ignoring lactation number. Recent results, however, suggest that lactation number should be considered, particularly for does kidding about 24 months of age. Equations recently developed at the University of California in Davis provide factors that vary by parity. These factors may be more accurate; however, the factors reported here should contribute to improved comparisons among does.

Artificial Insemination

If you have a few backyard does that you enjoy as a hobby, with little concern for genetic improvements of their offspring, then artificial insemination (AI) is probably not for you, assuming a suitable buck can be located for servicing the does. The expense of purchasing the necessary equipment and learning to do AI are likely not worthwhile. However, if there is an experienced inseminator in the area who is willing to work with your goats, then this may prove to be a viable alternative and certainly is much simpler than hauling your does in heat to the buck's home.

AI has some key advantages over natural breeding.

- It eliminates the necessity of keeping one or several bucks on the farm (depending on herd size). Costs of feeding, housing, separate fencing and labor are eliminated. However, heat detection may be more difficult in the absence of a buck.
- AI can increase the rate of genetic improvement in an herd, as long as superior bucks are consistently selected. In natural service, the prospective breeder has only the buck's pedigree to rely on, whereas AI bucks should be progeny tested for their transmitting ability of milk and fat percentage, weight gain, type conformation, etc.
- AI allows breeding of different portions of the herd to different bucks. Young does may be bred to not yet proven but high potential bucks, while the majority of the herd can be bred to proven high quality bucks.
- AI permits breeding of many does on one day when synchronization is practiced. No long drives to top bucks are involved.
- The danger of transmission of diseases or parasites is greatly reduced. (The transmission of diseases through frozen semen needs further study.)
- The time of breeding can be more carefully regulated, and the owner knows exactly when the doe was bred, as opposed to pasture servicing by a buck that is allowed to run with the herd.
- AI induces good recordkeeping of dates of heat, breeding, pedigrees, etc. This will aid in herd improvements and enable the owner to make better culling decisions.

Once the decision to use AI has been made, the next step is to determine whether to do the inseminating yourself or pay someone else to do it. If there are only a few does in your herd, and an experienced inseminator of goats is available, then it may be more practical to pay to have the

service done. However, if the number of does in the herd is rather large, or an experienced inseminator is nowhere to be found, then its probably time to learn how to practice AI techniques yourself.

AI technicians of the cattle industry may not necessarily be of much help when it comes to inseminating goats, for the modern method of inseminating cattle (rectal palpation) differs from that of breeding goats (speculum method) considerably. The speculum was used on cattle early in AI history, and some cattle inseminators may be capable of teaching goat insemination.

The cost of getting started in AI, not including semen purchases, will generally run around $500, of which $400 to $450 is tied up in the liquid nitrogen tank, which is necessary for storing semen any length of time. Temperatures must be kept at -320F (-196C) for sperm survival to be maximized at breeding time. It may be possible to share the cost of the tank with neighboring goat owners or dairy farmers, thus alleviating some initial costs of an AI program.

If AI is to be used with any hope of achieving a good level of success, much must be known and well understood by the prospective inseminator.

- basic knowledge of the doe's reproductive organs and their functions
- understanding of storage and handling of semen
- ability to use, in a proper and sanitary manner, the equipment required for inseminating goats
- ability to accurately detect heat at an early stage
- necessity of keeping accurate, up to date records of heat cycles, breeding, kidding, reproductive problems, treatments, and any other pertinent information that may reflect on the goat's reproductive patterns.

Reproductive Organs and Functions

The two ovaries are the sites of egg formation. They produce estrogens and progesterone, and as such are determining factors of heat cycle, ovulation and pregnancy. Basically the estrus (heat) cycle in goats operates as follows:

- Proestrus is the time of follicle growth. As an egg (ovum) begins to mature in an ovary, it becomes surrounded by a fluid filled sac on the outside of the ovary, much like a blister forms on the skin. This growth is accompanied by increasing levels of estrogen in the blood.
- Estrus - As estrogen levels peak, the doe will come into heat. This can be observed by changes in behavior (increased bleating and restlessness), willingness to be bred, and the swelling of the external genital area. The period of "standing heat" (acceptance of the buck) will generally last for 24 to 36 hours.
- Ovulation, or the release of the egg, is accomplished by the rupturing of the follicle, expelling the egg from the ovary, and receiving it into the oviduct via the fimbria funnel. This occurs very near, or soon after, the end of standing heat (6 hours before to 12 hours after). Egg life is 12 to 24 hours, while the sperm lasts 24 to 48 hours.
- Metaestrus - in this stage, the ruptured follicle is undergoing cellular differentation to form a functionally important tissue mass, the corpus luteum (yellow body). This structure is responsible for the secretion of progesterone, a hormone which prevents the development of

another follicle and prepares the uterus to receive a fertilized egg.

- Diestrus - is the longest period of the estrous cycle in does. During this period of corpus luteum influence, two events may happen. If fertilization of the egg occurred, the corpus luteum will persist for the entire gestation period, preventing follicular development and keeping estrogen levels low. If no fertilization took place, the progesterone secretions of the corpus luteum gradually lessen, allowing a new cycle of follicular development to begin, with a corresponding increase in estrogen levels. The length of time required for one estrous cycle without fertilization, ranges from 17 to 24 days in goats, with the majority taking 21 days. Shorter cycles are not uncommon (5-10 days).
- The egg, after being expelled from the ovary, passes into the oviduct via the infundibulum, and toward the cornua (horns) of the uterus. This movement is produced by wave-like motions of the ciliated (hair-like projections) cells of the oviduct. Sperm and eggs meet in the oviduct and fertilization occurs in the middle to upper one third of the duct.
- The egg continues into the horn of the uterus, where, if it has been fertilized and undergone several cellular divisions, it will become attached to the uterine wall. If no fertilization has occurred, the egg will degenerate and the cycle goes on.
- The cervix of the uterus plays a key role in artificial insemination, as it is the external entrance to the uterus which must be located and penetrated with the inseminating instrument. The cervix is normally tightly closed, except during periods of heat or kidding. Semen is deposited on the vaginal side of the cervix in natural services, but AI requires the deposition of semen in the uterine side of the cervix. This is because of the greatly reduced volume of semen that is used in AI. If the 0.5 to 1 cc of semen in AI were deposited on the vaginal side of the cervix, there is a good chance that none of the sperm would reach the egg.
- The vagina serves as the connecting tube between the uterus and the outside opening, the vulva. It is part of the birth canal, and also contains the urethral opening, from which urine will pass during emptying of the bladder.

Purchase and Preparation of Semen

In most cases, the inseminator will acquire the semen needed by direct purchase from a commercial operation, in which case it will be shipped to the inseminator. It is of the greatest importance that the semen be transferred to permanent storage (the liquid nitrogen tank) without exposing it to anything approaching air temperature. Generally, this means transferring the container element which houses the semen directly to the liquid nitrogen tank. Here it can be safely stored for long periods of time, since biological activity practically stops at liquid nitrogen temperatures (-320F). Semen is generally to be used within 6 months, but conceptions have resulted from semen stored for several years, although sperm survival is decreased, resulting in lower conception rates.

Semen Collection Bucks are handled basically the same way as bulls for semen collection. Three basic methods may be employed, but all three require an artificial vagina, a double walled device with an opening at one end and collection tube at the other. The inner lining holding warm water should be coated with a light application of water soluble lubricating jelly.

The three methods of semen collection are:

- A buck may be allowed to mount a doe, with the semen collector manually diverting the buck's penis into the artificial vagina (ram or dog size). Don't touch the penis directly, instead direct the penis into the artificial vagina by grasping the buck's sheath. After ejaculation (usually 0.5 to 1.0 cc) has occurred, remove the artificial vagina and tip it so that the semen will all run into the collection tube. This method may require practice and adjustment by both the buck and the collector before good samples are collected.
- A buck is trained to mount a dummy instead of a live doe. The same procedures are followed for sample collection. Mounting may be facilitated by applying vaginal mucus scrapings of a doe that is in heat to the dummy, at least during the training process.
- Use of electro-ejaculation. The buck is not required to mount an object, although an artificial vagina should still be used for semen collection. An electrode unit, which has a number of contact rings, is inserted into the buck's rectum. Slight electric stimulation brings on ejaculation. This technique generally results in good samples in quantity and quality. However, the sperm concentration of the sample will be lower. This method does not require extensive training, and will allow collections from bucks that may refuse or are unable to mount and serve an artificial vagina.

Semen, once collected, may be used in one of three different ways:

- As liquid semen, directly or on the same day one ejaculate can serve 3 to 5 does. If kept at body temperature, the semen may be good for three hours.
- Semen may be stored 24 to 48 hours by placing the collection tube in a container of water and putting this unit in a refrigerator. No diluter is needed, although plain egg yolk can serve as simple extender to double the number of does that can be served.
- Semen that is to be stored for longer periods of time must be mixed with a diluter and very carefully frozen. A commercially prepared diluter extender, such as Ortho Semen Diluter is desirable, although plain milk can be used successfully also.

Following are steps in semen extending:

1. With a commercial preparation, use a diluter to semen ratio of 19:1, adding the semen to the diluter, and rolling the bottle gently to achieve a thorough mixing. The semen and diluter should be at the same temperature. This mixture can be stored in the refrigerator and used for a week, or slowly cooled and stepwise frozen for storage in a liquid nitrogen tank for later insemination.
2. For a homemade milk diluter, it is best to use fresh 3.5 pasteurized, homogenized whole milk. It must be heated and held at 210F for 10 minutes in a glass boiler, keep the lid in place so that no moisture is lost. Next, the milk is cooled in a water bath with the lid on. When the milk is in equilibrium temperature with the water bath, the water condensation on the inside of the lid is shaken back into the milk. To every 400 cc of milk, add 100,000 units of potassium G crystalline penicillin and 500 mg crystallin di-hydrostreptomycin sulfate, mixing well. Warm this diluter to about body temperature before adding the fresh semen at 19:1 ratio. Place the diluted semen in a water bath at body temperature of 101F and allow to cool slowly. Semen may be frozen, if the extender contains an antifreeze compound, slowly, stepwise for storage on dry ice or in liquid nitrogen.
3. A microscope, capable of 900x magnification is an essential tool when doing your own

semen collection in order to determine semen quantity and quality. First, place a semen sample on a clean slide and cover with a coverslip or another slide. Set the magnification to 400x and observe the appearance of dark patches or spots thru the scope; four dark areas or more per microscope field represent high concentrations of sperm, a really good sample. Three dark areas is somewhat chancy for use at a diluted service, but is good enough for natural service. Two dark areas should be used only for natural services and one dark area means that the concentration of sperm is too low for even natural service. Switching to 900x, the sperm cells can be individually observed for normal structures. Diluting in warm saline is helpful. Coiled tails, broken tails, absence of tails and abnormal shapes all constitute deficient sperm cells. Sixty to 70% good motility before freezing should be observed in a good sample, with a minimum of 30% motility after freezing and thawing.

Any insemination program, no matter how carefully carried out, will yield poor results if the concentration and quality of the collected sperm is not of high standards. Sophisticated techniques of washing the sperm free of seminal plasma before extending and freezing will improve post-thaw viability.

The concentration of a buck semen ejaculate can be determined accurately by using a red blood cell diluting pipette and standard hemocytometer techniques. Typical results during the breeding season are 3 to 5 billion sperm per cc. Optical density can also be used to estimate sperm concentration if the photometer has been calibrated for buck semen. A simpler technique involves the determination of a spermatocrit using microhematocrit pipettes. The aliquot of semen is centrifuged for 10 minutes; for each percentage point of packed sperm, approximately 200 million sperm cells per cc are present. Correction is made for the percent motile sperm, after which the ejaculate can be diluted appropriately to supply a minimum of 125 million motile sperm in each breeding dose. It is often difficult to introduce more than 0.2 ml of semen into the cervix, so dilution to a final concentration of 600 million to 1.2 billion live sperm per cc has been recommended. When no laboratory support is available, fresh semen for immediate use may be diluted up to 5 times in extender if it is yellowish and 10 times if the ejaculate is white. A straw holding 0.5 cc of this diluted semen will provide adequate sperm if excessive reflux does not occur.

Storage and Removal of Semen from the Liquid Nitrogen Tank

A liquid nitrogen tank is basically a very large thermos-bottle in which liquid nitrogen is placed to keep the inner temperature near -320F (-196C). The spacing between the inner and outer walls is insulated and under vacuum. The temperature in the tank is maintained uniformly at -320F up to the bottom of the tank neck until the liquid nitrogen level gets down to around 5". To measure liquid nitrogen, use a piece of black metal rod that is long enough to hold and touch the bottom of the tank. Dip the rod to the tank bottom and remove after 30 seconds. By waving it in the air, a white frost line will appear on the rod. This line indicates the liquid nitrogen depth of the tank. Levels nearing 5" require a refill. The only real differences between tanks is their storage capacity (number of ampules or straws that they will hold) and their length of holding time (liquid nitrogen evaporation rate). The neck diameter varies somewhat also, with wider openings being easier to work with, but an increased evaporation rate usually results.

When working with semen in the liquid nitrogen tank, it is important to keep the racks below the

frost line in the neck of the tank. Removal of semen from the tank for periods as brief as 10 seconds, such as for identification, before replacing it to the tank will often result in lowered fertility levels. If the right rack can't be located in 5 seconds, lower the canister back to the bottom of the tank for at least 30 seconds before trying again. Also, when handling semen, try to stay out of any direct sunlight, as ultraviolet light has a spermicidial effect.

The semen comes in two basic types of packaging: ampules (1 ml) and straws (0.5 or 0.25 ml). The ampule is the most common type of packaging for buck sperm. Both ampules and straws are stored in racks (canes), which are aluminum pieces that hold a vertical row of ampules, usually six.

A few key reminders concerning semen storage:

- Always keep the liquid nitrogen level above 5".
- Never lift a canister above the frost line of the tank.
- When the semen is removed with a forceps from the tank it should be placed immediately in the thaw box.
- Never expose semen to direct ultraviolet light.
- Never refreeze semen that has been thawed as it will be destroyed.
- Check for proper identification on ampule or straw.
- A defective ampule may blow up after it is removed from the tank. This is due to a small leak that allows nitrogen to enter the ampule. When removed from the tank, the gas expands too rapidly to vent back out the hole and it explodes the glass. A hissing sound is usually audible when it is removed. Keep your hand between the ampule and your face when putting it into thaw box.
- Always wear gloves and goggles for your own protection when working inside a liquid nitrogen tank.

Thawing Procedures

Methods for semen thawing vary among manufacturers, and it is best to follow their recommendation. The thawing procedure for 1cc ampules, the most common for goat semen, is generally the ice water bath.

Ice water (38-42F) is placed in a styrofoam box long enough before-hand to allow temperature to equilibrate. Remove the ampule from tank and place immediately into thaw box. Ampule may be placed in a small plastic cup with holes in the bottom. This prevents ice from coming into direct contact with ampule. Ampule should thaw in 3 to 5 minutes. Check for slushiness and allow more time if needed. Ampule may sit in ice water for as long as 30 minutes with no damage. Once removed, the semen must be used right away. The layer of ice on the ampule must be peeled off before opening to avoid possible contamination. The ice water thaw method is especially good during winter breeding of does because of low risk of cold shock to thawed and exposed semen. Thawing of semen can be done from -320F rapidly, but any subsequent exposure to lower temperatures after thawing will kill many or all of the sperm.

The warm water method of thawing is more exact than the ice water method, but probably will not work in cold weather, although it may give somewhat better results the rest of the year. The procedure is basically the same as for the ice water thaw except that the water must be maintained

at 92 to 98F. This requires a source of warm water and an accurate thermometer. Thawing will be complete in about 1 minute with no ice layer formation of the ampule. Ampules thawed with the warm water method should be used within 5 minutes.

Straws (0.5 or 0.25 ml) can be thawed by either of the previous two methods. A given amount of semen in a straw will take about one half as long to thaw as an equal amount in an ampule. Many inseminators simply thaw straws by placing them into their shirt or pants pocket.

Inseminating Procedures

All the care in handling, storage and preparation of semen will be useless if the inseminating process is not done carefully and cleanly. Hygienic practices at this point cannot be over-emphasized. All reusable items such as inseminating guns (for straws), scissors for cutting straws, scribe for cutting ampules, etc. must be wiped clean with 70 0sopropyl alcohol and allowed to dry before reuse. Disposable items should be kept in their sealed packages until they are to be used. The speculum should be sterilized after each use (this is one reason why the cattle industry discontinued the speculum method; the inseminator would have to carry a few dozen specula on his daily rounds, sterilizing them each night). This is best accomplished by boiling for 10 minutes, allowing to air dry. Then place inside a sterile container or wrapping, such as a new plastic AI glove. Disposable plastic type specula for goats can be obtained from mail order companies, eliminating the need for constant resterilization.

Materials needed for artificial insemination:

- Speculum, Pyrex 22 x 175 mm for doelings; 25 x 200 mm for adult does; or stainless steel human vaginal speculum; or plastic disposables; with a small clip-on flashlight.
- Sterile lubricating jelly (K-Y)
- Thaw box
- Inseminating pipette with bulb or syringe (ampules only) or Inseminating gun (straws only)
- Paper towels
- Facility for securing doe (stanchion, fence, rope hoist)
- Recording journal for breeding dates, buck's name, etc.

Preparing Ampules:

1. Partially remove an inseminating pipette from its plastic bag.
2. Place bulb or syringe on exposed end.
3. Thaw ampule according to the described methods.
4. Dry ampule after thawing, hold in paper towel and scribe (with proper tool) one side of ampule collar. Some ampule types do not need to be scribed, but can be snapped open.
5. Pull syringe back 1/2 cc on plunger or squeeze bulb closed before placing pipette into ampule. Tip ampule to slight angle and maintain constant suction on pipette while it is slowly inserted into the ampule. Try to get all the semen into the pipette, keeping the semen column down near the end of the pipette.
6. When filled, the pipette should have a semen column with no air spaces, with the bottom of the column being 1 to 2" from the pipette tip. Do not draw semen into the syringe or bulb.

7. Keep the ampule for information to complete breeding records.
8. Keep the pipette away from sunlight or cover with paper towels.
9. The semen is now ready to be placed into the doe in estrus.

Preparing Straws:

1. An inseminating gun, designed for your type of straw is needed, obtainable thru farm supply houses or the local cattle AI technician. Have cover sheath available, sealed until needed.
2. Place straw in thaw box.
3. Remove when thawed, wipe dry. Check buck information.
4. Pull plunger on gun back 4 to 6" and insert straw into gun, cotton plug end first (towards plunger).
5. Hold gun in upright position, allowing air bubble to rise to the sealed end.
6. Cut sealed end of straw with scissors. Take care to cut straw squarely for proper seating.
7. Install the sheath over the gun, fastening it down with the provided O-ring. Install it so that the wider side of the ring faces the straw, with the narrower side facing the syringe end.

Insemination:

Assuming that the doe has been observed in heat, has been suitably restrained (i.e. in stanchion) and the steps for preparing the ampule or straw have been followed. The next steps are:

- Position doe on milk stand. The inseminator places his left foot on the stand and drapes the hindquarters of the goat across his horizontally positioned thigh. The goat is allowed to stand as long as she does not struggle or collapse. The vulva is cleaned.
- Hold pipette or inseminating gun, wrapped in a paper towel, in your mouth; or let someone else hold it if extra hands are available.
- Turn head light on and insert lubricated speculum in a slow and gentle manner. Begin entrance at a somewhat upward angle for the first several inches. This is to prevent the speculum from scraping across the vaginal floor, possibly doing damage to the urethral opening.
- Complete insertion of speculum and locate cervix. Center the end of the speculum over the os uteri (entrance to cervical canal).
- Cervix should be of a red-purple coloration with a viscous whitish mucus present if doe is truly in heat.
- Insert pipette or inseminating gun into speculum to the cervix. Gently manipulate the instrument through the cervical canal (cervix is 1 to 2" long) to the 4th or 5th annular ring.
- Deposit semen near the uterine end of the cervix or just inside the uterus. Do not enter too far into the uterus as the semen will then tend to be dumped into one horn or the other. If the semen is pushed into the wrong horn (i.e. egg produced in left ovary, semen dumped into right horn) then fertilization may not occur.
- Deposit semen slowly, taking at least five seconds.
- Slowly withdraw instrument without release of syringe or depressed bulb, then carefully remove the speculum.

- Record all pertinent breeding information.
- Carefully discard all disposable materials. Arrange to sanitize reuseable items and sterilize the speculum (if it is a non-disposable type).

Frequently, the pipette cannot be passed all the way through the cervix even though the doe is in heat. If it has penetrated deeply into the cervix (3 to 4 cm, as determined by laying another pipette alongside the first and observing the distance by which the outer ends are offset), cervical insemination will provide a conception rate almost equal to that of intrauterine semen deposition. The conception rate expected from intra-vaginal insemination, however, is less than 30. If semen is very valuable, it may be advisable to pass a trial pipette to determine patency of the cervix before thawing the semen unit.

In France, a doe is usually restrained by a second person who straddles the doe's neck and elevates the hindquarters to a vertical position while holding the hind limbs tightly flexed. The inseminator is free to stand in a comfortable position. He holds the speculum and the goat's tail in one hand and the pipette or straw gun in the other hand. If excess mucus is a problem, the assistant lowers the goat's hindquarters almost to the ground; if the mucus does not run out of the speculum, the latter is removed and shaken to clear it. The goat is then lifted to its former position. If many goats are to be bred, the assistant may tire using this technique. If the doe is not held in a vertical position, it is often impossible to adequately visualize and penetrate the cervix. Various slings have been devised to suspend the goat in the appropriate position.

Angora Goats

Angora goats may be the most efficient fiber producers on earth. These makers of mohair came from and were named after Ankara (Angora prior to 1930), the Turkish province where they have thrived for centuries. Turkey guarded these goats against exportation until 1849 when seven does and two bucks were imported into the United States. Later, more were imported from Turkey and South Africa, the two principal mohair producers in the 19th century. But now, the United States has become one of the two biggest producers (along with South Africa) of mohair - the long, lustrous, wavy hair that goes into fine garments. The other primary fiber from goats is cashmere. Never the twain should meet! To cross Angora with cashmere goats results in a fiber called cashgora, with very limited uses and characteristics of neither fine fiber. The two goat types differ in temperaments, too. The Angoras are pretty laid back and docile, while cashmere and/or Spanish meatgoats are often flighty and high strung. (Incidentally, Angora goats, which do produce mohair, do not produce Angora hair; only rabbits can produce that.)

Although Angora goats are somewhat delicate, they grow their fleeces year-round. This puts considerable strain on the animal and probably contributes to their lack of hardiness. About 90 percent of the U.S. mohair clip originates in Texas, but the goats are raised over wide areas of the United States. They adapt well to many conditions, but are particularly suited to the arid southwestern states. Central and southwestern Texas have all the major mohair warehouses.

Shear twice a year

Angora goats are sheared twice a year, before breeding and before kidding. The hair grows about 3/4 of an inch a month, and adult hair should be 4-6 inches long at shearing. Shearing most often

follows the method developed by the Mexicans, with the goats lying down with legs tied. Shearing should be done on a clean-swept floor or sheet of plywood. Care should be give to keep mohair clean and free from contaminants-weeds, grass seeds, or urine. Buyers severely discount unclean hair and hair showing second cuts. Fleeces should be bagged separately in 6-foot burlap bags. Not acceptable are polyethylene bags or poly twine. Each bag should show the grower's name marked with a permanent-type felt-tip pen, be tagged, and contain only one fleecetype clearly marked: Kid, yearling, young adult, adult, buck and stained with spring or fall clip. Special problems, such as burns or coarse, extra long, or short fleece, should also be listed. Buyers slit the bag's side when inspecting before buying; sellers must present a uniform product. An adult goat usually will produce 8-16 pounds of mohair ayear. Kid mohair should be 4 inches long, is finer, and may yield 3-5 pounds a year. Mohair fiber diameter ranges from 20 to 40 microns. If kemp fiber (long, straight, hollow and brittle) shows up on any goats, especially along the backbone and thighs, such "kempy"animals should be culled, as suggested by the U.S. Mohair Marketing Board. Kemp fiber breaks easily and does not readily accept dye. The U.S. Government has a direct-payment program for mohair producers which helps maintain a viable industry. The direct payment through the U.S. Department of Agriculture's (USDA) Agricultural Stabilization and Conservation Service (ASCS) is based on thedifference between the national average market price and a support price. In one recent year, producers received an average of @2.475 for every dollar's worth of mohair marketed. Details can be found at ASCS offices in many counties.

Selecting Bucks

Bucks should be chosen for body conformation and fine hair. Preferred are open-faced bucks not blinded by hair. Bucks should be left with does for 6 weeks. Angora goats are seasonally in estrus. The normal breeding season is from late September into December. The gestation period for goats is usually 150 days, but it can vary several days each way. Kids are usually dropped from late February through April or early May. Twins may account for 40 percent of births, with a much lower percentage being triplets.

Fiber Comes First

Angora goats have high nutrient requirements and give nutritional advantage to fiber growth at the expense of other demands. Meeting nutritional needs should be the producer's main concern. Range forage of browse and forbs, protein supplements, grain and crop residues, and cereal crop pastures can help supply needed nutrients for growth and reproduction. Goats, browsing animals, can be pastured with sheep and cattle; each species prefers different plants. Goats prefer brush, tree leaves, and rough plants. They can improve pasture, clear reforestation areas, control leafy spurge and destroy multifloraroses, red cedars, sand burs, knapweed, hound's tongue, Canadian thistle, sagebrush, backbrush, giant ragweed, sunflowers, and many other weeds. When growing plants are not available, Angora goats need supplemental hay and perhaps grain. While gaining at breeding time, young does should weigh at least 55 pounds (sheared weight) and mature does at least 75. Does need extra feed before and after breeding so fetuses can develop hair follicles. During pregnancy and lactation, does need almost 1/2 pound of crude protein daily. Supplement feeding must start as soon as does begin to lose weight and condition. Improved nutrition brings more and better big growth kids and heavier fleeces. Poor nutrition is the leading cause of abortion and poor mothering. Young or lighter-weight goats are most subject to abortion. Stress from disease, moving long distances, or cold wet weather also cause abortions. Goats should be given adequate

nutrition before and after shearing.

Angora goats must be able to take shelter from wet and cold; great death loss can occur without shelter for 4 to 6 weeks after shearing. Goats to not carry layers of body fat, unlike sheep.

Kidding on the Range

Due to lack of labor and facilities, large herds are usually kidded on the range, while many smaller herds use a more intensive confinement system. For open-range kidding, small pastures with shelter, centrally located watering and supplement feeding areas, and bedding spots reduce numbers of lost kids. Angora does and kids should be undisturbed for several weeks, since does may abandon their kids. When goats are moved, pastures should be rechecked for kids. An even more intensive kidding system uses buildings, small individual stalls, heat lamps, and feeder space. This "system kidding" can be done earlier in the year but is much more labor intensive and therefore more expensive. But a larger kid crop can be realized with good management. Before kidding, does should be outdoors except in cold or wet weather or at night; this helps keep bedding cleaned and dry and encourages needed exercise. As does kid, they should be moved into stalls and kids' navels treated with 7 percent iodine. C and D antitoxin should be given. Cold kids will not try to suck and may need a heat lamp. When warm, they will usually suck by themselves but may need help to begin. Angora kids, very sensitive to cold, can die within a short time if too chilled. Immersion in warm water to speed restorationof body temperature and then thorough drying may save severely chilled kids. After identification with matching paint or ear tags, well fed does and kids can be moved to group pens or holding areas. Twins and triplets should not be grouped with singles since stronger kids often rob milk from usually smaller multiple-birth kids. Groups should contain kids of similar age.

Parasites Trouble Goats

Among goats, major health problems are internal and external parasites, coccidiosis (in kids before and after weaning), and pneumonia. A good health care program includes vaccination for most diseases and should be established between a grower and a veterinarian. Goats' hooves may need to be trimmed, depending upon walking conditions. Rocky ground may take care of that problem.

Goats may need special 4-foot-high fencing to keep them in and predators out. Goats like to go under or through obstacles. Five wire electric fences, with three wires hot and two grounded, make a good system. Woven wire fences may be used with the addition of a 12 inch "outrigger" electric wire about 12 inches above ground. Small-mesh fencing also may be used. Horns caught in the fence or the crotch of a tree become life-threatening, not only from predators but also from other goats. While most goats are not aggressive toward humans, they are not always kind to other goats and in seconds can do serious or lethal damage with their horns. A goat raiser may find horns useful-as handles. For safety, both for the handler and for other animals, horns' sharp points may be clipped, using a bolt cutter or similar device.

Angora Goat Production

Angora goats are an important enterprise for ranch operators in certain areas of Texas, mostly, but also in New Mexico and a few other Western states. Angoras produce income from the sale of

mohair and meat. They also are used for biological control of brush and weeds in range improvement programs. Production costs have increased in recent years. This places a heavier burden on the ranch manager for decision making for greater efficiency in production and higher economic returns.

Goats require the same major production resources as other species of livestock. These include land, labor, capital and management. Goats often are grazed on forage land less suited for other livestock. They prefer browse, thus are not totally competitive with cattle and sheep for limited land resources. However, goats must convert forage into salable products to justify their presence in most multi-species operations. Since land is a costly resource in ranching operations, goats should recover their share of the costs.

The total annual cost of maintaining an Angora goat varies by area and from ranch to ranch. This is influenced by the productivity of the land resource and by the level of management. Annual income per goat also varies for the same reasons.

Type of Production

Doe and kid operation should consist of a flock of healthy animals of productive age, three to six years of age.

- Raise replacements to make improvements in flock.
- Keep Spanish or meat-type animals separate.
- Sell all crossbred kids so they do not become mixed in the Angora flock.
- Replace wether goats for mohair production when the mohair becomes coarse and loses its character.
- Stock goats at a rate that will insure maximum mohair production with a minimum of supplemental feed.

Range Management

Use stocking rates consistant with the area of production. Practice mixed grazing of livestock consistent with the area of production. Practice rotation grazing for pasture improvement and internal parasite control. Follow range improvement practices recommended for the area and consistent with ranch economics. Make use of supplemental grazing when available.

Breeding Practices

Flush does by supplying 1/4 to 1/3 lb of supplemental feed daily or move to a fresh, rested pasture about two weeks before turning bucks out. Protein blocks may be used in flushing when range conditions are not too severe. When ranges are extremely dry, it may pay to give does vitamins A, D and E two weeks before breeding.

Follow a good selective breeding program. Mate best does to best bucks, second best does to second best bucks, etc. Save replacement does from top two groups. Adaptability to the area of production is probably the most important single point. Good bucks are essential to a good selective breeding program. Purchase bucks from one breeder whose goats possess the desired characteristics to produce a uniform flock. Select animals for quantity and quality of mohair but do not sacrifice size and vigor. Fleeces also should be uniform in quality and length over the body of

the goat

Use three to four bucks per 100 does, depending upon the size, brushiness and roughness of the pastures. Avoid using one buck per pasture in commercial goat production. Condition bucks by supplemental feeding about two weeks before turning them out. Breed does in September and October for February and March kids. It is not good management to run does and kids in the same pasture with wether goats. Wether goats travel too much.

Supplemental Feeding

Angora goats respond to supplemental feeding more than other livestock. They reflect this through heavier fleece weights. Feed goats during dry periods and especially during the winter months. Feed 1/4 to 1/2 lb of cottonseed cake, 1/2 to 1 lb of yellow corn or 1/2 to 3/4 lb of goat cubes per head daily depending upon the condition of the pastures and the does. Pregnant does require larger amounts of feed than dry animals. Abortion often can be prevented by supplemental feeding.

Self-feeding, using salt as an inhibitor, may be used in large, rough or brushy pastures. Keep salt as low as possible and place the feeders 3/4 to 1 mile from water. Move feeders for better pasture utilization. A popular mixture is three parts of ground milo, one part cottonseed meal and one part salt. Salt-controlled feeding is not recommended unless all other methods are impractical.

Feed kids during winter months to insure good growth and development. This will improve the kid crop on two-year-old does. Cull undeveloped kids that do not learn to eat. Protein blocks may be fed during kidding season. This method of feeding prevents kids from becoming lost from their mothers.

Kidding

Use rested pastures for kidding and do not disturb does during the kidding season. Kid in a small pasture, confine kids and let does out to graze until kids are large enough to follow mothers.

Marking

Vaccinate kids for soremouth and earmark for identification when most of the kids are large enough to travel. Plastic ear tabs are a practical way of identification. Castrate kids the following December or January or when the kids are about nine to ten months old. This produces a heavier horn on wether goats that buyers prefer.

Shearing

Spring shearing time is January through March depending on the area of production. Goats may be shedded during this period. Goats may be caped. Caping is the practice of leaving a strip of unsheared mohair about eight inches wide down the neck and back of the goat. This should be sheared after a month or six weeks. If capes are not sheared, they should be taken out and packed separately at shearing. Goats may be sheared with special goat combs. These combs leave about 1/4 inch of stubble on the goat and give him about two weeks start over goats sheared with regular combs. Producers usually supply the special combs and pay a small premium for shearers using them. Goats are sensitive to weather changes for a month to six weeks following shearing.

Fall shearing runs from July through September. Most producers shear with regular combs in the

fall but some prefer the special combs. The responsibilities of the producers are to:

- Provide a clean place to shear.
- Instruct the shearing crew so they know what is expected.
- Separate kids and third shearing goats from older goats so they can be sheared separately.
- See that goats are dry and not too full for shearing.
- Supervise the shearing pen or provide a supervisor other than himself.
- Register complaints with shearing crew captain.
- Caution shearing crew about cutting off teats of does.
- When mohair contamination ("vegetable matter") is a severe problem, a change in shearing dates may be advisable.
- Do not pack mohair in plastic bags.

The responsibilities of the shearer are to:

- Keep fleeces clean and remove each fleece in one piece.
- Avoid double cutting.
- Avoid injury to animals.

Spraying

Spray goats out of the shearing pen and again in twelve to eighteen days for best control of external parasites. Change sprays occasionally to get best control. Spray so goats will dry before dark. Use only recommended sprays or dips in strengths advocated by the Food and Drug Administration. Follow guidelines for spraying or dipping animals to go to slaughter. Do not spray under a shed or barn. Spray with the wind, not against it. Do not mix solutions with your hands. Spray or dip animals at a time of day when you will be able to bathe and change clothes. Do not mix chemicals.

Drenching

Watch animals closely for signs of internal parasitism and drench as necessary. Drench out of the shearing pen using one of the recognized drenches. Change drenches occasionally so that parasites do not build up resistance to any specific drench. Move animals to a fresh pasture following drenching. Phenothiazine salt is not recommended for goats because it stains the mohair. Use care in drenching animals so that the linings of the mouth and throat are not injured.

Weaning Kids

Leave kids in the pasture and move does. Kids are familiar with the pasture and know where to water and rest. Wean in the drylot. This practice gentles kids, teaches them to eat and builds up their strength. Do not wean in an overgrazed, internal parasite-infested pasture. When weaning in a different pasture, move kids to a rested pasture along with a few gentle does who can lead them to water.

Marketing

Some producers sell kids out of the hair after first shearing. Most producers prefer to market as

yearlings after the second shearing. Sell through a reputable commission man or through an auction that specializes in handling goats. Market mohair through one of the recognized wool and mohair warehouses. Select one that provides service to meet your requirements. If the bulk of your clip is finer than 24s, it may pay to have your clip graded. Follow the recommendations of your warehouseman in preparing and marketing your mohair. Do not artificially oil goats.

Defect Control

Rearrange shearing dates so that a minimum of plant matter is in the fleece. Use supplemental pastures to avoid vegetable contamination. Provide for control of burr-producing plants in your pasture improvement program.

Records

Keep accurate records of percentage of kid crop, fleece weight by age group and staple length to assist with the breeding program. Keep records of costs and returns to aid with income tax returns and planning business program of the ranch.

Angora Goat Selection

The Angora goat has been selected almost exclusively for fiber (mohair) production, and as such can be considered one of the outstanding success stories in animal breeding. Many Angora goats produce up to 20-25% of their body weight annually in fiber. In terms of growth rate of mohair fiber, they produce approximately double the rate of most types of sheep. Expressed as a function of body weight or feed intake, their rate of fiber production is about four times that of most sheep. However, since a high proportion of their nutrient intake is expended for fiber production, Angora goats are relatively poor meat or milk producers. Of course, slaughter of cull breeding stock provides some meat. It may be possible to develop dual-purpose meat and fiber producers, but only under conditions of better nutrition than that where most are run at the present time. Thus, for this discussion it is assumed that Angoras are bred primarily for fiber. The possibility is recognized that Angoras are kept for their usefulness in clearing brush and weeds on the farm or ranch also and that some are simply pets.

In selecting for fiber, one is interested in both quantity (weight) and quality of fiber (length, fineness, style, character, absence of kemp, etc). In addition to fiber, one must be concerned with traits that contribute to the survival or viability (soundness, fertility, etc.) of the individual and flocks.

Selection for quantity of fiber is accomplished efficiently by using fleece weights of those Angoras (mostly young males or young females) which are being considered for use as breeding animals. However, history indicates that most producers practice visual selection. In this case the predicting indicators of fleece weight are: size of the animal, completeness of cover, length of fiber, diameter of fiber and differences in density. The amount of grease (oil) or dirt in the fleece contributes to overall fleece weight, but not to fiber weight. It is preferable to emphasize fiber weight over total fleece weight. Environmentally (i.e. phenotypically), the two tend to be positively correlated, but genetically they are negatively related since the oil production requires a substantial amount of feed-energy. Similarly, one should not overemphasize the size of Angoras as a means of obtaining

fleece weight.

Phenotypically, size and fleece weight are positively related but genetically they tend to be negatively correlated. For assessing efficiency of production, the genetic correlation is the more accurate term since it is not possible to produce meat and fiber from the same units of feed-energy. Fiber diameter is phenotypically and genetically positively related to fleece weight, but negatively to fleece quality since the finer fiber is more desirable. Completeness of cover includes mostly head, neck, belly and legs. They are genetically related to fiber production. Face cover, however, can interfer with vision and have serious effects on the animal's welfare. This is even more true with range goats where reduced vision can interfer with their ability to graze selectively. The amount of mohair cover on the face contributes little to total fleece weight, but is genetically linked to total cover at other points. The amounts of fiber on neck and belly make important contributions to fleece weight, but the value of fiber grown on the legs (below the knee or hock) is rather low. Therefore, selection for body cover should be limited to the neck and belly, primarily the former. Animals with extensive cover in the face should be eliminated.

Selection for mohair quality includes primarily fiber diameter (finer fibers preferred), length (four inches minimum), freedom from kemp (coarse, brittle, chalky white hair mixed in the fleece), and desirable lock formation. There is little technological support for selecting for a specific lock type or formation, but in the absence of detailed studies it seems undesirable to allow the fleece to become straight or without some more appealing lock character.

Limited research indicates that all the desirable economic traits of Angora goats are moderately to highly heritable and can thus be changed through selection. Some strong negative relationships exist. Also, problems may be encountered due to genetic, environmental interactions. For example, selection for high level of fiber production tends to make the animal poorly adaptable to the range conditions under which most are produced presently.

Age of selection deserves some discussion. Weaning or first shearing is a poor time to select Angora goats. The second and third shearing (one year and 18 months) provide a much better age to appraise the fiber production potential. Angora goats tend to have high longevity. Thus, culling of Angoras with advancing age can be based on fiber production and less on teeth wear as practiced with sheep. Fleece weights tend to deteriorate (quantitatively and qualitatively) with advancing age. Removing Angoras with deteriorating fleece production can improve directly the evaluation of fleece traits and long-term selection.

Arthritis

The limb joints of animals are designed for mobility. In conjunction with the muscles and tendons, the joints allow for flexion and extension of the legs and permits a wide range of motion and activity. Normal joint function is essential for good health, particularly in grazing animals such as goats which may have to cover large areas over varying terrain in search of food. Normal joint function also allows flight from predators and is important for breeding success in active bucks. In addition, lameness or swellings over joints may reduce an animal's chances in the show ring.

Normal limb joints are comprised of several structures. First are the bone ends, covered with cartilage and shaped to interlock for increased stability. The cartilage is quite smooth, for reducing

friction and wear in the joint. A space exists between the cartilage surfaces called the joint cavity. This space is filled with joint (or synovial) fluid which lubricates the joint and acts as a shock absorber to reduce the trauma associated with movement. The fluid is held in place by a fibrous joint capsule which is lined with a synovial membrane that produces the joint fluid. Outside the joint capsule are numerous ligaments, muscles and tendons which add further strength and stability to the joint. The tendons are also surrounded by sheaths containing fluid known as bursae. Inflammation of the tendon sheaths is known as bursitis. Inflammation of the joint from any cause is known as arthritis. Any or all of the structures comprising the joint may be damaged in arthritic conditions.

Recognizing Joint Disease

Arthritis may result from a variety of infectious and noninfectious causes. A single joint may be affected or multiple joints involved (polyarthritis). Depending on the cause, signs of arthritis may vary. For example, in bacterial or traumatic arthritis, the affected joint may be swollen and warm to the touch. In early viral or nutritional arthritis, no visible change may be detected in the joint. In these cases, the presence of arthritis is suggested by observation of signs such as reluctance or difficulty in rising, slowed return to the barn at milking time, inability of bucks to mount does at breeding time, limping or uneven gait, or complete disuse of a single limb. Even when these signs are noted, other conditions which might result in abnormal motion should be considered. These would include fractures, laminitis or founder, foot rot, and white muscle disease (vitamin E/selenium deficiency). In addition, various neurological problems may be misinterpreted as musculoskeletal disease.

Several diagnostic procedures may be employed to identify the cause of arthritis. Examination of the joint fluid obtained by aseptically tapping the joint may be useful. Large numbers of neutrophils in the fluid are suggestive of bacterial arthritis. Large numbers of mononuclear cells are more indicative of viral arthritis. Little change in the fluid composition may be observed in traumatic or nutritional arthritis. In the case of bacterial arthritis, joint fluid may be cultured to identify the causative organism and to select the appropriate antibiotic therapy.

In cases of nutritional or traumatic arthritis, radiographs may be helpful in establishing a diagnosis and prognosis for recovery. Serological testing may be required for the diagnosis of arthritis due to virus or mycoplasma. Successful treatment of individual cases of arthritis and control and prevention of additional cases depends on accurate and specific diagnosis.

Specific Causes of Caprine Arthritis Bacterial Arthritis

Lacerations or puncture wounds over joints can lead to bacterial infection. Injuries such as these should be cared for immediately. The affected area should be cared for immediately. The affected area should be cleaned thoroughly with soap and water. If the joint has been opened, suturing may be indicated. Antibiotic therapy should be initiated to prevent infection. In young kids, bacterial polyarthritis can occur. The organisms involved are usually E. coli, Corynebacterium pyogenes, or staphylococci. The condition is recognized by lameness and swelling in one or more joints, particularly the front knees (carpi), hocks and stifles. This condition is secondary to bacterial infection elsewhere in the body, usually the navel or digestive tract. The bacteria are carried to the joints via the bloodstream. Therapy is often ineffective and prevention is the preferred method of control. Unclean environment and improper kid care promote the incidence of polyarthritis.

Improved management practices will reduce the occurrence of this disease. Maternity pens should be used for kidding, and kept clean and dry with bedding changed between births. Navels of newborns should be dipped in iodine immediately after birth. Kids should receive adequate colostrum within six hours after kidding. They should be housed in warm, dry quarters, and not overcrowded.

Mycoplasma Arthritis

Mycoplasmas are small microorganisms which differ from bacteria in that they do not have a cell wall. They are difficult to culture in the laboratory and much confusion exits with regard to the species of mycoplasma responsible for caprine arthritis in the United States. Several species of goat mycoplasmas are known in the US but Mycoplasma mycoides subspecies mycoides, large colony type, appears to be most responsible for cases of mycoplasmal arthritis. The prevalence and distribution of caprine mycoplasma arthritis is unclear, and sporadic reports from several regions of the US have appeared in the veterinary literature, most notably from California.

Mycoplasma infection produces a severe systematic disease in which arthritis may be the only sign or may be accompanied by high fevers, inappetence, pneumonia, diarrhea, keratoconjunctivitis (pink eye), or sudden death. All animals in a herd may be affected, but the more dramatic signs are seen in kids and younger adults. Outbreaks are often preceded by some stress such as dehorning. The infection may be carried unnoticed in a herd for extended periods.

Whenever several animals in a group are suddenly affected with arthritis along with signs of illness elsewhere in the body, mycoplasma should be suspected. Any dead animals should be submitted to a diagnostic laboratory for specific diagnosis. Blood samples from living animals should also be taken for evaluation of titers to mycoplasma infection. Correct diagnosis is important since few antibiotics are effective against mycoplasma. Tylosin and tetracyclines may be useful in controlling herd outbreaks although losses may be high.

Viral Arthritis

(CAE) A recently discovered retrovirus has been identified as a cause of chronic arthritis in goats. It is very likely that many previously unexplained cases of caprine arthritis were the result of this slow virus infection. The caprine arthritis encaphalitis virus (CAEV) was first recognized as a cause of progressive paralysis in two of four month old kids resulting from infection of the brain (encephalitis). Later it was demonstrated that the same virus also produces a progressive chronic arthritis in older goats. The presence of this virus in the US goat production is believed to be very high.

Nutritional Arthritis

One specific syndrome of arthritis related to feeding deserves mention. It involves the excessive consumption of calcium in the ration by mature bucks. Lactating does and young growing animals may require supplemental calcium in the diet. However, mature bucks fed in similar ration are likely to develop arthritis due to excessive deposition of calcium in the bone (osteopetrosis). Proliferative calcification (osteophytes) forming on the margin of joints disrupts normal joint architecture and may impair mobility and breeding effectiveness. Osteophytes may be visible radiographically. To prevent this problem, mature bucks should be fed either grass hay or not more than two pounds of alfalfa hay daily.

Traumatic Arthritis

Because goats are prone to fighting, traumatic joint injuries (sprains, dislocations, torn ligaments) are not uncommon. Sudden lameness and swelling of a single joint without fever is suggestive of traumatic injury. Affected goats should be isolated and confined with exercise restricted. The joint may be wrapped with an elastic bandage and cold compresses applied to minimize swelling. The animal may be placed on aspirin to reduce pain and inflammation. The degree of recovery is dependent on the extent of the injury.

Other Causes of Arthritis

Herd outbreaks of polyarthritis in lambs due to Chlamydia sp., a virus-like organism, are known to occur in the United States. It has been suggested that chlamydial arthritis in goats also occurs, especially in herds which have experienced outbreaks of chlamydial abortion. As interest in and recognition of caprine diseases continues to develop in the United States, chlamydia as well as other organisms may be identified as causes of arthritis in goats.

Avoid Residues in Goat Meat and Milk

The wholesomeness of American food is a cherished goal for all involved in the production and processing of edible goods. In cooperation with producers, federal regulations ensure that food is safe and free from objectionable levels of residues. All persons involved in the daily production of meat and milk are constantly aware of the necessity to closely monitor their management practices to assure that their products, whether used on the family table or sold for processing, meet accepted standards.

Occasionally, animals become ill and require medication. Goats are no exception. However, the owner has little guidance in the use of medication because few drugs are labeled for goats and professional advice often is not available. As a result, treatment of an ailing animal may require a more cautious approach when deciding on the method of drug application and dosage. There is a greater chance for error and the possibility that goat meat and milk could contain unwanted chemical residues for an extended period of time.

A survey conducted among goat breeders in Pennsylvania as part of the USDA Residue Avoidance Program found that many goat owners subscribe to the organic method of food production. An awareness of situations that could induce residue problems in any food supply appears to be foremost in their management programs. Even so, there are numerous instances where medication of an animal for various ailments, infections, and parasite problems is a necessity. In nearly all cases, when animals were given medication there has been extreme caution in the use of milk and meat from the treated animal. Withholding products several days beyond the recommended period is an
accepted practice among goat owners. This type of concern and caution has sponsored a supply of meat, milk and milk products for use in the home or for sale, that meets federal standards. One packing house that slaughters approximately 1,000 goats each year has yet to find a carcass with a residue violation. This would support the observation that goat raisers are thoroughly conscious of potential problems and are taking steps to assure a wholesome product. The industry is to be

commended.

There appears to be an ever increasing number of persons practicing goat husbandry. The homesteading movement with its agrarian intent, but often limited to small acreage, finds the dairy goat a perfect animal to meet home food production needs. Many newcomers to the business are not agriculturally trained. The lack of knowledge about adequate ventilation in goat housing and uncertainty about sanitation procedures could lead to a greater incidence of pneumonia, diarrhea,
and parasite problems. This, coupled with a scarcity of drugs labeled for use on goats, and in some areas, no access to veterinary care, increases the risk of accidental medical application. Those raising goats for a long period of time find it difficult to make treatment decisions. It is doubly difficult for the newcomer.

Let's examine the route that drugs and chemicals take to get into meat and milk. Medication may be given orally, injected subcutaneously (under the skin) or into the muscle, infused into the udder or
reproductive tract, or applied to the skin as a salve or a powder. Regardless of the treatment method, the medication may be absorbed into the blood stream and carried to all parts of the body. Therefore, a drug injected into the muscle to treat pneumonia symptoms or fed to the animal to control internal parasites will eventually find its way to the milk secretory cells and all body tissues. Body tissues may retain detectable levels of drug residues longer than body fluids such as
milk. It is not uncommon to find labels stating a longer withholding time before it is safe to send the animal for slaughter as compared to using the milk. Withholding times vary! When you treat an animal, be sure to follow directions when administering the drugs. If it calls for intramuscular injection and you inject subcutaneously, the stated withholding time on the label may be rendered inaccurate. Unusually large doses of medication will require longer withholding times, so stay with the
recommended dosage if you expect the label to be an accurate guide.

Mastitis medication formulated for dry treatment generally has a long meat and milk withdrawal time because the drugs are mixed in a slow release, long acting vehicle. Treatment over several days can extend the withdrawal period because of the additive effect. Therefore, depending on the drug you use, the dose given, the length of the treatment, and the drug vehicle (substance used to mix
with or dissolve the drug), you may need to extend the withholding time to allow the body to eliminate the drug residue.

Residues may occur from sources other than medication. Forages, such as hay, weeds, and browse that may have grown on or near roadsides or right of ways that have been sprayed with herbicides or pesticides can become polluted by spray or spray drift. If eaten by the goat, they
can be the cause of residues in meat and milk. The browsing nature of goats can lead them to eat both dead and living forage that another species of animal might shun. In addition, if you spray or dust your sweet corn, cabbage, turnips and other garden vegetables to control disease or insects, do not permit the goats to eat any of the garden plants.

Be careful when purchasing a grain mix, especially one not formulated for a ruminant. Read the

feed tag. If it says medicated on the tag be sure you read further to find what limitations may be recommended. Also, some milk replacers may contain a medicated ingredient that could pose a problem in the sale of a kid consuming the replacer in its daily ration.

If you have treated a milking doe for mastitis, milk her last and discard all the milk even though you may have treated only one side of the udder. By milking her last, you prevent possible contamination of milk from other does. As little as a teaspoon of milk left in a pail or in a milk line can contaminate the milk from the next doe. Don't take chances. Mark a treated animal with a paint stick or a dye to remind you and anyone else doing the milking that the milk from that doe must be discarded.

Testing for Residues

Modern-day testing methods make it easier for officials to test for trace levels of residues. Levels that once went undetected now are found in both meat and milk. In addition, procedures have been developed to permit the tracking of a carcass in a slaughter plant back to an auction or buyer and finally to the person who sold the animal. Not only are the tests becoming more accurate and refined, it is now easier to identify the person who committed the error.

Several tests have been developed to assist the producer in checking for the possibility of residues present in the animal or the milk. The Live Animal Swab Test (LAST) developed by scientists in the
USDA's Food Safety and Inspection Service (FSIS), is the first tool available for on-the-farm use in checking animals for antibiotic residues before they are shipped for slaughter. LAST is an adaption of a test used since 1979 by FSIS, called STOP (Swab Test on Premises). STOP has been used in slaughter houses to check presence of antibiotics and other antimicrobial substances in the killed carcass. Now producers and/or their veterinarians can perform the LAST on live animals at the farm simply by testing the urine of any suspect animal. Test kits are available for purchase and anyone wishing to learn more about the test and how to perform it may write to Publications Office, FSIS-ILA, Room 1163-S, USDA, Washington, DC 20250.

The DELVO test has been used for several years by milk plants and sanitarians and more recently by dairymen to check for levels of antibiotics in milk. More and more farmers are routinely running this test on milk from any treated, mastitic cow prior to including her milk with that of the herd. It is also used on milk in the bulk tank prior to shipping. Contact any dairy sanitarian, milk plant, veterinarian or Extension agent for information on purchasing this test kit. Or, write to G. B. Fermentation Industries, Inc., 555077 Centre Drive, Charlotte, North Carolina 28224. Other test kits are being developed for on-farm use. LAST, STOP and DELVO tests are all designed to detect the presence of antibiotics and sulfas. They will not detect other chemicals such as wormers or insecticides. Federal meat inspectors use other methods to detect these chemicals.

Today, there is little reason to use or sell residue-contaminated products. You can test a product to be sure it is residue free. This should be especially good news to the goat producer since most of the goat products are used by the family. Rather than to waste several days milk or hold a live animal an extra couple weeks just to be sure the medicine has been eliminated from the body, you can now test and know when the product is safe to place on the family table.

Avoid Residues

- Provide a clean, well bedded, dry area for the does at kidding time.
- Be sure kids receive colostrum; 4 ounces (1/2 cup) within 2 hours following birth. Co lostrum contains protective antibodies and helps keep kids from getting sick.
- Provide kids and adult animals with clean, dry bedding and good ventilation to reduce incidence of scours and pneumonia.
- Feed hay in a hayrack or keyhole feeder; protect grain boxes and watering devices from manure contamination to reduce parasite problems.
- Dip teats in an approved germicidal dip after each milking.
- Clean and sanitize all feeding equipment.
- Fence animals away from chemically sprayed areas and don't feed forages or garden refuse that contain chemical residues.

Ask your veterinarian's advice regarding:

- Proper use of medication.
- Withholding times before slaughtering treated animals or milk offered for sale and/or used at home.
- Oral electrolyte mixtures--unmedicated but effective therapy for scouring kids.

Ask your county extension agent's advice regarding:

- Ventilating requirements and proper fan size to provide draft-free fresh air in stable area.
- How to build hayracks and keyhole feeders.
- Management programs that increase the potential for growth and production and reduce risks of disease.

Don't rely on memory:

- Always read label directions and check withdrawal times. They vary with each medication used.
- Identify with a chalk marker any treated animal. Keep a record of the medication used and date treated.

Use drugs wisely:

- Drugs are not a substitute for good management.
- Permit only one person to administer drugs.
- Limit access to drugs to competent and responsible people.
- When possible, avoid treatment of lactating does.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- Goats, an email list for goat issues. To join, send to listserv@wsuvm1.wsu.edu with message "subscribe goats-l Your Name".
- **GOATS: Discussion List for Goat Managers and Lovers**

  Subscription address: listproc@listproc.wsu.edu

  Topics:

  Subscribe to GOATS. Type "subscribe GOATS Your Name" in the message body. (Not supported by all browsers.)

Suggested references:

- Goat Husbandry - 5th Edition - Paperback - Publication date: July 1993
  List: $16.95
  Contents include: prospects for goat farming, principles of goat feeding, selection of breeding stock, and diseases.
- Goat Medicine - by Mary C. Smith, David M. Sherman - Hardcover - Publication date: April 1994 - List: $79.00
  Book News, Inc., 08/01/94: A comprehensive veterinary text addressing health and disease issues of goats raised under varying conditions around the world. The authors' primary experiences are with intensively managed dairy and fiber goats in temperate zones, but, because most of the world's goats live in tropical and subtropical regions, disease entities and production constraints in those areas are also fully covered. Annotation copyright Book News, Inc. Portland, Or.
- Goat Nutrition (European Association for Animal Production Publications, No 46) - by P. Morand-Fehr (Editor) - *NR Edition - Hardcover - Publication date: September 1990 - List: $83.00

- Goats : A Guide to Management - by Patricia Ross - Paperback - Publication date: August 1995 - List: $22.95
- Maedi-Visna and Related Diseases (Developments in Veterinary Virology) - by G. Petursson, R. Hoff-Jorgensen (Editor) - Hardcover - Publication date: January 1990 - List: $105.00
- Nutrient Requirements of Goats : Angora, Dairy, and Meat Goats in Temperate and Tropical Countries - by National Research Council Commission on Natural Resources Volume 15 - Paperback, 91 pages - Publication date: December 1981 - List: $24.95
- Raising Milk Goats Successfully - by Gail Luttmann, Gail Luttman - Paperback, 172 pages Publication date: November 1986 - List: $9.95
- Raising Milk Goats the Modern Way - by Jerry Belanger - Revised & Updated Edition Paperback, 200 pages - Publication date: March 1990 - List: $18.95
- The New Goat Handbook : Housing, Care, Feeding, Sickness, and Breeding With a Special Chapter on Using the Milk, Meat, and Hair - by Ulrich Jaudas, Matthew M. Vriends - Paperback, 93 pages - Publication date: March 1, 1989 - List: $9.95
- Your Goats : A Kid's Guide to Raising and Showing - by Gail Damerow - Paperback, 172 pages - Publication date: August 1, 1993 - List: $12.95
  Explores the fun of raising goats, discussing selection, purchase, housing, feeding, health, behavior, breeding, and showing.

Periodicals:

- None identified.

This page was last updated on November 15, 2002

Raising Pigs

Frequently Asked Questions Other Information Sources Return to Livestock Index

Frequently Asked Questions:

- Feeding requirements during drought.

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Feeding requirements during drought.

Since swine rations rely on grain, when grain supplies are limited, you as a producer must work out the most economical ration for your animals. Remember, if you use a ration low in energy, your hogs will gain weight more slowly and be home longer. You will have to watch closely how much less supplement you use so you don't waste grain by feeding longer than is necessary. You will probably still rely on wheat, oats, and barley for rations, although you could use pelleted screenings in some of your rations.

You can use wheat as the major grain in hog rations. If used alone, as finely ground, it does "paste up" in the mouth. Also, because it is high in energy, limit wheat or the pigs become overfat. So you will probably be better off mixing it with another grain such as oats. Oats are much lower in energy than wheat and need to be supplemented with a feed higher in energy. A 50:50 mixture of wheat and oat is equivalent in feed value to barley.

You can use pelleted screenings as up to 25 per cent of rations for growing pigs. Avoid them in sow rations because they may contain large amounts of unprocessed canola and wild mustard seeds which may cause reproductive problems.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- **PIGFARM: Pig Farming Discussion Group**

  Subscription address: listserv@ist01.ferris.edu

  Topics: About pigs (the animal variety) their breeding, care, diseases, how to farm them small scale, and other relevant topics.

  Subscribe to PIGFARM. Type "subscribe PIGFARM Your Name" in the message&127 body. (Not supported by all browsers.)

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- A Guide to Raising Pigs : Facilities, Breed Selection, Management (Storey Animal Handbook) - by Kelly Klober - Publication date: February 1998
- An Outline of Swine Diseases : A Handbook - by Ross P. Cowart - Publication Date: September 1, 1995 - List: $19.95
- Controlled Reproduction in Pigs (Controlled Reproduction in Farm Animals, 3) - by Ian R. Gordon - Publication Date: March 1997 - List: $80.00
  This book is the third in a set of four providing a series on controlled reproduction in farm animals. The aim of the series is to provide a general review of the literature dealing with the different ways in which reproduction in the major farm mammals can be controlled and manipulated. The four volumes are effectively an expanded and new edition of a previous work, Controlled Breeding in Farm Animals (Pergamon Press, 1983).
- Diseases of Swine - by Allen D. Leman, Barbara E. Straw, William L. Mengeline - Publication Date: November 1994 - List: $129.95
- Manual of Pig Production in the Tropics - by H. Serres, Julian

Wiseman (Translator) - Publication Date: December 1992 - List: $45.00

- Nutrient Requirements of Swine - by National Research Council - Publication Date: 1988 - List: $14.95
- Pictorial Anatomy of the Fetal Pig - by Stephen G. Gilbert
- Pigs : A Guide to Management - by Neville Beynon
- Pork Production Systems : Efficient Use of Swine and Feed Resources - by Wilson G. Pond, Jerome H. Maner, Dewey L. Harris
- Raising Pigs Successfully - by Kathy Kellogg, Bob Kellogg - Publication Date: September 1, 1985 - List: $9.95
- Small-Scale Pig Raising - by Dirk Van Loon, Dick Van Loon - Publication Date: August 1, 1983 - List: $14.95
- Swine Housing and Equipment Handbook - by Midwest Plan Service Engineers - Publication Date: June 1982 - List: $8.00 + $1.35 special surcharge

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Periodicals:

- None identified.

This page was last updated on November 16, 2002

Frequently Asked Questions:

- Feeding requirements during drought.

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

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Feeding requirements during drought.

Since swine rations rely on grain, when grain supplies are limited, you as a producer must work out the most economical ration for your animals. Remember, if you use a ration low in energy, your hogs will gain weight more slowly and be home longer. You will have to watch closely how much less supplement you use so you don't waste grain by feeding longer than is necessary. You will probably still rely on wheat, oats, and barley for rations, although you could use pelleted screenings in some of your rations.

You can use wheat as the major grain in hog rations. If used alone, as finely ground, it does "paste up" in the mouth. Also, because it is high in energy, limit wheat or the pigs become overfat. So you will probably be better off mixing it with another grain such as oats. Oats are much lower in energy than wheat and need to be supplemented with a feed higher in energy. A 50:50 mixture of wheat and oat is equivalent in feed value to barley.

You can use pelleted screenings as up to 25 per cent of rations for growing pigs. Avoid them in sow rations because they may contain large amounts of unprocessed canola and wild mustard seeds which may cause reproductive problems.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- **PIGFARM: Pig Farming Discussion Group**

  Subscription address: listserv@ist01.ferris.edu

  Topics: About pigs (the animal variety) their breeding, care, diseases, how to farm them small scale, and other relevant topics.

  Subscribe to PIGFARM. Type "subscribe PIGFARM Your Name" in the

message&127 body. (Not supported by all browsers.)

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- A Guide to Raising Pigs : Facilities, Breed Selection, Management (Storey Animal Handbook) - by Kelly Klober - Publication date: February 1998
- An Outline of Swine Diseases : A Handbook - by Ross P. Cowart - Publication Date: September 1, 1995 - List: $19.95
- Controlled Reproduction in Pigs (Controlled Reproduction in Farm Animals, 3) - by Ian R. Gordon - Publication Date: March 1997 - List: $80.00
  This book is the third in a set of four providing a series on controlled reproduction in farm animals. The aim of the series is to provide a general review of the literature dealing with the different ways in which reproduction in the major farm mammals can be controlled and manipulated. The four volumes are effectively an expanded and new edition of a previous work, Controlled Breeding in Farm Animals (Pergamon Press, 1983).
- Diseases of Swine - by Allen D. Leman, Barbara E. Straw, William L. Mengeline - Publication Date: November 1994 - List: $129.95
- Manual of Pig Production in the Tropics - by H. Serres, Julian Wiseman (Translator) - Publication Date: December 1992 - List: $45.00
- Nutrient Requirements of Swine - by National Research Council - Publication Date: 1988 - List: $14.95
- Pictorial Anatomy of the Fetal Pig - by Stephen G. Gilbert
- Pigs : A Guide to Management - by Neville Beynon
- Pork Production Systems : Efficient Use of Swine and Feed Resources - by Wilson G. Pond, Jerome H. Maner, Dewey L. Harris
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Raising Poultry

Frequently Asked Questions Other Information Sources Return to Livestock Index

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Egg Producing Chickens

Breeds Available

Two types of chickens are used for egg-production purposes in small flocks: the dual purpose and the egg producing breeds.

Egg producing chickens have been bred for maximum egg production rather than meat yield, and can produce up to 300 eggs per year. They have a mature body weight of 1.8-2.0 kg (4-5 lb). These chickens are usually of the White Leghorn type or California Grey crosses. They usually lay white eggs.

Dual purpose chickens are often raised in small flocks for both meat and egg production. They are smaller than commercial broilers, but reach a mature body weight of approximately 2.5 kg (5.5 lb) for females and 3.0 kg (6.5 lb) for males. The hens will produce 200-250 eggs per year. Available breeds include Rhode

Island Red crossed with Barred Rock, Columbian Rock, or Light Sussex. These hens usually produce brown eggs.

Brooding and Rearing

If pullets are purchased just prior to laying, it is important to obtain information on the management procedures used. This includes lighting program, feeding program, vaccination program and any disease exposure. This history will aid in planning flock management and assist in determining causes of any production problems. Pullets should weigh approximately 1.3-1.55 kg at the start of egg production.

Lighting

Proper light management is important when raising pullets in order to obtain maximum egg production. Lighting will stimulate egg production and help to synchronize the pullets so that they start to lay at approximately the same time.

If pullets are raised in a windowless barn which is light-tight, the daylengths should be controlled with a time-clock. During the brooding and rearing period (1-20 weeks), the daylength can be held at 8-10 hours of light or gradually reduced from 12-13 hours of light per day to 8-10 hours by 6 weeks of age. To bring the pullets into production, the light should be increased abruptly to 12 hours/day. It can then be gradually increased to 16 hours. Once egg production has been stimulated with increased lighting, the day lengths should not be reduced, or the hens will lay fewer eggs.

Often with smaller flocks, pullets are raised in barns with windows or are outside during the day and are subject to natural daylengths. They are also usually hatched in the spring. In this situation, by the time they reach 19-20 weeks of age, the natural daylengths are decreasing. Increasing the daylength with supplementary lighting will help bring them into peak production, and synchronize the flock into similar egg production cycles.

Light intensity should be held at 5 lux (.5 foot candles) in the barn, if possible. At this intensity it is still possible to read a newspaper, but with some difficulty.

Hours of Light to Provide by Age of Chicks

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to help hens reach the entrance. Nesting material, such as straw, should be placed inside the nests and replaced regularly.

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Perches made of a hardwood are easier to clean and disinfect than those made with a softwood. They should be approximately 33 mm wide at the top. If perches are too wide, they can cause breast bone deformities. The perches should be deep enough so that the hens cannot puncture their own footpads by curling toenails around the bottom. Rounded edges at the top are also recommended. It is recommended that 12 to 15 cm of perch length be provided for each bird.

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Nutrient recommendations for egg-laying chickens are illustrated below.

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Feed Consumption

Laying hens should always have ready access to feed. They will eat from 100 to 120 grams of feed each day. Feed consumption is affected by temperature, age of

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Calcium intake is very important for laying birds, because the egg shell contains a great deal of calcium. It is also important in the pre-lay period (2 weeks prior to egg production), because this is the time period in which the pullets build up their medullary bone to enable them to manufacture egg shells. A deficiency in calcium can lead to skeletal problems, reduced egg production and thin egg shells. The main calcium source for laying hens is limestone and/or oystershell in the feed.

Yolk Color

Preference for yolk color varies. Some people like the pale yellow color, while others prefer dark gold yolks. Yolk color is influenced by pigment content in the feed. Essentially, if the hens have access to greenfeed, alfalfa or corn, the yolks will be darker.

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Eggs should be collected regularly and nesting material kept clean in order to avoid bacterial contamination. Eggs should be allowed to cool gradually prior to refrigeration to avoid sweating (which could also lead to contamination). Eggs are normally stored for 3-4 days at temperatures of 10-13 °C before marketing. Albumen (egg white) quality will decrease as the length of storage increases.

If eggs require cleaning, they can be brushed off with sand-paper or washed. If washing, a water temperature at least 12 °C higher than the eggs themselves should be used. A sanitizer should also be used in the water (not dishwashing liquid). Water with a high iron content should not be used. Eggs should be rinsed and then completely dried prior to storage.

Poor Egg Production

A problem often encountered with smaller flocks is poor egg production or sudden drops in production. There are many possible causes for low egg production, and often it is a combination of a few different factors. These factors may also influence egg size and shell quality. The items discussed below should be examined and corrected if necessary.

Feed which is poor in quality, with nutrient deficiencies and imbalances, can lead to reduced egg production. Protein, energy, and calcium are the more common culprits. An extra calcium source, such as oystershell or limestone, is usually required with diets made up of poultry supplement and grain. Also, if hens run out of feed or water, a drop in production could result. Toxins contained in the feed may also cause a drop in egg production.

Lighting programs which are not appropriate may cause problems. Low production may result if the pullets are reared with daylengths that are too long, or there is no proper increase in daylength to bring them into production. Daylengths which are too long may result from sunlight coming into barn windows. Hens may stop

laying eggs if daylengths are decreased at anytime during the production period.

Sudden changes in temperature can affect egg production. Hot temperatures may cause a reduction in feed consumption, leaving the hen with insufficient nutrient intake to produce eggs. Both sudden increases and decreases in temperature will stress hens, and could adversely affect production.

Poor ventilation may cause a build-up of gases which might cause a drop in egg production. High stocking densities will also adversely affect egg production.

The age of the birds will also affect how many eggs they produce. Commercial pullets begin laying eggs at 19-20 weeks of age, and peak production occurs around 24-26 weeks. The hens in smaller flocks may not start until later. Production begins to drop slowly after the peak and by 72 weeks of age is down to 70% of the hens laying in a given day. The hens will eventually cease to produce and go into a moult (lose and replace feathers). Following moulting, hens will lay eggs for at least a second year. Egg production after a moult will be approximately 10-15% lower than the first year.

Various diseases will cause a drop in egg production. These include infectious bronchitis, mycoplasma gallisepticum (MG) and avian encephalomyelitis. Parasite infections such as coccidiosis and mites can also cause a reduction in production. If a disease is suspected to be present, a veterinarian should be consulted.

Disease

Nutrient deficiencies, cannibalism, parasites and cage-layer fatigue are specific diseases affecting laying birds.

Cage-layer Fatigue (osteoporosis)

Cage-layer fatigue, as the name implies, is typically found only in hens housed in cages. Inadequate dietary calcium, phosphorus and/or vitamin D can, however, can lead to the disease in hens housed on litter floors.

High levels calcium are put into each eggshell, and this calcium is removed daily from bones. Normally the bone is replaced, but in situations of nutrient deficiency (calcium, phosphorus, and/or vitamin D), the hen is unable to do so. Poor skeletal development and lack of exercise (especially in cages) are also causative factors.

Hens with cage-layer fatigue have lost a significant amount of bone and will go out of production. Other signs of the disease include paralysis, fragile and deformed bones, fractures, and weak egg shells. In extreme cases, hens will die.

Treatment by removing hens from the cages and placing on the floor with easy access to feed and water may be effective. However, prevention of the disease is much more important.

Good nutrition during the rearing and pre-lay periods is essential for good skeletal development. Proper levels of calcium, phosphorus and vitamin D are important during the laying period. In small flocks it is common to supplement the diets with a calcium source (oystershell, limestone) that the hens can obtain free-choice.

What variety of chicken is best for roasting?

- **Suggestion A:** The best roasters are the Cornish cross. They live to eat. You will be eating in about 3 months from hatch. Other than that they are disgusting, dirty and stupid. You will be happy to dispatch them. But they are tasty and meaty, much more so than ordinary chickens.

Is it ok to use sawdust as litter in the chicken coop?

- **Suggestion A:** Sawdust should be avoided as litter for chickens. Wood shavings are fine, but should be avoided for chicks that are less than a couple of weeks old, since they don't really know what is food versus litter. If you use sawdust as litter, the chickens may eat the fine material. This will cause bulbous crops and in some cases result in death by starvation.

Any ideas how to protect the chickens from predators when they are out of the coop?

- **Suggestion A:** We have a flock of about 60 chickens, purebred Astrolorps and Aracaunas. We solved both the coyote and bird problems (hawks and eagles) by running the hens with the goats. The birds won't attack the hens near the goats and the coyotes can't get in the goat pen.

What is a good way to kill the chickens when it is time to butcher them?

- **Suggestion A:** For butchering I prefer to decapitate. The usual method is to get a big piece of lumber, put two nails in it about 1 inch apart and sticking up about 2 inches (just far enough apart to hold the chickens neck), stick his neck in it , stretch him out and use a cleaver to do the work. Not pretty but works and helps them to bleed.
- **Suggestion B:** The two nail method is good for killing. We use a cone. (Sheet metal about 16 inches tall with a hole at the bottom for the head.) In either case pull to stretch the neck and cut. Some people claim that a small knife poked through the roof of the mouth into the brain results in tenderer meat. I have not tried that. I would hate to botch it. We do not pluck the chickens, we skin them. If we want plucked chicken we take live birds to our local poultry butcher. I noticed he uses cones and cuts off the head too.

Related web pages:

- The Poultry Page, provides lots of information about chickens, ducks, geese, guinea fowl, peafoul, pigeons, turkeys, and some other non-domestic bird breeds.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- <DOM_BIRD@PLEARN.EDU.PL> - For owners, breeders, and farmers of domesticated birds DOM_BIRD is a new list for owners, breeders and farmers of the wide variety of domesticated birds. This list was created for the express purpose of discussing anything from the nutritional requirements of your breeders, to the shows and events held for displaying the many variety of fancy breeds of domesticated birds. If you wish to discuss equipment used for incubating eggs, the veterinary care and management of adults or chicks, or find the best way to handle any aspect of domesticated bird ownership, you are welcome to join DOM_BIRD. In the future, DOM_BIRD may also serve as a gateway to a newsgroup on domesticated birds, so that a wider audience can be reached.

  DOM_BIRD will NOT be a place for campaigning for the rights of animals, debating the ethics of maintaining or hunting of domesticated birds, discussing the pros and cons of vegetarianism, or the swapping of recipes. This is, first and foremost, a list for people who enjoy and prosper from a relationship with domesticated birds.

  To subscribe to DOM_BIRD, send the following command to LISTSERV@PLEARN.EDU.PL in the BODY of e-mail:

  SUBSCRIBE DOM_BIRD firstname lastname

Suggested references:

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- A Guide to Raising Chickens : Care, Feeding, Facilities (Storey Animal Handbook)
  by Gail Damerow - Publication Date: January, 1996 - List: $16.95

- The Chicken Health Handbook - by Gail Damerow - Publication Date: June, 1994
  List: $19.95

- Small-Scale Poultry Keeping : A Guide to Free Range Poultry Production - by Ray Feltwell - Publication Date: October 1992 - List: $12.95

Periodicals:

- None identified.

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Hens with cage-layer fatigue have lost a significant amount of bone and will go out of production. Other signs of the disease include paralysis, fragile and deformed bones, fractures, and weak egg shells. In extreme cases, hens will die.

Treatment by removing hens from the cages and placing on the floor with easy access to feed and water may be effective. However, prevention of the disease is much more important.

Good nutrition during the rearing and pre-lay periods is essential for good skeletal development. Proper levels of calcium, phosphorus and vitamin D are important during the laying period. In small flocks it is common to supplement the diets with a calcium source (oystershell, limestone) that the hens can obtain free-choice.

What variety of chicken is best for roasting?

- **Suggestion A:** The best roasters are the Cornish cross. They live to eat. You will be eating in about 3 months from hatch. Other than that they are disgusting, dirty and stupid. You will be happy to dispatch them. But they are tasty and meaty, much more so than ordinary chickens.

Is it ok to use sawdust as litter in the chicken coop?

- **Suggestion A:** Sawdust should be avoided as litter for chickens. Wood shavings are fine, but should be avoided for chicks that are less than a couple of weeks old, since they don't really know what is food versus litter. If you use sawdust as litter, the chickens may eat the fine material. This will cause bulbous crops and in some cases result in death by starvation.

Any ideas how to protect the chickens from predators when they are out of the coop?

- **Suggestion A:** We have a flock of about 60 chickens, purebred Astrolorps and Aracaunas. We solved both the coyote and bird problems (hawks and eagles) by running the hens with the goats. The birds won't attack the hens near the goats and the coyotes can't get in the goat pen.

What is a good way to kill the chickens when it is time to butcher them?

- **Suggestion A:** For butchering I prefer to decapitate. The usual method is to get a big piece of lumber, put two nails in it about 1 inch apart and sticking up about 2 inches (just far enough apart to hold the chickens neck), stick his neck in it , stretch him out and use a cleaver to do the work. Not pretty but works and helps them to bleed.
- **Suggestion B:** The two nail method is good for killing. We use a cone. (Sheet metal about 16 inches tall with a hole at the bottom for the head.) In either case pull to stretch the neck and cut. Some people claim that a small knife poked through the roof of the mouth into the brain results in tenderer meat. I have not tried that. I would hate to botch it. We do not pluck the chickens, we skin them. If we want plucked chicken we take live birds to our local poultry butcher. I noticed he uses cones and cuts off the head too.

Related web pages:

- The Poultry Page, provides lots of information about chickens, ducks, geese, guinea fowl, peafoul, pigeons, turkeys, and some other non-domestic bird breeds.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- <DOM_BIRD@PLEARN.EDU.PL> - For owners, breeders, and farmers of domesticated birds DOM_BIRD is a new list for owners, breeders and farmers of the wide variety of domesticated birds. This list was created for the express purpose of discussing anything from the nutritional requirements of your breeders, to the shows and events held for displaying the many variety of fancy breeds of domesticated birds. If you wish to discuss equipment used for incubating eggs, the veterinary care and management of adults or chicks, or find the best way to handle any aspect of domesticated bird ownership, you are welcome to join DOM_BIRD. In the future, DOM_BIRD may also serve as a gateway to a newsgroup on domesticated birds, so that a wider audience can be reached.

  DOM_BIRD will NOT be a place for campaigning for the rights of animals, debating the ethics of maintaining or hunting of domesticated birds, discussing the pros and cons of vegetarianism, or the swapping of recipes. This is, first and foremost, a list for people who enjoy and prosper from a relationship with domesticated birds.

  To subscribe to DOM_BIRD, send the following command to LISTSERV@PLEARN.EDU.PL in the BODY of e-mail:

  SUBSCRIBE DOM_BIRD firstname lastname

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- A Guide to Raising Chickens : Care, Feeding, Facilities (Storey Animal Handbook) by Gail Damerow - Publication Date: January, 1996 - List: $16.95

- The Chicken Health Handbook - by Gail Damerow - Publication Date: June, 1994 List: $19.95

- Small-Scale Poultry Keeping : A Guide to Free Range Poultry Production - by Ray Feltwell - Publication Date: October 1992 - List: $12.95

Periodicals:

- None identified.

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Raising Sheep

Frequently Asked Questions Other Information Sources Return to Livestock Index

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Feeding requirements during drought.

Sheep will not eat as wide a variety of roughage or as poor a quality of roughage as will cattle. However, on pasture sheep will consume different feeds readily and, if hungry, may eat poisonous weeds as well.

An ewe needs at least one pound of roughage a day to keep her digestive system functioning normally. Increase this to 1 1/2 pounds of heavy barley or feed-wheat during early pregnancy and 2 1/2 pounds during late pregnancy. Conception rates are better and ewes have more lambs if they are gaining weight during the breeding season. So, for flushing on low roughage, give each ewe one pound of good, whole grain daily.

As well as roughage, ewes need adequate amounts of vitamins and minerals and a good, clean supply of water. Breeding ewes may need 10,000 to 15,000 I.U of vitamin A and 1,000 to1,500 IU of vitamin D per head per day. Pregnant ewes need abut 5,000 I.U. of vitamin A and 500 I.U. of vitamin D each, daily. Allow 5 I.U.of vitamin E for each pound of feed for sheep.

The mineral mixture for sheep should supply salt, calcium, phosphorus, iodine and cobalt. Sheep are sensitive to excess copper. Choose a supplement with little if any copper, if you are in an area where the soil has enough copper.

Always make sure sheep have enough water. When they don't have water, they cut down on how much they eat.

Related web pages:

- Ronald Florence maintains an excellent FAQ on lambing, which we highly recommend.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

- A Handbook for Raising Small Numbers of Sheep - by Ralph L. Phillips - Publication Date: April 1985 - List: $5.00 + $2.35 special surcharge
- Agribusiness Reforms in China : The Case of Wool - by John W. Longworth, Colin G. Brown - Publication Date: April 1995 - List: $80.00
- Beginning Shepherd's Manual - by Barbara Smith, Mark Aseltine, Gerald Kennedy - Publication Date: January 1997 - List: $24.95
  Whether you are raising a few sheep for a 4-H project or raising a large flock for breeding stock, for meat, or for wool, Beginning Shepherd's Manual provides a clear and practical introduction to shepherding. Original author Barbara Smith has updated the book and added chapters by two new contributors. "On Location" presents interesting stories about people who are active shepherds dealing with varying aspects of the industry today. Appendixes provide extension service contacts and sheep equipment catalog sources.
- Colored Sheep and Wool : Exploring Their Beauty and Function : The Proceedings of the World Congress on Coloured Sheep, U.S.A. - by World Congress on Coloured Sheep - Publication Date: June 1989 - List: $24.95

- Controlled Reproduction in Sheep and Goats (Controlled Reproduction in Farm Animals, 2) - by Ian R. Gordon - Publication Date: February 1997 - List: $115.00
- Design of Shearing Sheds and Sheep Yards - by A.A. Barber, R.B. Freeman Publication Date: December 1987 - List: $64.95
- Early American Weaving and Dyeing : The Domestic Manufacturer's Assistant and Family Directory in the Arts of Weaving and Dyeing - by J. Bronson - Publication Date: December 1977 - List: $7.95 + $1.35 special surcharge
- Handspinning, Dyeing and Working With Merino and Superfine Wools - by Margaret Stove - Publication Date: November 1991 - List: $21.95
- In Sheep's Clothing : A Handspinner's Guide to Wool - by Nola Fournier, Jane Fournier - Publication Date: February 1996 - List: $24.95
- Manual of Sheep Production in the Humid Tropics of Africa - by Alan Leeson - Publication Date: September 1992 - List: $35.00
- Nutrient Requirements of Sheep (Nutrient Requirements of Domestic Animals) - Publication Date: November 1985 - List: $19.95
- Planned Sheep Production - by David Croston, Geoff Pollott - Publication Date: March 1996 - List: $41.75

Periodicals:

- None identified.

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Growing Kentucky Bluegrass

Frequently Asked Questions Other Information Sources Return to Forage Crops

Frequently Asked Questions:

Other Information Sources:

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Kentucky bluegrass (Poa pratensis L.) is a short- to medium height, cool-season, long-lived, highly palatable, perennial grass that has smooth, soft, green to dark green leaves with boat-shaped tips. It grows best during cool, moist weather on well-drained, fertile soils with a pH between 6 and 7 and spreads via rhizomes to form a dense sod. Although Kentucky bluegrass is found throughout the United States it is most important agriculturally in the north central and northeastern regions. It is best adapted to areas where the average daily temperature during July does not exceed 75 F. Warm summer temperatures are the most limiting environmental factor to Kentucky bluegrass production.

Kentucky bluegrass is found in most pastures in the northeast U.S. because it tolerates close and frequent grazing better than other cool-season forage grasses. This ability makes Kentucky bluegrass and ideal species in permanent pastures that are continuously grazed. In addition, the dense sod formed by Kentucky bluegrass rhizomes make it ideal for erosion control, particularly in grass waterways.

Adapted Kentucky Bluegrass Varieties

Most varieties of Kentucky bluegrass have been developed for use in lawns, consequently, it is widely considered the most important lawn grass in the U.S. Only three forage-type Kentucky bluegrass varieties, 'Park', 'Troy', and 'Ginger', have been released in the past 45 years. Unfortunately, turf-type varieties compared with forage-type varieties of Kentucky bluegrass, in general, require higher nitrogen fertilization, greater irrigation, and dethatching to remain productive.

Kentucky Bluegrass Establishment

Very few fields in the Northeast are sown with Kentucky bluegrass seed. However, Kentucky bluegrass generally appears in these fields, coming from seed or rhizomes in the soil, particularly if the field was previously a pasture. If Kentucky bluegrass is to be planted, it should be done at 10 to 14 pounds per acre in late summer or early fall when temperatures begin to moderate and rains are more frequent. Higher seeding rates ensure quicker ground cover. Kentucky bluegrass is slightly slower to establish than many other cool-season grasses. This is primarily a result of slow (approximately 14 days) germination. However, once established it spreads quickly via its extensive rhizome production. Kentucky bluegrass's nitrogen requirements and low summer production make it ideal for seeding with a legume such as white clover at 4 pounds per acre, red clover at 6 pounds per acre, or birdsfoot trefoil at 8 pounds per acre. Legumes in mixture with Kentucky bluegrass also improves the nutritional value of the pasture compared with pure grass pastures. Tall-growing grasses such as orchardgrass, timothy, smooth bromegrass, or tall fescue may also be included in a pasture seeding mixture with Kentucky bluegrass where hay or silage harvests will be made each year before grazing begins. The tall-growing grasses typically thin over time and require reseeding while the Kentucky bluegrass will persist indefinitely.

Kentucky bluegrass can be "frost seeded" (in early spring when the soil is still honeycombed with frost) into existing pastures to thicken the stand. Successful seeding requires good seed-to-soil contact. This can be accomplished with frost seeding by seeding into a field with a thin stand of existing plants or where the pasture was grazed "into the ground" the previous fall. Greatest success is generally achieved when frost seeding is completed while the soil contains frost. Delaying seeding until mid-morning when the soil has become slippery on the surface will result in poorer stand establishment.

Seeding Kentucky bluegrass alone or in a mixtures into a conventionally prepared seedbed or no-till seeding can also be an excellent method of establishment. Do not plant deeper than 1/4 inch when seeding. Press wheels or cultipacking used in conjunction with or after band seeding will improve the seed-soil contact and the chances of obtaining a good stand. To obtain a proper seeding depth, the seedbed should be firm. This can be accomplished by cultipacking before seeding.

Kentucky Bluegrass Grazing or Harvest Management

Under normal environmental conditions in Pennsylvania, Kentucky bluegrass produces nearly 70% of its annual forage production by early June. Consequently, proper management during the early growing

season is essential to maximize Kentucky bluegrass's production potential. Since Kentucky bluegrass is a short growing plant, compared to many other cool-season forage grasses, it is ideally suited for grazing.

Kentucky bluegrass pastures are often under grazed in the spring, which results in an accumulation of mature, low-quality forage. Use high stocking densities early in the growing season when Kentucky bluegrass is most productive or harvest excess growth as hay or silage. Reduce the stocking density later in the grazing season as grass growth slows. In hilly areas, grazing of Kentucky bluegrass should begin on south-facing slopes which warm first and begin growth early in the spring. Maintaining a stubble height of 2 to 4 inches in spring promotes tiller (new shoot) formation, which helps keep a dense sod. Excessive defoliation often results in shallow rooting, an open sod, and weed invasion. These effects are particularly damaging to Kentucky bluegrass in a dry summer when it is less able to recover. Kentucky bluegrass productivity is increased substantially with proper pasture rotation and rest.

Kentucky bluegrass has a large proportion of its leaves close to the soil surface and below the grazing height in managed pastures. This characteristic makes it more tolerant of over grazing than most other cool-season grasses. Consequently, tall-growing grasses will thin under abusive management while Kentucky bluegrass volunteers and thickens providing high-quality forage and protection from soil erosion. However, heavy stocking densities and continuos over grazing as is frequently the case in sheep and horse pastures, especially in midsummer when grass growth has slowed, will weaken Kentucky bluegrass and increase weed invasion.

As growth of Kentucky bluegrass declines in mid summer, livestock production on these pastures is also reduced, particularly during a dry growing season. In addition, grazing days per year and animal gains per acre are generally less on Kentucky bluegrass than other cool-season, tall-growing grasses. Exceptions to this trend occur at higher elevations and latitudes where temperatures and rainfall are not limiting.

The botanical composition of Kentucky bluegrass pastures changes over and within growing seasons depending on environmental conditions and grazing management. Under conditions of high temperatures, limited rain fall, or low soil fertility the amount of Kentucky bluegrass in a pasture will decline which allows the invasion of undesirable weed species. The ratio of Kentucky bluegrass and white clover in a pasture is strongly influenced by grazing management. As the amount of clover in the pasture declines, the pasture can be grazed more closely so that the grass competes less with the clover. If the

amount of white clover in the pasture is too great, then allowing the pasture to reach a height of 8 to 12 inches will encourage the Kentucky bluegrass to compete better with the white clover. In addition, nitrogen fertilizer favors the Kentucky bluegrass component of the pasture and may be used to manipulate the clover to grass ratio.

Kentucky Bluegrass Fertility

Lime and fertilizer needs of Kentucky bluegrass should be determined by soil testing. For best results the soil pH should be between 6 and 7. If the soil test calls for large amounts of nutrients, they should be applied prior to seeding and incorporated into the seedbed. If the Kentucky bluegrass is already established then surface application of recommended nutrients is equally beneficial.

Nitrogen application to Kentucky bluegrass is not recommended if greater than 30% of the pasture is a legume. Application of nitrogen fertilizer (approximately 25 lb per acre) to Kentucky bluegrass in early spring before green-up will stimulate growth and generally allow grazing to begin earlier. Additional nitrogen applications to pure Kentucky bluegrass stands should be made in late spring and early fall when the grass is growing rapidly. Remember that nitrogen application will increase the grass's competitiveness at the expense of clover and weeds in the stand. Kentucky bluegrass-white clover pastures can be maintained indefinitely and their forage quality improved by applying lime and fertilizers according to soil test recommendations. In a recent study, when soil pH was adjusted to 6.5, 60 pounds per acre of P2O5, and 30 pounds per acre of K2O were applied to a Kentucky bluegrass pasture, yield of total digestible nutrients, carrying capacity, and beef production increased 50% over unfertilized pastures. Additional application of 120 pounds of nitrogen per acre increase beef production by an additional 39%.

Kentucky Bluegrass Disease and Insect Pests

Kentucky bluegrass is susceptible to many of the same diseases as other cool-season forage grasses. However, these diseases rarely affect plant persistence but may reduce yield and quality.

Grubs cause the most serious damage Kentucky bluegrass pastures. Adult Japanese beetle, May beetle, green June beetle, northern masked chafer, and European chafer lay eggs in thin overgrazed bluegrass pastures, and the larvae feed on bluegrass roots and rhizomes. Damage is most severe and recovery slowest during dry years. Controlling insects in Kentucky bluegrass pastures is most easily done through good grazing and fertility practices which maintain a healthy and vigorous grass

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- None identified.

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Electronic mailing lists:

- None identified.

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- Alternative Agriculture: Committee of the Role of Alternative Farming Methods in Modern Production Agriculture - by National Research Council - List: $30.25 - Publication Date: September 1989
  Book News, Inc., 01/01/90:
  Eleven case studies explore how alternative farming systems have been adopted--and with what economic results--on farms of various sizes producing different crops across the country. Annotation copyright Book News, Inc. Portland, Or.

- Making Hay - by Verlyn Klinkenborg - Publication Date: October 1997 - List: $14.95
  The New York Times Book Review, Christopher Lehmann-Haupt :
  Mr. Klinkenborg has achieved a terse idiom that amounts almost to Middle Western rural poetry.... what is most admirable about Making Hay is that it memorializes a way of life we take for granted. Its language celebrates both the changes and permanence of modern farming, its earthiness and ethereality.

- Biodiversity and Wheat Improvement - by A.B. Damania (Editor) - Publication Date: March 1994 - List: $165.00
  The publisher, John Wiley & Sons :

A multidisciplinary group of leading scientists present articles regarding research in areas crucial to the conservation, evaluation and utilization of biodiversity in wild relatives and old forms of wheat. The recommendations and conclusions will prove useful to further research on a topic which is rapidly gaining importance in the efforts to meet the growing demands for increased food production.

- Crop Production : Evolution, History, and Technology - by C. Wayne Smith - Publication Date: November 1995 - List: $71.50
  The publisher, John Wiley & Sons :
  One of the nation's leading agronomists presents an outstanding resource that deals with the agronomy of the eight major grain, fiber and oilseed row crops produced in the U.S. Each crop listed includes a structured discussion of the types of cultivars: its history, uses and processing, how to plant and grow the crop, pests and other problems and the harvesting, grading and marketing processes.

- Acid Soil and Acid Rain (Research Studies in Botany and Related Applied Fields, No. 10) - by Ivan R. Kennedy - Publication Date: May 1992 - List: $165.00
  The publisher, John Wiley & Sons :
  Examines the basic chemical processes involved in acidification in order to better assess their long-term effects on the status of soils, the health of plants and other living species that depend on them. Discusses acidity, pH and protons--their significance in bioenergetics and the consequent role of autotrophic organisms in acidifying ecosystems. The Second Edition incorporates and integrates recent findings that render more explanations of the causes of the environmental impacts of acidity, especially in forests and lakes. Also explores current research into acid rain and soil in order to devise appropriate measures for their amelioration. Features numerous case studies and a bibliography that has doubled in size.

- Australian Sodic Soils; Distribution, Properties and Management - by R. Naidu - Publication Date: 1995 - List: $120.00
  Card catalog description
  Sodic soils cover almost a third of the total land in Australia and are represented to some extent on all continents except Antarctica. They can occur naturally, as in Australia, or may develop as a result of the removal of salts from saline soils. Sodicity impacts adversely on many soil properties and interferes with the proper functioning of the soil and of the plants grown in it. Problems arise as a result of the deterioration in soil

structure, decreased retention and availability of water, decreased nutrient availability and impaired biological activity. Sodic soils are easily eroded and this causes severe land degradation and pollution of water resources. The management of sodic soils is often difficult and challenging. Because they are so widespread in Australia, their impact on productivity is immense. Australian Sodic Soils: Distribution, Properties and Management brings together for the first time the results of scientific studies carried out in Australia and presented at the first national conference on Australian sodic soils.

- Fundamentals of Soil Science - by Henry D. Foth - Publication Date: January 1991 - List: $87.95
- Reducing Soil Water Evaporation With Tillage and Straw Mulching - by S. K. Jalota, S. S. Prihar - Publication Date: October 1997 - List: $64.95
- Slash/Mulch Systems : Sustainable Methods for Tropical Agriculture - by H. David Thurston - Publication Date: January 1997 - List: $59.00
- Sustainable Dryland Farming : Combining Farmer Innovation and Medic Pasture in a Mediterranean Climate - by Lynne Chatterton, Brian Chatterton - Publication Date: March 1996 - List: $90.00
- Corn : It's Origin, Evolution and Improvement - by Paul C. Mangelsdorf - Publication Date: June 1974 - List: $33.00
- Grass Varieties in the United States - by James Alderson, W. Curtis Sharp - Publication Date: June 1995 - List: $45.00
  Booknews, Inc. , 08/01/96:
  Previously published as Agriculture Handbook, no. 170 (revised 1994), Soil Conservation Service, US Department of Agriculture. This handbook is a working guide to the status of named and experimental grasses available for use in the US. No attempt has been made to appraise the relative merits of included varieties, nor to verify the adaptation information provided by the preparer. Descriptions, with some exceptions are those reported by developers. They include brief descriptive text and information on source, method of breeding, intended use, and sources of seed and stock and further information. Annotation c. by Book News, Inc., Portland, Or.

- Grazing Management : Science into Practice (Longman Handbooks in Agriculture) - by John G. Hodgson - Publication Date: November 1990 - List: $59.95
  The publisher, John Wiley & Sons :
  This text considers grazing management from the viewpoint of the ecology of grazing systems and focuses on the interrelationships between plant and animal populations which affect the stability of such systems, and the output of animal products from them. Relates the steps in the production process to the grassy surface characteristics that influence plant and animal behavior and uses these relationships to create a practical framework for management decisions.

- Legumes of Africa - by J.M. Lock - Publication Date: December 1989 - List: $45.00

Periodicals:

- None identified.

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Growing Orchardgrass

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Characteristics of Orchardgrass

Orchardgrass (Dactylis glomerata L.) is a perennial, cool-season, tall-growing, bunch-type grass with an open sod. It starts growth early in spring, develops rapidly and flowers during May under Pennsylvania conditions. Orchardgrass is more tolerant of shade, drought, and heat than timothy, perennial ryegrass or Kentucky bluegrass but also grows well in full sunlight. Orchardgrass is adapted to the better well- drained soils and is especially well adapted for mixtures with legumes such as alfalfa or red clover. It will generally persist longer than the other cool-season grasses in frequently cut, properly managed alfalfa mixtures.

Orchardgrass is a versatile grass and can be used for pasture, hay, green chop, or silage. A high-quality grass, it will provide excellent feed for most classes of livestock.

Adapted Orchardgrass Varieties

Several varieties of orchardgrass have been tested and were high-yielding in Pennsylvania variety trials. Potomac is an early-maturing (early May) variety, Dawn and Rancho are medium-maturing (mid-to late-May) varieties, and Pennlate is a late-maturing (late May to early June) variety. When seeding an orchardgrass- legume mixture, the two should mature at about the same time. This will enable harvesting of both species at proper developmental stages and improve the potential of harvesting top quality forage.

Orchardgrass Establishment

Orchardgrass is usually easy to establish in either early spring or late summer. Late summer seedings, however, have been most successful in

Pennsylvania. There is increased risk of winter injury with summer seedings made after mid- August.

Seed at the rate of 8-12 lbs. per acre. When seeding in combination with legumes, orchardgrass seeding rate should be reduced. Orchardgrass should not be seeded with other grasses because of differences in maturity and palatability.

Seed 1/4-1/2 inch deep into a well- prepared seedbed that has been limed and fertilized according to a soil test. Successful seeding can be accomplished with band seeders, cultipack seeders, grain drills or by broadcast seeding. Cultipack after seeding with grain drills not equiped with press wheels or broadcast seeding to insure good seed-soil contact and hasten germination and emergence.

If orchardgrass or orchardgrass-legume mixtures are seeded with a small grain companion crop, remove the small grain at the boot stage to minimize competition with the forage seedlings. This will increase the chances of obtaining a good orchardgrass stand.

Orchardgrass Harvest Management

For highest quality and high yielding hay, orchardgrass should be harvested in spring during boot stage. Beyond this stage, there is little increase in yield and the digestibility decreases at the rate of about 1/2% per day. Aftermath growth can be harvested at 4-6 week intervals. Production and cutting frequency are greatly affected by soil moisture, temperature, fertility and disease.

Since orchardgrass is a high-quality grass, it can be grazed by most classes of livestock. Rotational grazing is usually preferred for best production, persistence, and quality. Fields should be grazed heavily and frequently (every 10 -12 days) during the flush growth of spring, but overgrazing should be avoided. Leave a 3-4 inch stubble so the grass can recover quickly. Heavy grazing during October can lead to depleted root reserves and increased winter injury.

In a 3-year study at Purdue University, animal performance was compared when grazing orchardgrass and tall fescue. Both cows and calves gained approximately 1/2 pound more per day on orchardgrass than on tall fescue. Conception rate of the cows was 18 percentage points higher on the orchardgrass pastures. Although some tests have shown orchardgrass and tall fescue to give similar animal performance, it is generally agreed that orchardgrass is of higher quality than fescue during spring and summer. This is probably associated with the endophyte problem in older varieties of tall fescue. However, fescue is of higher quality in fall, especially after frost.

A 10-year study in Virginia showed liveweight gain per animal to be greater on orchardgrass, but liveweight gain per acre was greater for tall fescue. Palatability, as measured by grazing preference, was higher for orchardgrass than either tall fescue, bromegrass, or bluegrass.

Orchardgrass Fertility

Maintain soil pH between 6.0 and 7.0 for best results. In the absence of a soil test, assuming a medium-fertility soil and orchardgrass seeded alone, incorporate 0-45-135 lb. per acre prior to seeding and apply 20-20-20 lb. per acre (banded if possible) at seeding. Top dressings with lime, phosphorus (P), and potassium (K) based on soil- test results will be necessary for top production and long stand life.

If soil fertility is low, a large proportion of the total production of orchardgrass occurs in spring, whereas with proper fertility and split applications of nitrogen, aftermath production may contribute from 35 to 65% of total production. As a comparison, aftermath of timothy with similar management and fertility contributes only about 20% of the total production.

Orchardgrass is responsive to fertilizer, especially nitrogen (N), and becomes very competitive when adequate nutrients are available. Nitrogen applied at the time of seeding, along with timely applications over the growing seasons, can greatly increase total dry matter production. Annual nitrogen applications of 150 pounds per acre are economical. The nitrogen should be applied in split applications of 50 pounds per acre in early spring when the orchardgrass begins to green up and 50 pounds per acre after each cutting.

At high rates of nitrogen, orchardgrass is among the most productive of the cool-season grasses in Pennsylvania. Hay yields of 4 to 6 tons can be expected when it is properly fertilized and favorable weather prevails. Yields are reduced during periods of drought.

Orchardgrass Summary

Orchardgrass is a bunch type grass with neither rhizomes or stolons, which establishes rapidly and is suitable for pasture, hay, or silage. However, because it becomes coarse and less palatable as it matures it is best suited for pastures. The rapid decline in palatability and quality as orchardgrass matures is the major deterrent to its use. Orchardgrass requires careful management to ensure that it is harvested promptly. Orchardgrass responds well to N fertilization and is very compatible with legumes in a mixture. It is not as winter hardy or drought tolerant as smooth bromegrass but can survive and be highly productive

throughout all of Pennsylvania.

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Commercial suppliers:

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Electronic mailing lists:

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Suggested references:

If you are interested in any of the titles below, click on the title and it will take you to Amazon.com for ordering. Click on the icon at the left for more information.

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Characteristics of Prairie Grass

Prairie grass (Bromus Wildenowii Kunth.) is a tall growing perennial grass that is suited to well drained soils with medium to high fertility levels and a pH of 6.0 or greater. It is a type of bromegrass, but is different from smooth bromegrass in that it does not have rhizomes and it produces seed heads in each growth period, especially during the summer. Herbage and immature seedheads of prairie grass are highly palatable.

Prairie grass is more drought resistant and continues to grow later in the fall than most cool-season forage grasses. Fall harvesting improves the winter persistence of prairie grass. It will persist for 4 to 6 years in Pennsylvania if properly managed. It matures about the same time or a little later in the spring than orchardgrass. Forage quality of prairie grass compares well with other cool-season grasses but is more palatable. It is an excellent grass for providing forage during droughts and for extending the grazing season well into the fall in Pennsylvania.

Prairie grass is occasionally refered to as rescue grass (Bromus catharticus Vahl). While these grasses are related, they are not the same and rescue grass is less persistent than prairie grass in Pennsylvania's climate.

Adapted Prairie Grass Varieties

'Matua' is the only cultivar of prairie grass that is currently sold in the U.S.. This variety was developed in New Zealand under grazing conditions and has been very productive in Pennsylvania. Other prairie grass varieties are being evaluated by the USDA-Pasture Laboratory and Penn State University for persistence and productivity; however, none of these varieties are commercially marketed in Pennsylvania at

this time.

Prairie Grass Establishment

Prairie grass is slower to emerge after seeding than either tall fescue or smooth bromegrass. However, prairie grass growth and development after emergence is greater than either of those grasses. A moist, firm seedbed is required for prairie grass or prairie grass-legume mixtures. Spring or summer seeding of prairie grass are recommended in Pennsylvania. However summer seedings should be completed by early August in the northern half of the state and by mid August in the lower half of the state. Later seedings are generally inadequately established to survive Pennsylvania winters.

Seed may be either drilled or broadcast. Drilling is preferred because it provides a more uniform depth of planting. Plant prairie grass seeds 1/4 inch deep. Although prairie grass seed sold in the United States has generally had the awn removed, the long fluffy seeds often bridge in conventional seed drills and make planting difficult. Using one of the alternate seeding methods listed will help reduce this problem: 1) mix prairie grass seed with a small amount of triple superphosphate and sow through the fertilizer attachment of the grain drill, or 2) mix prairie grass seed with a small amount of oats and sow through the small grain attachment of your grain drill (only for spring seeding).

Most hopper-type fertilizer spreaders can be calibrated to broadcast prairie grass seed. If seed is broadcast, however, be sure to lightly cover the seed with soil. This can be done by light disking or by following with a drag or harrow. Unlike many other cool-season grasses, prairie grass should not be cultipacked after seeding because it increases the difficulty of seedling emergence and the risk of stand failure.

Prairie grass seeding rate varies with seedbed condition, method of seeding, and quality of seed. Generally, when seeding prairie grass alone, rates of 30 to 35 lb per acre are sufficient. When seeding in mixtures with a legume, seeding rates of 20 to 30 lb per acre of prairie grass are recommended. Germination of stored seed can decline rapidly, therefore seed should be used promptly and not stored from year to year.

Weed control at the time of seeding and during prairie grass establishment is extremely important because of prairie grass's slow emergence and upright growth. The upright growth allows emerging weeds below the prairie grass to receive sufficient sunlight to continue growing. If weeds are anticipated (previous weed problem) in a field to be seeded to prairie grass, use of a preplant or preemergence herbicide is recommended. Refer to the most recent edition of the Penn State

Agronomy Guide for efficacy and use restrictions of herbicides labeled for use during and after forage grass establishment.

Prairie Grass Harvest Management

After spring seeding, prairie grass can be grazed after 50 to 70 days or harvested for hay after 80 to 110 days, depending on climatic conditions. Grazing the initial harvest after spring seeding will stimulate the formation and development of new shoots. Even though prairie grass roots develop faster than smooth bromegrass or tall fescue roots, make sure the grazing animals do not pull the young plants out of the ground.

If the seedling growth of prairie grass is harvested for silage or hay, fewer new shoots will develop and the stand will have reduced ground cover and a bunch type appearance. Prairie grass yield from the first harvest after seeding will be similar to that from smooth bromegrass but less than that from tall fescue. Grazing in the fall after a summer seeding is not recommended.

In established prairie grass stands, delaying the first spring harvest will reduce recovery rate and lower the yield potential of the next cutting. Under normal weather conditions, about 25 to 30 days of regrowth is sufficient between harvests. This period is a good balance between yield and quality of prairie grass. Generally, by this time new shoots have developed at the base of the plant and harvesting or grazing will allow more light to reach the shoots and stimulate their growth. A growth period of approximately 50 days in mid-summer will allow the prairie grass seed heads to mature and drop seed during August. This will thicken up the stand the following year.

Prairie grass's ability to grow at cool temperatures makes it ideal for late fall or early spring grazing. Fall yields of nearly 3.5 tons per acre are possible. It persists best when managed so that monthly harvests are made during the fall. In addition, spring yield and shoot density increase when multiple harvests are made in the fall. Harvesting only once in the fall (November) caused 98 percent of the of the basal shoots (source for growth the following spring) to winter kill. However, when prairie grass was harvested or grazed 3 times during the fall only 35 percent of the basal shoots winter killed. Compromise is needed with regard to fall harvesting because late fall grazing will slightly reduce prairie grass vigor the following spring and restrict its use as an early spring grazing source.

Prairie grass should not be cut or grazed below a 3 inch stubble height because regrowth energy reserves and buds for plant regrowth are contained in this region. Cutting or grazing below this height will

weaken the plant and delay regrowth. Yields of nearly 7 tons per acre have been achieved when harvesting prairie grass for silage.

Prairie grass is an ideal grass for grazing systems because of its potential for early spring and fall growth. Its spring growth offers the opportunity for earlier spring grazing and its fall growth can effectively extend the grazing season by as much as two months over traditional cool- season grass species. In addition, since seed heads are palatable, it is not necessary to mow off the seed heads that remain after grazing.

Prairie grass persists better under rotational grazing than continuous grazing management. It will not withstand overgrazing, especially when it is under stress of excessively wet or dry conditions.

The quality of prairie grass is not as strongly affected by time of harvest as other cool-season grasses. Digestible dry matter intake (DDMI) is greater for Matua prairie grass than orchardgrass. When harvested on May 21, Matua had 25 percent greater DDMI than orchardgrass. This difference increased to 35 percent when harvesting one week later. Prairie grass may contain lower levels of trace elements than other grasses. Inclusion of a legume in the mixture with prairie grass, or providing trace elements to animals consuming primarily prairie grass will eliminate potential problems.

Prairie Grass Fertility

Fertility needs at seeding should be determined by soil test. Soil pH between 6.0 and 7.0 is best for prairie grass, however it is adapted to slightly alkaline or acid soils. In the absence of a soil test, assuming a medium-fertility soil, plow down 0- 45-135 lb. per acre and apply 20-20-20 lb. per acre at seeding (banded if possible). If prairie grass is seeded with a legume, reduce or eliminate nitrogen application at seeding.

Prairie grass requires a high level of fertility for maximum production. It is also very responsive to N fertilization. If prairie grass is planted with alfalfa or another legume, restrict annual N applications to 40 or 50 lb. per acre to limit the effect N has on reducing nitrogen fixation of the legume. If prairie grass is grown without a legume, apply 100 to 200 lbs N per acre in split applications of 50 lbs per acre in early spring when the grass becomes green and 50 lbs per acre after each harvest and in early fall. Adequate nitrogen fertilization is essential for maximizing prairie grass growth in the fall.

Prairie Grass Summary

Prairie grass is a deep-rooted grass which grows best on fertile,

well-drained soils. It will provide early spring growth and excellent fall growth to extend the grazing season. Matua, the only variety of prairie grass currently sold in Pennsylvania, is a good cool-season grass for Pennsylvania conditions. However, proper management is essential to obtain adequate yield and persistence.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

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Suggested references:

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Frequently Asked Questions:

Other Information Sources:

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Characteristics of Prairie Grass

Prairie grass (Bromus Wildenowii Kunth.) is a tall growing perennial grass that is suited to well drained soils with medium to high fertility levels and a pH of 6.0 or greater. It is a type of bromegrass, but is different from smooth bromegrass in that it does not have rhizomes and it produces seed heads in each growth period, especially during the summer. Herbage and immature seedheads of prairie grass are highly palatable.

Prairie grass is more drought resistant and continues to grow later in the fall than most cool-season forage grasses. Fall harvesting improves the winter persistence of prairie grass. It will persist for 4 to 6 years in Pennsylvania if properly managed. It matures about the same time or a little later in the spring than orchardgrass. Forage quality of prairie grass compares well with other cool-season grasses but is more palatable. It is an excellent grass for providing forage during droughts and for extending the grazing season well into the fall in Pennsylvania.

Prairie grass is occasionally refered to as rescue grass (Bromus catharticus Vahl). While these grasses are related, they are not the same and rescue grass is less persistent than prairie grass in Pennsylvania's climate.

Adapted Prairie Grass Varieties

'Matua' is the only cultivar of prairie grass that is currently sold in the U.S.. This variety was developed in New Zealand under grazing conditions and has been very productive in Pennsylvania. Other prairie grass varieties are being evaluated by the USDA-Pasture Laboratory and Penn State University for persistence and productivity; however, none of these varieties are commercially marketed in Pennsylvania at this time.

Prairie Grass Establishment

Prairie grass is slower to emerge after seeding than either tall fescue or smooth bromegrass. However, prairie grass growth and development after emergence is greater than either of those grasses. A moist, firm seedbed is required for prairie grass or prairie grass-legume mixtures. Spring or summer seeding of prairie grass are recommended in Pennsylvania. However summer seedings should be completed by early August in the northern half of the state and by mid August in the lower half of the state. Later seedings are generally inadequately established to survive Pennsylvania winters.

Seed may be either drilled or broadcast. Drilling is preferred because it provides a more uniform

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Prairie grass seeding rate varies with seedbed condition, method of seeding, and quality of seed. Generally, when seeding prairie grass alone, rates of 30 to 35 lb per acre are sufficient. When seeding in mixtures with a legume, seeding rates of 20 to 30 lb per acre of prairie grass are recommended. Germination of stored seed can decline rapidly, therefore seed should be used promptly and not stored from year to year.

Weed control at the time of seeding and during prairie grass establishment is extremely important because of prairie grass's slow emergence and upright growth. The upright growth allows emerging weeds below the prairie grass to receive sufficient sunlight to continue growing. If weeds are anticipated (previous weed problem) in a field to be seeded to prairie grass, use of a preplant or preemergence herbicide is recommended. Refer to the most recent edition of the Penn State Agronomy Guide for efficacy and use restrictions of herbicides labeled for use during and after forage grass establishment.

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After spring seeding, prairie grass can be grazed after 50 to 70 days or harvested for hay after 80 to 110 days, depending on climatic conditions. Grazing the initial harvest after spring seeding will stimulate the formation and development of new shoots. Even though prairie grass roots develop faster than smooth bromegrass or tall fescue roots, make sure the grazing animals do not pull the young plants out of the ground.

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Growing Red Clover

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Characteristics of Red Clover

Red clover (Trifolium pratense L.) is grown throughout the northeastern U.S. for forage production and use in rotations for soil improvement. It is adapted to areas where summer temperatures are moderate and adequate moisture is available throughout the growing season. Unlike alfalfa, red clover will grow moderately well on slightly acid soils. However, maximum yields are obtained when the pH is 6.0 or higher.

Red clover is a short-lived perennial, which usually produces two or three hay crops per year. It is characterized by rapid spring growth and low winterhardiness which contributes to its short-lived nature.

The growth habit of red clover varies from erect to prostrate. Numerous stems with large trifoliate leaves arise from the crown region each year. Red clover has a thick tap root which grows to a length of 24-36 inches. Lateral roots which arise from the tap root are mainly concentrated in the upper 5 inches of the soil. Small ovoid, pinkish, nitrogen fixing nodules can be found on the lateral roots if it is actively incorporating atmospheric nitrogen into protein nitrogen.

Adapted Varieties

Look for good disease resistance and persistence in a red clover variety. Varieties which are resistant to both Northern and Southern Anthracnose and Powdery Mildew are recommended for use throughout the states. There are several red clover varieties marketed in Pennsylvania that have been bred for better persistence. With proper management, you can expect these varieties to persist for two to three years after the establishment year. Refer to the current Penn State Forage Trial Report for red clover variety performance and resistance information.

Red Clover Establishment

Red clover can be established as a pure stand, with or without a companion crop, seeded with forage grass, or sod-seeded into a grass sod to improve the existing stand. Each situation has special requirements that should be considered.

Seeding red clover in the spring (April to early May) alone or with a spring oat companion crop in a conventionally prepared seed bed is common. Best clover stands result from seeding the oats at about 1.5 to 2 bushels per acre. Harvesting the oats early for silage is recommended because will greatly reduce the competition with the red clover. If the oats are harvested for grain, remove the straw so that it will not shade or suppress the red clover.

Red clover direct seeded in the spring without a companion crop, will yield less total forage than when seeded with a companion crop to be harvested as a forage. However, a larger portion of the forage will be red clover when seeded without the companion crop. Use of herbicides may be necessary when direct seeded red clover without a companion crop. Direct seedings of red clover can be made either by broadcast, band seeding or fluid seeding. The success of red clover establishment by the fluid seeding technique (planting in a carrier of water or fertilizer solution) is dependent on the preparation of firm and fine seed bed prior to seeding and cultipacking after seeding. Fluid seeding requires special equipment, therefore a custom applicator is recommended.

Red clover can be no-till seeded and is the easiest legume to establish using this method. Early spring seeding in winter grains or grass pastures when the soils are honeycombed from frost has also been successful.

Red clover should be seeded at a rate of 10 to 12 lb. per acre in pure stand and 6 to 8 lb. per acre when seeded with a forage grass. Best establishment occurs when red clover is not seeded deeper than 1/4 in.

To insure adequate nodulation, red clover seed should be inoculated just before seeding with Rhizobium trifolii bacteria and a sticking agent. Pre- inoculated seed should be kept in a cool, dark place to optimize survival of the nitrogen fixing bacteria.

Red Clover Harvest Management

Red clover quality is comparable to that of alfalfa under similar harvest schedules. However, intake by the consuming animal is generally greater for alfalfa than red clover. Red clover quality does not decline

as rapidly with maturity as does alfalfa quality. This provides a longer time period over which high quality forage can be harvested.

Spring-seeded red clover can be harvested three times during the seeding year if growing conditions are favorable. This more aggressive harvest management in the seeding year than has traditionally been implemented provides greater forage and nutrient yields and has not negatively effected yield in the year after establishment. In addition, the third harvest during early September will help maintain better stands the following harvest season. Initial harvest 60-70 days after seeding and subsequent harvest on a 30-35 day interval will generally allow for three harvests during the seeding year.

Established red clover stands should be harvested at prebloom or early bloom. This harvest timing is a compromise between red clover yield and quality. Traditionally, 3 annual harvest are made in most of Pennsylvania. However, newer red clover varieties may tolerate 3 harvests during the summer and an additional fall harvest. The fall harvest should be made only if adequate herbage is present to offset the cost of harvesting. This harvest schedule will not allow red clover to reseed itself but will minimize the occurance of black patch disease and optimize yield and quality.

Red clover silage, if properly harvested and stored, provides a high quality forage. However, red clover is more difficult to cure for hay than other legumes. Establishing with a forage grass will decrease the curing time of red clover. The use of chemical drying agents and hay preservatives may make it possible to successfully make red clover hay under Pennsylvania's rainy conditions.

Red Clover Fertility

Soil tests are required for proper determination of soil nutrient availability. In soils with a pH below 6.0, addition of lime is essential to make the soil less acidic and improve the nitrogen fixing activity of red clover. Nutrients should be added to the soil on the basis of a soil test. Starter fertilizer applications up to 20-60-20 lb. per acre may benefit red clover seedings. Soil test recommendations which exceed this amount should be incorporated into the seedbed prior to planting.

Nitrogen (N) is essential for amino acid and protein production. Atmospheric N is captured (fixed) and converted into plant N by well nodulated plants. On acid soils with pH less than 5.5, nodulation and N fixation are suppressed and fertilizer N should be suppled for vigorous growth. However, excess N fertilizer also reduces nodulation and substitutes for atmospheric N which would have been fixed by the nodule.

Red clover should be top dressed annually with fertilizer (using soil testing as a guide for determining fertilizer requirements) as long as the plant numbers are sufficient for economic production. When the red clover makes up less than 30 percent of the clover-grass mix, apply 30 or 50 pounds of N per acre on sandy or clay soils, respectively.

Red Clover Summary

Red clover is a short-lived perennial which is adapted to wetter and lower pH soils than alfalfa. It is a vigorous establisher and good yielder in the establishment year. It is very well suited for use as the forage legume in short rotations with corn. However, difficulties drying the herbage enough under Pennsylvania weather to safely bale has been a deterrent to its wide spread use. Red clover use for silage production will circumvent that problem.

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Characteristics of Red Clover

Red clover (Trifolium pratense L.) is grown throughout the northeastern U.S. for forage production and use in rotations for soil improvement. It is adapted to areas where summer temperatures are moderate and adequate moisture is available throughout the growing season. Unlike alfalfa, red clover will grow moderately well on slightly acid soils. However, maximum yields are obtained when the pH is 6.0 or higher.

Red clover is a short-lived perennial, which usually produces two or three hay crops per year. It is characterized by rapid spring growth and low winterhardiness which contributes to its short-lived nature.

The growth habit of red clover varies from erect to prostrate. Numerous stems with large trifoliate leaves arise from the crown region each year. Red clover has a thick tap root which grows to a length of 24-36 inches. Lateral roots which arise from the tap root are mainly concentrated in the upper 5 inches of the soil. Small ovoid, pinkish, nitrogen fixing nodules can be found on the lateral roots if it is actively incorporating atmospheric nitrogen into protein nitrogen.

Adapted Varieties

Look for good disease resistance and persistence in a red clover variety. Varieties which are resistant to both Northern and Southern Anthracnose and Powdery Mildew are recommended for use throughout the states. There are several red clover varieties marketed in Pennsylvania that have been bred for better persistence. With proper management, you can expect these varieties to persist for two to three years after the establishment year. Refer to the current Penn State Forage Trial Report for red clover variety performance and resistance information.

Red Clover Establishment

Red clover can be established as a pure stand, with or without a companion crop, seeded with forage grass, or sod-seeded into a grass sod to improve the existing stand. Each situation has special requirements that should be considered.

Seeding red clover in the spring (April to early May) alone or with a spring oat companion crop in a conventionally prepared seed bed is common. Best clover stands result from seeding the oats at about 1.5 to 2 bushels per acre. Harvesting the oats early for silage is recommended because will greatly reduce the competition with the red clover. If the oats are harvested for grain, remove the straw so that it will not shade or suppress the red clover.

Red clover direct seeded in the spring without a companion crop, will yield less total forage than when seeded with a companion crop to be harvested as a forage. However, a larger portion of the forage will be red clover when seeded without the companion crop. Use of herbicides may be necessary when direct seeded red clover without a companion crop. Direct seedings of red clover can be made either by broadcast, band seeding or fluid seeding. The success of red clover establishment by the fluid seeding technique (planting in a carrier of water or fertilizer solution) is dependent on the preparation of firm and fine seed bed prior to seeding and cultipacking after seeding. Fluid seeding requires special equipment, therefore a custom applicator is recommended.

Red clover can be no-till seeded and is the easiest legume to establish using this method. Early spring seeding in winter grains or grass pastures when the soils are honeycombed from frost has also been successful.

Red clover should be seeded at a rate of 10 to 12 lb. per acre in pure stand and 6 to 8 lb. per acre when seeded with a forage grass. Best establishment occurs when red clover is not seeded deeper than 1/4 in.

To insure adequate nodulation, red clover seed should be inoculated just before seeding with Rhizobium trifolii bacteria and a sticking agent. Pre- inoculated seed should be kept in a cool, dark place to optimize survival of the nitrogen fixing bacteria.

Red Clover Harvest Management

Red clover quality is comparable to that of alfalfa under similar harvest schedules. However, intake by the consuming animal is generally greater for alfalfa than red clover. Red clover quality does not decline as rapidly with maturity as does alfalfa quality. This provides a longer time period over which high quality forage can be harvested.

Spring-seeded red clover can be harvested three times during the seeding year if growing conditions are favorable. This more aggressive harvest management in the seeding year than has traditionally been implemented provides greater forage and nutrient yields and has not negatively effected yield in the year after establishment. In addition, the third harvest during early September will help maintain better stands the following harvest season. Initial harvest 60-70 days after seeding and subsequent harvest on a 30-35 day interval will generally allow for three harvests during the seeding year.

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Growing Reed Canarygrass

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Characteristics of Reed Canarygrass

Reed canarygrass (Phalaris arundinacea L.) is a tall, leafy, high-yielding perennial. It is a cool- season grass which is greater in winterhardiness and more resistant to foliar diseases than other cool-season grasses grown in Pennsylvania. The plants spread and thicken from short rhizomes, creating a dense sod. If not grazed or clipped, plants will reach heights exceeding 6 feet under high fertility conditions.

Reed canarygrass does well on most Pennsylvania soils except droughty sands. It is a "natural" for poorly drained soils because of its tolerance to flooding and standing water. In addition to its adaptation to wet sites, reed canarygrass is one of the most drought-tolerant of the cool season grasses. Thus, under proper management this species does well on upland sites.

Adapted Reed Canarygrass Varieties

Older varieties (Common, Rise, Vantage) contain high levels of alkaloids which make these reed canarygrasses less palatable than other grasses. Newer varieties (developed since 1976) contain lower levels of alkaloids and are more palatable. Low-alkaloid varieties that have performed well in Pennsylvania are Palaton and Venture. Both varieties are high yielding, have good winter hardiness and can be used for pasture or in mixture with a legume for hay and silage.

Reed Canarygrass Establishment

Spring seedings are most common. However, late-summer seedings are often more successful because weeds are less of a problem. Reed canarygrass can be slow to establish and may fail when weed competition is severe during establishment. Grass weeds are especially

harmful. Companion crops can be used for spring seedings, but should not be used for late-summer seedings. Oats are the most common companion crop, but early removal for silage or by grazing is necessary to reduce competition for light and moisture.

If a late-summer seeding is planned, prepare the seedbed 2 to 4 weeks ahead of seeding, if possible. This will allow the soil to become firm and provide an opportunity to accumulate moisture in the seedbed . Best seeding time is before Aug. 15 in northern Pennsylvania and Sept. 1 in southern Pennsylvania.

Best stands of reed canarygrass are obtained when sown not deeper than 1/2 inch in a well-prepared, firm seedbed. This is best accomplished with band seeders equipped with press wheels. Other seeding methods can be used, but chances of obtaining thick stands and vigorous growth in the seeding year are reduced. Cultipacker seeders and grain drills work well if the seedbed is firm and the seed is covered to a depth not exceeding 1/2 inch. Roll or cultipack after seeding with grain drills not equipped with press wheels or after broadcast seeding. Caution must be used not to bury the seed after broadcast seeding.

Reed canarygrass should be seeded at 14 lb. per acre when seeded alone. This is a relatively high seeding rate compared to orchardgrass or timothy; however, reed canarygrass seed tends to have a low percentage of germination which necessitates a high seeding rate. Legume mixtures are recommended especially for hay or silage production. When seeding reed canarygrass in a mixture, decrease the seeding rate to 6-8 lb. per acre for reed canarygrass.

Reed Canarygrass Harvest Management

Reed canarygrass can be used for pasture, hay or silage. Recovery following defoliation is excellent in the spring and early summer and is fair to good in late summer and early fall. However, it is frost-sensitive and will turn brown quickly after early fall frosts.

Reed canarygrass is high yielding when cut for hay or silage. Highest yield is obtained when harvested at heading. In contrast, highest quality is obtained before seed heads begin to appear and declines rapidly thereafter. This change in quality is primarily due to increases in portions of the stem relative to the leaf. There is not a close relationship between time of first harvest and stand persistence. Regrowth after harvesting reed canarygrass will be leafy with stem elongation but no seed heads will be produced.

When using reed canarygrass for pasture, excessive forage growth must be avoided to maintain quality and palatability. Animals who have a

choice will often choose grasses other than reed canarygrass. This is accentuated if the reed canarygrass is a high alkaloid variety or is allowed to become mature before grazing. Growth starts early in the spring with grazing generally available by the third or fourth week in April. Approximately 60% of the total yield of reed canarygrass is produced by July. Maintain the grass below 10 to 12 inches tall during the rapid spring growth of May and June.Short duration rotational grazing with a heavy grazing pressure will allow the best utilization and greatest animal gains per acre. In addition, rotational grazing is recommended to allow hay harvesting of the ungrazed paddocks during the spring. Reed canarygrass should not be grazed closer than 3 to 4 inches above the ground. A recovery period following grazing will also improve productivity.

Reed Canarygrass Fertility

Fertilization is important to take advantage of the high yielding characteristics of reed canarygrass. Determine the lime and fertilizer needs by soil testing before seeding. If pH is below 6.0, apply lime. In the absence of a soil test, assuming medium fertility soil, plow down 0-45-135 lb per acre and apply 20-20-20 lb per acre at seeding. When seeding with a legume, apply none or less than 20 lb per acre of nitrogen at seeding. Nitrogen application in excess of 20 lb per acre will stimulate reed canarygrass development and inhibit legume establishment.

A soil test is the best guide for proper fertilization of established reed canarygrass. In pure reed canarygrass stands, apply nitrogen annually. Reed canarygrass responds more to nitrogen fertilization than the other cool-season grasses. Annual rates of N application may range from 80 to 240 lb per acre depending on soil condition and type and consequently yield potential. Generally, about 40 lbs of nitrogen is required per ton of forage produced. Nitrogen rates in excess of 120 lb per acre should be applied in split applications. Fertilization systems which apply at least 1/2 of the annual N in August can be utilized to take advantage of the high-yielding characteristics of reed canarygrass in the fall.

A productive stand of reed canarygrass will require about 30 lb of phosphorus per acre annual for stand maintenance. Potassium fertilization of reed canarygrass for maintenance is more variable than phosphorus. Depending on the soil type and cropping history, rates may range from none to 160 lb potassium per acre per year. On higher organic matter soils, higher rates would be necessary.

Reed Canarygrass Summary

Reed canarygrass is a tall-growing, perennial grass which is widely adapted to Pennsylvania conditions. It is particularly well adapted to wet soils and soils with a pH below 6.0. Reed canarygrass has unjustly gained a reputation as a low quality, undesirable forage. This misconception is in part due to the high alkaloid content of native varieties and the practice of delaying harvest until reed canarygrass is mature. However, newer varieties of reed canarygrass are equal in quality to other cool-season grasses when harvested at similar stages on maturity. Yield of reed canarygrass is closely related to the rate on N fertilization.

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Characteristics of Reed Canarygrass

Reed canarygrass (Phalaris arundinacea L.) is a tall, leafy, high-yielding perennial. It is a cool-season grass which is greater in winterhardiness and more resistant to foliar diseases than other cool-season grasses grown in Pennsylvania. The plants spread and thicken from short rhizomes, creating a dense sod. If not grazed or clipped, plants will reach heights exceeding 6 feet under high fertility conditions.

Reed canarygrass does well on most Pennsylvania soils except droughty sands. It is a "natural" for poorly drained soils because of its tolerance to flooding and standing water. In addition to its adaptation to wet sites, reed canarygrass is one of the most drought-tolerant of the cool season grasses. Thus, under proper management this species does well on upland sites.

Adapted Reed Canarygrass Varieties

Older varieties (Common, Rise, Vantage) contain high levels of alkaloids which make these reed canarygrasses less palatable than other grasses. Newer varieties (developed since 1976) contain lower levels of alkaloids and are more palatable. Low-alkaloid varieties that have performed well in Pennsylvania are Palaton and Venture. Both varieties are high yielding, have good winter hardiness and can be used for pasture or in mixture with a legume for hay and silage.

Reed Canarygrass Establishment

Spring seedings are most common. However, late-summer seedings are often more successful because weeds are less of a problem. Reed canarygrass can be slow to establish and may fail when weed competition is severe during establishment. Grass weeds are especially harmful. Companion crops can be used for spring seedings, but should not be used for late-summer seedings. Oats are the most common companion crop, but early removal for silage or by grazing is necessary to reduce competition for light and moisture.

If a late-summer seeding is planned, prepare the seedbed 2 to 4 weeks ahead of seeding, if possible. This will allow the soil to become firm and provide an opportunity to accumulate moisture in the seedbed . Best seeding time is before Aug. 15 in northern Pennsylvania and Sept. 1 in southern Pennsylvania.

Best stands of reed canarygrass are obtained when sown not deeper than 1/2 inch in a well-prepared, firm seedbed. This is best accomplished with band seeders equipped with press wheels. Other seeding methods can be used, but chances of obtaining thick stands and vigorous

growth in the seeding year are reduced. Cultipacker seeders and grain drills work well if the seedbed is firm and the seed is covered to a depth not exceeding 1/2 inch. Roll or cultipack after seeding with grain drills not equipped with press wheels or after broadcast seeding. Caution must be used not to bury the seed after broadcast seeding.

Reed canarygrass should be seeded at 14 lb. per acre when seeded alone. This is a relatively high seeding rate compared to orchardgrass or timothy; however, reed canarygrass seed tends to have a low percentage of germination which necessitates a high seeding rate. Legume mixtures are recommended especially for hay or silage production. When seeding reed canarygrass in a mixture, decrease the seeding rate to 6-8 lb. per acre for reed canarygrass.

Reed Canarygrass Harvest Management

Reed canarygrass can be used for pasture, hay or silage. Recovery following defoliation is excellent in the spring and early summer and is fair to good in late summer and early fall. However, it is frost-sensitive and will turn brown quickly after early fall frosts.

Reed canarygrass is high yielding when cut for hay or silage. Highest yield is obtained when harvested at heading. In contrast, highest quality is obtained before seed heads begin to appear and declines rapidly thereafter. This change in quality is primarily due to increases in portions of the stem relative to the leaf. There is not a close relationship between time of first harvest and stand persistence. Regrowth after harvesting reed canarygrass will be leafy with stem elongation but no seed heads will be produced.

When using reed canarygrass for pasture, excessive forage growth must be avoided to maintain quality and palatability. Animals who have a choice will often choose grasses other than reed canarygrass. This is accentuated if the reed canarygrass is a high alkaloid variety or is allowed to become mature before grazing. Growth starts early in the spring with grazing generally available by the third or fourth week in April. Approximately 60% of the total yield of reed canarygrass is produced by July. Maintain the grass below 10 to 12 inches tall during the rapid spring growth of May and June.Short duration rotational grazing with a heavy grazing pressure will allow the best utilization and greatest animal gains per acre. In addition, rotational grazing is recommended to allow hay harvesting of the ungrazed paddocks during the spring. Reed canarygrass should not be grazed closer than 3 to 4 inches above the ground. A recovery period following grazing will also improve productivity.

Reed Canarygrass Fertility

Fertilization is important to take advantage of the high yielding characteristics of reed canarygrass. Determine the lime and fertilizer needs by soil testing before seeding. If pH is below 6.0, apply lime. In the absence of a soil test, assuming medium fertility soil, plow down 0-45-135 lb per acre and apply 20-20-20 lb per acre at seeding. When seeding with a legume, apply none or less than 20 lb per acre of nitrogen at seeding. Nitrogen application in excess of 20 lb per acre will stimulate reed canarygrass development and inhibit legume establishment.

A soil test is the best guide for proper fertilization of established reed canarygrass. In pure reed canarygrass stands, apply nitrogen annually. Reed canarygrass responds more to nitrogen fertilization than the other cool-season grasses. Annual rates of N application may range from 80 to 240 lb per acre depending on soil condition and type and consequently yield potential. Generally, about 40 lbs of nitrogen is required per ton of forage produced. Nitrogen rates in excess of 120 lb per acre should be applied in split applications. Fertilization systems which apply at least 1/2 of the annual N in August can be utilized to take advantage of the high-yielding characteristics of reed canarygrass in the fall.

A productive stand of reed canarygrass will require about 30 lb of phosphorus per acre annual for stand maintenance. Potassium fertilization of reed canarygrass for maintenance is more variable than phosphorus. Depending on the soil type and cropping history, rates may range from none to 160 lb potassium per acre per year. On higher organic matter soils, higher rates would be necessary.

Reed Canarygrass Summary

Reed canarygrass is a tall-growing, perennial grass which is widely adapted to Pennsylvania conditions. It is particularly well adapted to wet soils and soils with a pH below 6.0. Reed canarygrass has unjustly gained a reputation as a low quality, undesirable forage. This misconception is in part due to the high alkaloid content of native varieties and the practice of delaying harvest until reed canarygrass is mature. However, newer varieties of reed canarygrass are equal in quality to other cool-season grasses when harvested at similar stages on maturity. Yield of reed canarygrass is closely related to the rate on N fertilization.

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Growing Ryegrass

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Characteristics of Ryegrass

Ryegrasses are the most widely grown cool- season grasses in the world. They have numerous desirable agronomic qualities. They establish rapidly, have a long growing season, are high yielding under favorable environments when supplied with adequate nutrients, posses high nutrient contents, and can be used for grazing, hay, or silage. Ryegrasses grows best on fertile, well- drained soils but can be grown on soils where it is too wet at certain times of the year for satisfactory growth of other grasses. Ryegrasses are heavy users of water and will perform less than optimum during a drought or periods of extended low or high temperatures. They are indigenous to Europe, Asia, and North Africa, but are grown world wide. The ryegrasses are considered to be high quality forage and their high digestibility makes them suitable for all types of ruminants.

Types of Ryegrass and Adapted Varieties

The two most important ryegrass species are Italian ryegrass (Lolium multiflorum Lam.) and perennial ryegrass (Lolium perenne L.). Traditionally, Italian ryegrass would not survive for more than a single growing season in northern climates. However, new experimental varieties from Switzerland have shown no stand loss after three production years in Pennsylvania. Italian ryegrass has a bunch-type growth (lacks rhizomes) and flowers in day lengths greater than 11 hours. There is no winter or cold weather requirement for Italian ryegrass to flower and therefore will flower throughout the summer. Italian ryegrass is not widely recommended as a forage crop in Pennsylvania because available varieties will not survive Pennsylvania winters.

Perennial ryegrass is also a bunch-type grass but generally will survive

for several growing seasons in Pennsylvania. Unlike Italian ryegrass, perennial ryegrass requires a dormancy period of cool temperatures before the photoperiod can induce flowering and therefore will normally produce seedheads only once per year during the late spring. However, researchers at Penn State have observed seedhead production by perennial ryegrass during mid-summer regrowths. Perennial ryegrass can withstand considerable grazing mismanagement and remain productive. Unfortunately, perennial ryegrass has proven to be slightly less persistent in Pennsylvaina's climate than other cool-season grasses such as orchardgrass, tall fescue, and timothy.

Within the Italian and perennial ryegrass species there are two basic groups, the diploids and tetraploids. The distinction between the two groups is based on the number of chromosomes within each plant cell. In the diploid ryegrass cells, each chromosome is present twice; however, in the tetraploid ryegrasses cells each chromosome is doubled and is present four times. Tetraploid perennial ryegrasses have larger leaves, fewer but larger tillers, produce a more open (less ground cover) growth, and are more suited for production ina legume mixture than the diploid perennial ryegrasses. Tetraploids have a higher percentage of sugars in the forage than diploids, which explains their higher digestibility and grazing preference over diploids. Both the seed and seedlings of tetraploid varieties are larger, but the growth following emergence and persistence is often greater for diploid varieties.

Numerous tetraploid perennial ryegrasses have been tested in Pennsylvania variety trials, including Grimalda, Bastion, Reveille, Citadel, Nestor, and Taptoe. Grimalda matures 10 to 14 days earlier than Bastion, Reveille or Nestor. Citadel and Taptoe mature later than these varieties.

Grimalda was one of the first ryegrass varieties marketed in Pennsylvania. Unfortunately, it matured earlier than most alfalfa varieties with which it was seeded and reduced the forage quality when the mixture was harvested based on alfalfa maturity. The experience with this early maturing variety resulted in producers concluding that all ryegrasses were not adapted to their system, a conclusion from which perennial ryegrass is now starting to recover.

Natural hybridization between the Italian and perennial species has occurred frequently. Persistence of hybridized ryegrasses is intermediate between the parents. Therefore they are frequently referred to as "short rotation ryegrasses" in recognition of their lack of persistence compared to perennial ryegrass. In addition, flowering in the hybridized ryegrasses is similar to that of the Italian species in that there is no dormancy requirement for flowering and tillers will continue to flower sporadically throughout the growing season. Bison, a

hybridized ryegrass, has been tested in Pennsylvania and matures in the spring about 10 days later than Grimalda.

Ryegrass Establishment

Normal winter temperatures in Pennsylvania are mild enough to allow ryegrass seeding in either the spring (April or May) or late summer (before August 15 and 25 in northern and southern Pennsylvania, respectively). Ryegrass may be seeded alone; however, to improve hay yields when growing ryegrass a mixture with a legume is recommended. Legumes, such as alfalfa or white clover in the mixture will also provide some nitrogen to the ryegrass and can also improve the quality of forage produced. Ryegrass seedings have been successful in both a clean, tilled seedbed and in existing grass sod. However, when no-till seeding, the existing grass sod should be mowed or grazed very short or desiccated with a chemical prior to seeding to reduce competition. Ryegrass should be band seeded 0.25 to 0.5 inch deep. If the seedbed is dry and press wheels are not used, cultipack before and after seeding for additional stand insurance.

Ryegrass seeding rates depend on its intended use and the condition of seedbed. When seeding into a well-prepared seedbed, 15-20 lb per acre is recommended. When seeded with a compatible or adapted legume (alfalfa, birdsfoot trefoil, and white or red clover) 4-8 lbs per acre is recommended. In a USDA-ARS Pasture Research Laboratory study, alfalfa yield was not effected by ryegrass seeding rate (6 to 18 lbs per acre) in late summer seedings of alfalfa-ryegrass mixtures. In the same study, alfalfa became the dominant species within one year regardless of seeding mixtures, even when seeding rates heavily favored ryegrass establishment.

Ryegrass Harvest Management

Seeding year harvest management of perennial ryegrass is dependent on time and method of seeding, fertility, growing conditions, and other factors which effect rate of establishment. However, with favorable establishment and growing conditions one or more harvests are possible in the seeding year. First time harvest or grazing on newly established ryegrass should be delayed until it is 10 to 12 inches tall.

As a hay crop, ryegrass yields may be relatively low unless considerable time is allowed for forage accumulation for fall harvest. Ryegrass plants contain less dry matter and therefore require longer curing time before baling relative to other cool season grasses. In addition, they are more difficult to mow with a sickle bar mower than other grasses.

Established ryegrass pastures can be initially grazed when spring growth reaches 2 to 3 inches in height and the pasture does not risk excessive damage due to wet soil conditions. It may be continually grazed but yield and plant persistence are compromised if it is continuously grazed below 1.5 inches in height. Greater yields are possible when ryegrass is rotationally grazed. A grazing system which allows 7 to 10 inches of regrowth between grazings will benefit grass yield as well as persistence. Animals should be removed from rotationally grazed pastures when the ryegrass stubble is from 1.5 to 2 inches in height. Under grazing, perennial ryegrass-alfalfa mixtures are superior to orchardgrass-alfalfa mixtures in production of crude protein, digestible dry matter, and alfalfa persistence.

Ryegrass Fertility

Soil pH for optimum ryegrass production is between 6.0 and 7.0; however, ryegrass has been grown at pH of 5.0. Determine fertility and lime needs by soil testing, but in the absence of a soil test on soil with a medium-fertility level, plow down 0-45- 135 lb per acre and apply 20-20-20 lb per acre at seeding (banded if possible) when seeding without a legume. When seeding ryegrass with a legume, apply none or less than 20 lb per acre of nitrogen at seeding. Nitrogen application in excess of 20 lb per acre will stimulate ryegrass development and inhibit legume establishment. On well adapted soils, ryegrass is very competitive with other grasses, legumes, or weeds.

A soil test is the best guide for proper fertilization of established ryegrass. Do not apply fertilizers in excess of soil test recommendations because nutrient imbalances may occur in animals consuming the ryegrass. Ryegrass responds very well to nitrogen fertilization which is very important for economical production. Profitable economic returns over investment can usually be obtained with applications of 150 lbs of N per acre per year. It should be applied in split applications of 50 to 60 lbs per acre in the spring with the remaining amount being evenly divided and applied after each grazing or cutting. Seeding mixtures of ryegrass and a legume reduces the need for nitrogen fertilization. Applying high rates of nitrogen (in the form of manure) to alfalfa-ryegrass mixtures, caused ryegrass to dominated; however, ryegrass was less suppressive than orchardgrass in alfalfa mixtures when manure was added.

Ryegrass Summary

Ryegrasses have numerous desirable agronomic characteristics. They establish rapidly, have long growing seasons, are relatively high yielding in suitable environments, have high nutritive value, and can be used for grazing, hay, or silage. However, the lower persistence of

perennial ryegrass relative to other cool-season grasses and the increased drying time of ryegrasses should be considered prior to their use. The use of ryegrass as a part of a forage production system should be carefully evaluated. Ryegrass does not fit into every farming operation but should be considered as a viable options on many Pennsylvania farms, especially those which include grazing as a harvesting method.

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The two most important ryegrass species are Italian ryegrass (Lolium multiflorum Lam.) and perennial ryegrass (Lolium perenne L.). Traditionally, Italian ryegrass would not survive for more than a single growing season in northern climates. However, new experimental varieties from Switzerland have shown no stand loss after three production years in Pennsylvania. Italian ryegrass has a bunch-type growth (lacks rhizomes) and flowers in day lengths greater than 11 hours. There is no winter or cold weather requirement for Italian ryegrass to flower and therefore will flower throughout the summer. Italian ryegrass is not widely recommended as a forage crop in Pennsylvania because available varieties will not survive Pennsylvania winters.

Perennial ryegrass is also a bunch-type grass but generally will survive for several growing seasons in Pennsylvania. Unlike Italian ryegrass, perennial ryegrass requires a dormancy period of cool temperatures before the photoperiod can induce flowering and therefore will normally produce seedheads only once per year during the late spring. However, researchers at Penn State have observed seedhead production by perennial ryegrass during mid-summer regrowths. Perennial ryegrass can withstand considerable grazing mismanagement and remain productive. Unfortunately, perennial ryegrass has proven to be slightly less persistent in Pennsylvaina's climate than other cool-season grasses such as orchardgrass, tall fescue, and timothy.

Within the Italian and perennial ryegrass species there are two basic groups, the diploids and tetraploids. The distinction between the two groups is based on the number of chromosomes within each plant cell. In the diploid ryegrass cells, each chromosome is present twice; however, in the tetraploid ryegrasses cells each chromosome is doubled and is present four times. Tetraploid perennial ryegrasses have larger leaves, fewer but larger tillers, produce a more open (less ground

cover) growth, and are more suited for production ina legume mixture than the diploid perennial ryegrasses. Tetraploids have a higher percentage of sugars in the forage than diploids, which explains their higher digestibility and grazing preference over diploids. Both the seed and seedlings of tetraploid varieties are larger, but the growth following emergence and persistence is often greater for diploid varieties.

Numerous tetraploid perennial ryegrasses have been tested in Pennsylvania variety trials, including Grimalda, Bastion, Reveille, Citadel, Nestor, and Taptoe. Grimalda matures 10 to 14 days earlier than Bastion, Reveille or Nestor. Citadel and Taptoe mature later than these varieties.

Grimalda was one of the first ryegrass varieties marketed in Pennsylvania. Unfortunately, it matured earlier than most alfalfa varieties with which it was seeded and reduced the forage quality when the mixture was harvested based on alfalfa maturity. The experience with this early maturing variety resulted in producers concluding that all ryegrasses were not adapted to their system, a conclusion from which perennial ryegrass is now starting to recover.

Natural hybridization between the Italian and perennial species has occurred frequently. Persistence of hybridized ryegrasses is intermediate between the parents. Therefore they are frequently referred to as "short rotation ryegrasses" in recognition of their lack of persistence compared to perennial ryegrass. In addition, flowering in the hybridized ryegrasses is similar to that of the Italian species in that there is no dormancy requirement for flowering and tillers will continue to flower sporadically throughout the growing season. Bison, a hybridized ryegrass, has been tested in Pennsylvania and matures in the spring about 10 days later than Grimalda.

Ryegrass Establishment

Normal winter temperatures in Pennsylvania are mild enough to allow ryegrass seeding in either the spring (April or May) or late summer (before August 15 and 25 in northern and southern Pennsylvania, respectively). Ryegrass may be seeded alone; however, to improve hay yields when growing ryegrass a mixture with a legume is recommended. Legumes, such as alfalfa or white clover in the mixture will also provide some nitrogen to the ryegrass and can also improve the quality of forage produced. Ryegrass seedings have been successful in both a clean, tilled seedbed and in existing grass sod. However, when no-till seeding, the existing grass sod should be mowed or grazed very short or desiccated with a chemical prior to seeding to reduce competition. Ryegrass should be band seeded 0.25 to 0.5 inch deep. If the seedbed is dry and press wheels are not used, cultipack before and after seeding for additional stand insurance.

Ryegrass seeding rates depend on its intended use and the condition of seedbed. When seeding into a well-prepared seedbed, 15-20 lb per acre is recommended. When seeded with a compatible or adapted legume (alfalfa, birdsfoot trefoil, and white or red clover) 4-8 lbs per acre is recommended. In a USDA-ARS Pasture Research Laboratory study, alfalfa yield was not effected by ryegrass seeding rate (6 to 18 lbs per acre) in late summer seedings of alfalfa-ryegrass mixtures. In the same study, alfalfa became the dominant species within one year regardless of seeding mixtures, even when seeding rates heavily favored ryegrass establishment.

Ryegrass Harvest Management

Seeding year harvest management of perennial ryegrass is dependent on time and method of seeding, fertility, growing conditions, and other factors which effect rate of establishment. However, with favorable establishment and growing conditions one or more harvests are possible in the seeding year. First time harvest or grazing on newly established ryegrass should be delayed until it is 10 to 12 inches tall.

As a hay crop, ryegrass yields may be relatively low unless considerable time is allowed for forage accumulation for fall harvest. Ryegrass plants contain less dry matter and therefore require longer curing time before baling relative to other cool season grasses. In addition, they are more difficult to mow with a sickle bar mower than other grasses.

Established ryegrass pastures can be initially grazed when spring growth reaches 2 to 3 inches in height and the pasture does not risk excessive damage due to wet soil conditions. It may be continually grazed but yield and plant persistence are compromised if it is continuously grazed below 1.5 inches in height. Greater yields are possible when ryegrass is rotationally grazed. A grazing system which allows 7 to 10 inches of regrowth between grazings will benefit grass yield as well as persistence. Animals should be removed from rotationally grazed pastures when the ryegrass stubble is from 1.5 to 2 inches in height. Under grazing, perennial ryegrass-alfalfa mixtures are superior to orchardgrass-alfalfa mixtures in production of crude protein, digestible dry matter, and alfalfa persistence.

Ryegrass Fertility

Soil pH for optimum ryegrass production is between 6.0 and 7.0; however, ryegrass has been grown at pH of 5.0. Determine fertility and lime needs by soil testing, but in the absence of a soil test on soil with a medium-fertility level, plow down 0-45- 135 lb per acre and apply 20-20-20 lb per acre at seeding (banded if possible) when seeding without a legume. When seeding ryegrass with a legume, apply none or less than 20 lb per acre of nitrogen at seeding. Nitrogen application in excess of 20 lb per acre will stimulate ryegrass development and inhibit legume establishment. On well adapted soils, ryegrass is very competitive with other grasses, legumes, or weeds.

A soil test is the best guide for proper fertilization of established ryegrass. Do not apply fertilizers in excess of soil test recommendations because nutrient imbalances may occur in animals consuming the ryegrass. Ryegrass responds very well to nitrogen fertilization which is very important for economical production. Profitable economic returns over investment can usually be obtained with applications of 150 lbs of N per acre per year. It should be applied in split applications of 50 to 60 lbs per acre in the spring with the remaining amount being evenly divided and applied after each grazing or cutting. Seeding mixtures of ryegrass and a legume reduces the need for nitrogen fertilization. Applying high rates of nitrogen (in the form of manure) to alfalfa-ryegrass mixtures, caused ryegrass to dominated; however, ryegrass was less suppressive than orchardgrass in alfalfa mixtures when manure was added.

Ryegrass Summary

Ryegrasses have numerous desirable agronomic characteristics. They establish rapidly, have long growing seasons, are relatively high yielding in suitable environments, have high nutritive value, and can be used for grazing, hay, or silage. However, the lower persistence of perennial ryegrass relative to other cool-season grasses and the increased drying time of ryegrasses should be considered prior to their use. The use of ryegrass as a part of a forage production system should be carefully evaluated. Ryegrass does not fit into every farming operation but should be considered as a viable options on many Pennsylvania farms, especially those which include grazing as a harvesting method.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

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Growing Sorghum & Sudangrass

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Characteristics of Sorghum & Sudangrass

Shortages of forage crops in Pennsylvania most often occur during the summer months when the productivity of pastures, hay crops, or silage corn fields have been reduced by dry conditions. Summer- annual grasses, which maintain relatively high levels of production during hot and dry conditions, can greatly reduce the risk of inadequate forage production during the summer. They can also be used as an emergency forage source when production from corn and hay crops is likely to be less than adequate.

Descriptions of Different Summer-Annual Grass Species

Summer-annual grasses differ in growth and production potential but have several similar characteristics. They grow best at relatively high temperatures (80 degrees F) and can produce under conditions of limited moisture.

Sorghum is an upright growing grass which has been bred for both grain and forage production. The grain sorghum types are relatively short growing (less than 6 feet) and provide moderate yields when harvested as a forage. Forage sorghum, on the other hand, grows tall (6 to 15 feet) and has the potential for high yields. Of the two types, forage sorghum is the preferred type for forage production. Like corn, sorghum hybrids are classified into maturity classes. Late-maturing sorghum types yield more than earlier- maturing types, but may not reach maturity before a killing frost. The forage sorghums are usually harvested only once and used for silage or green-chop production.

Sudangrass usually grows between 3 and 8 feet high and has stems about 1/4 inch in diameter. Solid stands of sudangrass grow shorter than when seeded in rows. Sudangrass develops only fibrous roots and does not have rhizomes. However, many stems may develop from a single seed if space is available. Sudangrass will regrow following each

harvest until cool temperatures or lack of moisture inhibit growth.

Sorghum-Sudan Hybrids or Sudax resemble sudangrass but are taller, have larger stems and leaves, and give higher yields. Hybrids tend to be coarser than sudangrass and vary in seed color and size, yield and growth characteristics depending on their parents. Like sudangrass, sorghum-sudangrass hybrids will regrow after each harvest unless environmental conditions are restrictive.

Millet has smaller stems and is more leafy than the sorghum, sudangrass, or sorghum-sudangrass hybrids. Pearl millet will regrow after harvest but not as rapidly as either the sudangrass or sorghum-sudangrass hybrids. German or Foxtail millet, however, does not regrow after harvest. Millet yields are usually lower than sorghum-sudangrass hybrids.

Sorghum & Sudangrass Establishment

Summer annuals should be planted from two weeks after corn until the end of June. Soil temperatures should be at least 60 degrees F. Seedings may be made as late as July 15 in emergency situations, but yields will be reduced because of limited moisture in the summer and cool temperatures during the fall. When utilizing any of the summer annual crops in a planned rotational grazing situation, two seedings should be made about three weeks apart. This will stagger the maturities and make grazing management easier.

Forage and grain sorghum planted for forage should be planted in rows to facilitate harvest and minimize lodging. Avoid planting the sorghums too deeply as emergence problems may occur when planted deeper than one inch in most Pennsylvania soils. Also, avoid seeding rates above 10-12 pounds per acre since they can increase the risk of lodging, particularly with the tall forage sorghum types. Corn planters work well for planting sorghum provided the appropriate plates or feed cups are used to achieve the desired seeding rates. Sorghum can be planted using any tillage system provided adequate weed control can be achieved.

Fewer herbicides are labeled for grain and forage sorghum than corn so select fields where weeds can be controlled with labelled herbicides. When using Lasso or Dual, be sure to use seed that has been treated with the appropriate safener. When planting after a failed corn crop, be sure that the herbicides used on the corn are labelled for sorghum.

The other summer-annual species can be broadcast seeded and cultipacked or seeded with a grain drill into a well-prepared seed bed. A firm, well- prepared seedbed is best, however, acceptable stands may be established without tillage using no-till drills. Solid seedings result in finer and shorter plants which are desirable for silage and grazing.

Wider row spacings (20 to 36 inches) allow for cultivation and results in better regrowth and more uniform production throughout the season. Narrow rows provide intense competition and herbicides are rarely necessary when seeded in this fashion. Only a few herbicides are labelled for these summer-annual crops so weed control should be considered carefully in selecting a row spacing. Row spacing itself, however, has relatively little effect on total forage production. Seeding rates vary depending on seeding method and anticipated moisture conditions.

Plant sudangrass, sorghum-sudangrass hybrids, and millets 1 inch deep in medium to heavy soils and 1 1/2 inches deep on sandy soils. If the soil is dry and rain is not anticipated before seedling emergence, cultipack the seedbed to maximize seed-to-soil contact and moisture conservation.

Sorghum & Sudangrass Harvest Management

Both the grain and forage sorghums are most frequently used for silage or green chop in a single cut system, although they can be grazed if desired. Silage should be cut when the grain is in the medium to hard dough stage. Generally, whole plant moisture should be near the desired level for ensiling at this time. In some cases, where maturity is delayed, a frost may be necessary to reduce whole plant moistures to an acceptable level. Under most conditions, corn silage will produce higher silage yields and quality. The sorghums will produce similar or higher yields than corn silage on droughty soils or in fields with significant deer damage. Deer will not graze the sorghums to the extent they will corn. Digestibility of silage made from the sorghums will usually be about 90-95% of well preserved corn silage.

The other summer-annual grasses can be used for grazing, green chop, silage or hay. When used for grazing, these grasses must be grazed at the proper stage of growth to reduce herd health problems and optimize production. The best time to graze is when the plants are between 18 and 30 inches tall (6 to 8 weeks after planting). Grazing when the plants are less than 18 inches tall will delay regrowth and increase the chances of prussic acid poisoning in sorghum, sudangrass, and sorghum-sudangrass hybrids.

Sufficient animals should be placed on the pasture area to graze the grass down in less than 10 days. Six or more animals per acre may be necessary to accomplish this rapid grazing. After grazing, clip the residue at about 8 inches high to eliminate old stems and insure high quality for the next grazing period. Do not graze or clip these grasses too close (less than 8 inches) because it will weaken and may kill the plants. It will normally take three to four weeks for sufficient regrowth before grazing again.

Grazing can continue on these grasses until frost, or even after frost if the plants are allowed to to turn brown (one week after a killing frost) before they are grazed. Do not graze frost damaged or stunted sorghum, sudangrass, or sorghum-sudangrass hybrids until they have been killed (turn brown) by the frost. If the plants begin to grow again after being frost damaged, they should not be grazed until the regrowth is 18 inches tall or the entire plant is killed by frost and turns brown.

Summer-annual grasses are ideal for green chop. Use the same harvest precautions when feeding as green chop as used when grazing to avoid prussic acid poisoning. Cut the plants down to about 8 inches. Green-chop harvesting should not begin until the plants are at least 18 inches tall, however, it should begin early enough to complete harvesting before the plants begin to head. Harvesting after the plants have headed will reduce dry matter intake and milk production in cows, and regrowth potential of the plants.

Sudangrass, sorghum-sudangrass hybrids, and millet should be harvested for silage when they are between 36 and 48 inches tall or in the boot to early- head stage, whichever comes first. At this maturity, they contain excessive moisture for proper ensiling and should be wilted (mowed and allowed to partially dry in the field) before ensiling.

Greatest hay yields are obtained if the annual grasses are harvested when the seed is in the soft- dough stage. However, proper drying is difficult at this stage. Therefore, harvest for hay is recommended during the vegetative stage before the heads emerge or the plant reaches a height of 4 feet. A hay conditioner should be used to mow and crush the stems for rapid, uniform drying. It is extremely difficult to field cure these grasses adequately for safe storage as hay.

Sorghum & Sudangrass Fertility

For forage production, fertilize grain and forage sorghums using soil test recommendations. In lieu of a soil test, fertilize similar to corn silage. Starter fertilizers can be used and should be most beneficial on the earliest plantings.

Fertilization of the other summer-annuals grasses, should be similar to other annual grass crops. Apply sufficient nitrogen (40 to 80 lb/acre) at planting to insure establishment and stimulate plant development. Use the low rate of N when manure has been applied and when planting after a failed corn crop which already received N. Another 50 pounds of nitrogen after the first harvest is also recommended for optimum production. Crude protein content of these grasses is directly related to rate of nitrogen fertilization. In a Pennsylvania study, crude protein content of summer- annual grasses was 7.7% when 50 pounds of N was applied and 11.4% when 200 pounds was applied. However, caution

must be exercised to avoid nitrate poisoning when high rates of nitrogen fertilizer or manure are applied especially if dry conditions persist. The amount of phosphorus and potassium will depend on the soil test level and yield goal. At optimum soil test levels and a yield of about 4 tons dry matter per acre, 60 pounds of P_2O_5 and 120 pounds of K_2O would be removed.

Potential Animal Health Hazards Associated with Sorghum & Sudangrass

Prussic Acid Poisoning is a major concern when feeding sorghum, sudangrass, or sorghum- sudangrass hybrids. These species contain varying amounts of cyanogenic glucosides. In the rumen, these compounds are converted into prussic acid which is readily absorbed into the blood stream where it interferes with respiration. If prussic acid is present in the rumen and absorbed rapidly enough, the animal will soon die from respiratory paralysis.

Forage species and varieties may be selected that contain low levels of cyanogenic glucosides. Piper sudangrass has low levels and millet is free of these compounds. The management practices described below can also reduce the risk of prussic acid poisoning from sorghum, sudangrass, and sorghum- sudangrass hybrids:

1. Graze or green chop only when they are greater than 18 inches tall.
2. Don't graze plants during or immediately after a drought when growth has been reduced.
3. Don't graze on nights when a frost is likely. High levels of the toxic compounds are produced within hours after a frost occurs.
4. Don't graze after a killing frost until the plant is dry (the cyanogenic glucosides usually dissipate within several days).
5. Don't graze after a non-killing frost until regrowth is greater than 18 inches.
6. Delay feeding silage for 6 to 8 weeks after ensiling.

Nitrate Poisoning can be a problem under conditions of high nitrogen fertilization, heavy manure applications, drought, or overcast weather, when the plants can accumulate high levels of nitrates. When plants containing high levels of nitrates are eaten, the nitrates are converted into nitrites faster than they can be properly utilized by the animal. These excessive nitrites are absorbed into the bloodstream and alter the blood so that it can not carry oxygen. This causes rapid breathing, fast and weak heartbeat, muscle tremors, staggering and ultimately death if corrective steps are not taken.

The same precautions for prussic acid poisoning will help prevent

nitrate poisoning. Millet can cause nitrate poisoning but not prussic acid poisoning. High nitrate levels will persist in forages cut for hay but will be reduced by one-half or so if the crop is ensiled. If you suspect high nitrates in the forage, have it tested by a forage testing laboratory.

Poisoning of Horses fed sorghum, sudangrass, or sorghum-sudangrass hybrids has also been reported. The exact cause of this poisoning is not known. Affected horses exhibit a staggering gait, urine dribbling, and aborting in pregnant mares. There is currently no treatment for this poisoning and affected horses rarely recover. Don't feed horses any of these summer-annual species.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

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Characteristics of Sorghum & Sudangrass

Shortages of forage crops in Pennsylvania most often occur during the summer months when the productivity of pastures, hay crops, or silage corn fields have been reduced by dry conditions. Summer- annual grasses, which maintain relatively high levels of production during hot and dry conditions, can greatly reduce the risk of inadequate forage production during the summer. They can also be used as an emergency forage source when production from corn and hay crops is likely to be less than adequate.

Descriptions of Different Summer-Annual Grass Species

Summer-annual grasses differ in growth and production potential but have several similar characteristics. They grow best at relatively high temperatures (80 degrees F) and can produce under conditions of limited moisture.

Sorghum is an upright growing grass which has been bred for both grain and forage production. The grain sorghum types are relatively short growing (less than 6 feet) and provide moderate yields when harvested as a forage. Forage sorghum, on the other hand, grows tall (6 to 15 feet) and has the potential for high yields. Of the two types, forage sorghum is the preferred type for forage production. Like corn, sorghum hybrids are classified into maturity classes. Late-maturing sorghum types yield more than earlier- maturing types, but may not reach maturity before a killing frost. The forage sorghums are usually harvested only once and used for silage or green-chop production.

Sudangrass usually grows between 3 and 8 feet high and has stems about 1/4 inch in diameter. Solid stands of sudangrass grow shorter than when seeded in rows. Sudangrass develops only fibrous roots and does not have rhizomes. However, many stems may develop from a single seed if space is available. Sudangrass will regrow following each harvest until cool temperatures or lack of moisture inhibit growth.

Sorghum-Sudan Hybrids or Sudax resemble sudangrass but are taller, have larger stems and leaves, and give higher yields. Hybrids tend to be coarser than sudangrass and vary in seed color and size, yield and growth characteristics depending on their parents. Like sudangrass, sorghum-sudangrass hybrids will regrow after each harvest unless environmental conditions are restrictive.

Millet has smaller stems and is more leafy than the sorghum, sudangrass, or sorghum-sudangrass hybrids. Pearl millet will regrow after harvest but not as rapidly as either the sudangrass or sorghum- sudangrass hybrids. German or Foxtail millet, however, does not regrow after harvest. Millet yields are usually lower than sorghum-sudangrass hybrids.

Sorghum & Sudangrass Establishment

Summer annuals should be planted from two weeks after corn until the end of June. Soil temperatures should be at least 60 degrees F. Seedings may be made as late as July 15 in emergency situations, but yields will be reduced because of limited moisture in the summer and cool temperatures during the fall. When utilizing any of the summer annual crops in a planned rotational grazing situation, two seedings should be made about three weeks apart. This will stagger the maturities and make grazing management easier.

Forage and grain sorghum planted for forage should be planted in rows to facilitate harvest and minimize lodging. Avoid planting the sorghums too deeply as emergence problems may occur when planted deeper than one inch in most Pennsylvania soils. Also, avoid seeding rates above 10-12 pounds per acre since they can increase the risk of lodging, particularly with the tall forage sorghum types. Corn planters work well for planting sorghum provided the appropriate plates or feed cups are used to achieve the desired seeding rates. Sorghum can be planted using any tillage system provided adequate weed control can be achieved.

Fewer herbicides are labeled for grain and forage sorghum than corn so select fields where weeds can be controlled with labelled herbicides. When using Lasso or Dual, be sure to use seed that has been treated with the appropriate safener. When planting after a failed corn crop, be sure that the herbicides used on the corn are labelled for sorghum.

The other summer-annual species can be broadcast seeded and cultipacked or seeded with a grain drill into a well-prepared seed bed. A firm, well- prepared seedbed is best, however, acceptable stands may be established without tillage using no-till drills. Solid seedings result in finer and shorter plants which are desirable for silage and grazing. Wider row spacings (20 to 36 inches) allow for cultivation and results in better regrowth and more uniform production throughout the season. Narrow rows provide intense competition and herbicides are rarely necessary when seeded in this fashion. Only a few herbicides are labelled for these summer-annual crops so weed control should be considered carefully in selecting a row spacing. Row spacing itself, however, has relatively little effect on total forage production. Seeding rates vary depending on seeding method and anticipated moisture conditions.

Plant sudangrass, sorghum-sudangrass hybrids, and millets 1 inch deep in medium to heavy soils and 1 1/2 inches deep on sandy soils. If the soil is dry and rain is not anticipated before seedling emergence, cultipack the seedbed to maximize seed-to-soil contact and moisture conservation.

Sorghum & Sudangrass Harvest Management

Both the grain and forage sorghums are most frequently used for silage or green chop in a single cut system, although they can be grazed if desired. Silage should be cut when the grain is in the medium to hard dough stage. Generally, whole plant moisture should be near the desired level for ensiling at this time. In some cases, where maturity is delayed, a frost may be necessary to reduce whole plant moistures to an acceptable level. Under most conditions, corn silage will produce higher silage yields and quality. The sorghums will produce similar or higher yields than corn silage on droughty soils or in fields with significant deer damage. Deer will not graze the sorghums to the extent they will corn. Digestibility of silage made from the sorghums will usually

be about 90-95% of well preserved corn silage.

The other summer-annual grasses can be used for grazing, green chop, silage or hay. When used for grazing, these grasses must be grazed at the proper stage of growth to reduce herd health problems and optimize production. The best time to graze is when the plants are between 18 and 30 inches tall (6 to 8 weeks after planting). Grazing when the plants are less than 18 inches tall will delay regrowth and increase the chances of prussic acid poisoning in sorghum, sudangrass, and sorghum-sudangrass hybrids.

Sufficient animals should be placed on the pasture area to graze the grass down in less than 10 days. Six or more animals per acre may be necessary to accomplish this rapid grazing. After grazing, clip the residue at about 8 inches high to eliminate old stems and insure high quality for the next grazing period. Do not graze or clip these grasses too close (less than 8 inches) because it will weaken and may kill the plants. It will normally take three to four weeks for sufficient regrowth before grazing again.

Grazing can continue on these grasses until frost, or even after frost if the plants are allowed to to turn brown (one week after a killing frost) before they are grazed. Do not graze frost damaged or stunted sorghum, sudangrass, or sorghum-sudangrass hybrids until they have been killed (turn brown) by the frost. If the plants begin to grow again after being frost damaged, they should not be grazed until the regrowth is 18 inches tall or the entire plant is killed by frost and turns brown.

Summer-annual grasses are ideal for green chop. Use the same harvest precautions when feeding as green chop as used when grazing to avoid prussic acid poisoning. Cut the plants down to about 8 inches. Green-chop harvesting should not begin until the plants are at least 18 inches tall, however, it should begin early enough to complete harvesting before the plants begin to head. Harvesting after the plants have headed will reduce dry matter intake and milk production in cows, and regrowth potential of the plants.

Sudangrass, sorghum-sudangrass hybrids, and millet should be harvested for silage when they are between 36 and 48 inches tall or in the boot to early- head stage, whichever comes first. At this maturity, they contain excessive moisture for proper ensiling and should be wilted (mowed and allowed to partially dry in the field) before ensiling.

Greatest hay yields are obtained if the annual grasses are harvested when the seed is in the soft-dough stage. However, proper drying is difficult at this stage. Therefore, harvest for hay is recommended during the vegetative stage before the heads emerge or the plant reaches a height of 4 feet. A hay conditioner should be used to mow and crush the stems for rapid, uniform drying. It is extremely difficult to field cure these grasses adequately for safe storage as hay.

Sorghum & Sudangrass Fertility

For forage production, fertilize grain and forage sorghums using soil test recommendations. In lieu of a soil test, fertilize similar to corn silage. Starter fertilizers can be used and should be most beneficial on the earliest plantings.

Fertilization of the other summer-annuals grasses, should be similar to other annual grass crops. Apply sufficient nitrogen (40 to 80 lb/acre) at planting to insure establishment and stimulate plant

development. Use the low rate of N when manure has been applied and when planting after a failed corn crop which already received N. Another 50 pounds of nitrogen after the first harvest is also recommended for optimum production. Crude protein content of these grasses is directly related to rate of nitrogen fertilization. In a Pennsylvania study, crude protein content of summer-annual grasses was 7.7% when 50 pounds of N was applied and 11.4% when 200 pounds was applied. However, caution must be exercised to avoid nitrate poisoning when high rates of nitrogen fertilizer or manure are applied especially if dry conditions persist. The amount of phosphorus and potassium will depend on the soil test level and yield goal. At optimum soil test levels and a yield of about 4 tons dry matter per acre, 60 pounds of P_2O_5 and 120 pounds of K_2O would be removed.

Potential Animal Health Hazards Associated with Sorghum & Sudangrass

Prussic Acid Poisoning is a major concern when feeding sorghum, sudangrass, or sorghum-sudangrass hybrids. These species contain varying amounts of cyanogenic glucosides. In the rumen, these compounds are converted into prussic acid which is readily absorbed into the blood stream where it interferes with respiration. If prussic acid is present in the rumen and absorbed rapidly enough, the animal will soon die from respiratory paralysis.

Forage species and varieties may be selected that contain low levels of cyanogenic glucosides. Piper sudangrass has low levels and millet is free of these compounds. The management practices described below can also reduce the risk of prussic acid poisoning from sorghum, sudangrass, and sorghum- sudangrass hybrids:

1. Graze or green chop only when they are greater than 18 inches tall.
2. Don't graze plants during or immediately after a drought when growth has been reduced.
3. Don't graze on nights when a frost is likely. High levels of the toxic compounds are produced within hours after a frost occurs.
4. Don't graze after a killing frost until the plant is dry (the cyanogenic glucosides usually dissipate within several days).
5. Don't graze after a non-killing frost until regrowth is greater than 18 inches.
6. Delay feeding silage for 6 to 8 weeks after ensiling.

Nitrate Poisoning can be a problem under conditions of high nitrogen fertilization, heavy manure applications, drought, or overcast weather, when the plants can accumulate high levels of nitrates. When plants containing high levels of nitrates are eaten, the nitrates are converted into nitrites faster than they can be properly utilized by the animal. These excessive nitrites are absorbed into the bloodstream and alter the blood so that it can not carry oxygen. This causes rapid breathing, fast and weak heartbeat, muscle tremors, staggering and ultimately death if corrective steps are not taken.

The same precautions for prussic acid poisoning will help prevent nitrate poisoning. Millet can cause nitrate poisoning but not prussic acid poisoning. High nitrate levels will persist in forages cut for hay but will be reduced by one-half or so if the crop is ensiled. If you suspect high nitrates in the forage, have it tested by a forage testing laboratory.

Poisoning of Horses fed sorghum, sudangrass, or sorghum-sudangrass hybrids has also been reported. The exact cause of this poisoning is not known. Affected horses exhibit a staggering gait, urine dribbling, and aborting in pregnant mares. There is currently no treatment for this poisoning and affected horses rarely recover. Don't feed horses any of these summer-annual species.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

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- Sustainable Agriculture - by John Mason - Publication Date: August 1998 - List Price: $19.95

Periodicals:

- None identified.

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Growing Smooth Bromegrass

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Characteristics of Smooth Bromegrass

Smooth bromegrass (Bromus inermis L.) is a leafy, sod-forming perennial grass that is best suited for hay or early spring pasture. It is deep- rooted and spreads by underground rhizomes. It matures somewhat later in the spring than orchardgrass and makes less summer growth than orchardgrass. Forage quality of smooth bromegrass compares well with other cool-season grasses, being affected primarily by stage of maturity.

Smooth bromegrass is the most widely used cool-season grass in North America. It is grown extensively in Canada and the north-central United States. Smooth bromegrass survives periods of drought and extremes in temperature. It can be grown on a variety of soil types, but it grows best on well-drained silt-loam or clay- loam soils. It is fairly tolerant of alkalinity and somewhat tolerant of salinity and acidity but will perform best at a soil pH between 6.0 and 7.0.

Adapted Smooth Bromegrass Varieties

Saratoga, a variety recommended for many years in Pennsylvania, is a vigorous, high- yielding and persistent variety which is adapted to well-drained soils. Baylor, like Saratoga, is a high- yielding and persistent variety in Pennsylvania. These varieties start growing earlier in the spring and stay green longer than "common" bromegrass. Common bromegrass is not a variety but a bromegrass of uncertain genetic makeup.

Smooth Bromegrass Establishment

A moist, firm seedbed is required for smooth bromegrass or bromegrass-legume mixtures. Most often planted in spring, smooth

bromegrass may also be planted in late summer, when weather conditions usually are more favorable.

Seed may be either drilled or broadcast. Drilling is preferred because it provides a more uniform depth of planting. Plant seed 1/4 to 1/2 inch deep. Long, narrow bromegrass seeds, however, often bridge in conventional seed drills and make planting difficult. Alternate seeding methods: 1) mixing bromegrass seed with a small amount of super phosphate and sowing through the fertilizer attachment of the grain drill, or 2) mixing bromegrass with a small amount of oats and sowing through the small grain attachment of your grain drill (only for spring seeding), may help avoid this problem.

Most hopper-type fertilizer spreaders can be calibrated to broadcast smooth bromegrass seed. If seed is broadcast, however, be sure to cover the seed. This can be done by light disking or by following with a drag or harrow.

Smooth bromegrass seeding rate varies with seedbed condition, method of seeding, and quality of seed. Generally, when seeding bromegrass alone rates of 12-16 lb. per acre are sufficient. When seeding in mixtures with a legume, seeding rates of 6-8 lb. per acre of bromegrass are recommended.

Smooth Bromegrass Harvest Management

Growth stage is the most important factor in smooth bromegrass harvest management. Bromegrass is somewhat tolerant of light grazing during the tillering stage of growth. During this initial flush of growth, the growing point is below the ground. Later, shoots enter the jointing stage of growth. During this stage, the growing point may be destroyed by mowing or close grazing.

If the growing point is destroyed at early jointing (stem elongation), regrowth will be slow as new growth will have to come from basal buds not yet developed. When seed heads emerge, it is time to clip pastures or to harvest the forage for hay or silage. This will assure quality forage and quick regrowth of the new crop. Timely harvest of the spring crop resulted in a 33% increase in total season yield over harvesting too early. Smooth bromegrass persistence and yield are adversely affected by early harvesting of the spring growth. However, delaying the spring harvest beyond early bloom will result in large reductions in forage digestibility and protein content.

The aftermath crop similarly produces a growing point that is above ground approximately 5 weeks after the first harvest. If it is necessary to harvest the regrowth during the jointing stage of development, adjust

the cutter bar above the growing point (4 inches) to assure a good third harvest. The quality of the aftermath harvests is only slightly affected by time of harvest.

Smooth Bromegrass Fertility

Fertility needs at seeding should be determined by soil test. Soil pH between 6.0-7.0 is best for smooth bromegrass, however it is adapted to slightly alkaline or acid soils. In the absence of a soil test, assuming a medium-fertility soil, plow down 0-45-135 lb. per acre and apply 20-20-20 lb. per acre at seeding (banded if possible). If bromegrass is seeded with a legume, reduce or eliminate nitrogen application at seeding.

Smooth bromegrass is very responsive to N fertilization and requires a high level of fertility for maximum production. If you plant smooth bromegrass with alfalfa or another legume, restrict N applications to 40 or 50 lb. per acre to limit the effect N has on reducing nitrogen fixation of the legume. If smooth bromegrass is grown without a legume, apply 100 to 200 lbs N per acre in split applications of 50 lbs per acre in early spring when the grass becomes green and 50 lbs per acre after each cutting.

Smooth Bromegrass Summary

Smooth bromegrass is a deep-rooted, sod- forming grass which grows best on fertile, well- drained soils with pH above 6.0. It will not tolerate frequent cutting. Spring harvest should be made before jointing or after the early-flower stage of development to ensure maximum smooth bromegrass persistence. This restriction on harvesting makes bromegrass unsuitable in mixture with alfalfa that will be harvested at the bud stage. However, mixtures with legumes that will not be harvested before 1/10 bloom are excellent. Smooth bromegrass is a good cool-season grass for Pennsylvania conditions but proper management is essential to obtain adequate yield and persistence.

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Growth stage is the most important factor in smooth bromegrass harvest management. Bromegrass is somewhat tolerant of light grazing during the tillering stage of growth. During this initial flush of growth, the growing point is below the ground. Later, shoots enter the jointing stage of growth. During this stage, the growing point may be destroyed by mowing or close grazing.

If the growing point is destroyed at early jointing (stem elongation), regrowth will be slow as new growth will have to come from basal buds not yet developed. When seed heads emerge, it is time to clip pastures or to harvest the forage for hay or silage. This will assure quality forage and quick regrowth of the new crop. Timely harvest of the spring crop resulted in a 33% increase in total season yield over harvesting too early. Smooth bromegrass persistence and yield are adversely affected by early harvesting of the spring growth. However, delaying the spring harvest beyond early bloom will result in large reductions in forage digestibility and protein content.

The aftermath crop similarly produces a growing point that is above ground approximately 5 weeks after the first harvest. If it is necessary to harvest the regrowth during the jointing stage of development, adjust the cutter bar above the growing point (4 inches) to assure a good third harvest. The quality of the aftermath harvests is only slightly affected by time of harvest.

Smooth Bromegrass Fertility

Fertility needs at seeding should be determined by soil test. Soil pH between 6.0-7.0 is best for smooth bromegrass, however it is adapted to slightly alkaline or acid soils. In the absence of a soil test, assuming a medium-fertility soil, plow down 0-45-135 lb. per acre and apply 20- 20-20 lb. per acre at seeding (banded if possible). If bromegrass is seeded with a legume, reduce or eliminate nitrogen application at seeding.

Smooth bromegrass is very responsive to N fertilization and requires a high level of fertility for maximum production. If you plant smooth bromegrass with alfalfa or another legume, restrict N applications to 40 or 50 lb. per acre to limit the effect N has on reducing nitrogen fixation of the legume. If smooth bromegrass is grown without a legume, apply 100 to 200 lbs N per acre in split applications of 50 lbs per acre in early spring when the grass becomes green and 50 lbs per acre after each cutting.

Smooth Bromegrass Summary

Smooth bromegrass is a deep-rooted, sod- forming grass which grows best on fertile, well- drained

soils with pH above 6.0. It will not tolerate frequent cutting. Spring harvest should be made before jointing or after the early-flower stage of development to ensure maximum smooth bromegrass persistence. This restriction on harvesting makes bromegrass unsuitable in mixture with alfalfa that will be harvested at the bud stage. However, mixtures with legumes that will not be harvested before 1/10 bloom are excellent. Smooth bromegrass is a good cool-season grass for Pennsylvania conditions but proper management is essential to obtain adequate yield and persistence.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

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Growing Tall Fescue

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Characteristics of Tall Fescue

Tall fescue (Festuca arundinacea Schreb.) is a deep-rooted, long-lived, sod-forming grass that spreads by short underground stems called rhizomes. In Pennsylvania it has primarily been used for conservation purposes but is well suited as hay, silage, or pasture for beef cattle and sheep. It is well adapted to the soil and weather conditions of Pennsylvania. It is especially adapted to acid, wet soils of shale origin and will produce more forage on soils with pH less than 5.5 than other cool-season grasses. Tall fescue is drought resistant and will maintain itself under rather limited fertility conditions. Tall fescue is also ideal for waterways, ditch and pond banks, and farm lots and lanes. It is the best grass in areas of heavy livestock and machinery traffic.

Animals will readily graze tall fescue during April, May and early June and again in the fall, but show reluctance to graze it during the summer months of July and August. Some of this reduced summer palatability and traditionally low-quality forage, which resulted in poor animal performance, is associated with the presence of a fungus in the plant (endophytic). The fungus grows between the plant cells and overwinters in the base of the plant. The fungus produces alkaloids which are toxic to animals. These alkaloids are thought to cause the poor conception rates, low birth weights, and low daily gains of animals grazing fungus infected tall fescue. Low endophyte varieties are now available and are recommended for new seedings.

Tall fescue is the best adapted cool-season grass for stockpiling (accumulating growth) for use in the fall and winter. In addition, tall fescue generally has greater quality in the fall because of greater leaf retention than other cool-season grasses in the fall. Thus it can provide much of the spring, fall and winter feed for a beef cow herd.

Adapted Tall Fescue Varieties

Numerous varieties are adapted for use in Pennsylvania. However, the endophyte free varieties have improved quality compared to those infected with the endophyte fungus. Endophyte infected varieties are well-suited for use on reclaimed strip mines and other conservation uses where the soil conditions are unusually adverse for plant growth.

Because of differences in growth habits, palatability and time of the year when they should be used, other grasses should not be included with tall fescue at seeding time. However, legumes can be used in the seeding mixture with tall fescue, although the stand may eventually be used as a pure tall fescue stand for winter stockpiling. The legumes will persist for several years, improve the forage quality and serve as a source of nitrogen for the tall fescue. Regardless of the seeding mixture, it is recommended that low endophyte seed be used if the tall fescue is to be used for animal feed.

Tall Fescue Establishment

Tall fescue and accompanying legumes can be seeded in the spring or late summer. Spring seedings should be made as early as possible to avoid hot dry weather when the seedlings are small. Late-summer seedings usually have less weed competition and more favorable moisture conditions than spring seedings. Late- summer seedings should be made before August 15 in northern Pennsylvania and September 1 in Southern Pennsylvania.

When seeding alone,12 lb of tall fescue seed per acre is adequate. Tall fescue in legume mixtures should be seeded at 8-10 lb per acre.

For best results, band seed tall fescue 1/4 inch deep. Press wheels used in conjunction with band seeding will add additional stand insurance. If the seedbed is dry and not firm, cultipack before seeding to make a firm seedbed.

Tall Fescue Harvest Management

Tall fescue can be part of a forage program but should not be all of it. Legumes with tall fescue improves animal performance and increases forage production during the summer. Legumes are difficult to maintain in a tall fescue sod, but there are a number of management practices that will help keep legumes in the stand. Two of these practices are maintaining pH above 6.0 and annual applications of potash. Tall fescue grown with either red or white clover should not be allowed to smother the legume in the spring. This can be avoided by grazing early and close to the soil surface. Red clover is a short-lived perennial and must be managed to produce seed if red clover is desired in the stand

after 2-3 years.

Tall fescue will withstand closer grazing and more abuse than most cool-season grasses. But it can be overgrazed to the point that vigor as well as production is reduced. Don't graze closer than 3 or 4 inches, and allow at least 30 days for the tall fescue to recover.

Improved animal performance has been reported for the new endophyte free varieties of tall fescue relaitive to endophyte infected varieties. Increased average daily gains of 0.5 lb per animal per day have been reported for 7-12 month old angus steers when grazing endophyte free compared to endophyte infected tall fescue. Other tests comparing orchardgrass and endophyte free tall fescue have shown similar animal performance. In a two-year study at Penn State University comparing endophyte free tall fescue varieties, animal performance was similar on all varieties. While orchardgrass is generally of higher quality during spring and summer, tall fescue is of higher quality in fall, especially after frost.

If fescue is to be used during the summer, maintain a legume in the stand to improve animal performance. Otherwise, allow the late summer growth to accumulate for use in the fall or winter stockpiling. Tall fescue that is used exclusively for stockpiling is usually maintained in a pure stand.

Tall Fescue Fertility

Prior to seeding, lime and fertilizer needs should be determined by soil test. Although tall fescue can achieve adequate yields on low pH soils, maximum productivity is obtained when the pH is between 6.0 and 7.0. In the absence of a soil test for tall fescue seeded alone, plow down 0-45- 135 lb per acre and apply 20-20-20 lb per acre at planting (banded if possible) when seeding without a legume. While small amounts of nitrogen and potash are beneficial at seeding, too high a concentration of these elements can interfere with germination. Do not apply nitrogen at seeding if tall fescue is seeded with a legume.

Under pasture conditions it is difficult to evaluate the amounts of nutrients removed by the grazing animals. Grazing animals will trample or leave some of the total growth available to them. This is returned directly to the soil. Manure is not deposited evenly across the field, most studies show about 12 to 15 percent of a pasture area is covered with manure by grazing animals each year. If there is an estimated 3 tons of forage produced from a pasture field, then a 0-20-60 fertilizer per acre, applied each year should maintain production.

If pure tall fescue stands are used, high yields can be expected if fertilizer is applied during the winter or very early spring. This is especially true for the nitrogen portion of the fertilizer. Tall fescue to be

used for hay should receive 100 to 150 pounds of N during the winter period. The same fertilization practices apply for early grazing as well a for hay. If much fall pasture is desired, then fertilizer should be reapplied in July.

When legumes make up 30 percent or more of a tall fescue or any grass stand, do not use nitrogen fertilizer. When these stands are topdressed with fertilizer containing nitrogen the growth looks darker and appears more lush, but research shows that production is not increased. In addition, applying nitrogen fertilizer to mixed stands will cause the grass to dominate the mixture.

Tall fescue-legume mixtures should be topdressed annually with phosphorus and potassium. A fescue-legume mixture will remove about 15 pounds of phosphate and 45 pounds of potash from the soil for each ton of hay produced. Phosphorus and potassium can be applied anytime during the year with satisfactory results.

Tall Fescue Summary

Tall fescue is a deep-rooted sod forming grass which is best adapted to cool season production. It is extremely well suited for use as a stockpile forage because it retains its quality and improves in palatability in the fall. It is well adapted to soils of low pH such as strip mine reclamation. It is more tolerant of animal and machinery traffic, and mismanagement than other cool-season grasses. Low endophyte varieties improve animal acceptance of and performance on tall fescue. Tall fescue can be part of a forage program but should not be the only species in the program.

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Growing Timothy

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Characteristics of Timothy

Timothy (Phleum pratense L.) is a perennial, bunch-type, shallow-rooted, cool- season grass which is well adapted to the Northeast and upper Midwest. Its shallow root system, however, make it unadapted to droughty soils. Timothy is popular in the northern half of Pennsylvania and most of New York because of its natural adaptation to moist, cool environments. Timothy is the most popular grass in New York, with the majority of New York's hay crop acerage sown to timothy-legume mixtures. Its sensitivity to high temperatures has limited its productivity in southern Pennsylvania. Timothy stores energy reserves for regrowth and tillering in its haplocorm or corm (enlarged bulbous stem structure) at the stem base. Its energy storage pattern makes it a better hay crop than a pasture species.

Timothy is grown primarily for hay for horses but is frequently included in pasture mixtures. It is less competitive in a legume mixture than most sod-forming grasses and is frequently grown in a legume mixture for hay. However, special attention must be made to match the maturity of the timothy with the maturity of the legume to ensure timothy persistence and quality forage.

Adapted Timothy Varieties

Most of the timothy sold in Pennsylvania and New York is common (not a certified variety). However, seed of several improved varieties is available. Climax is a leafy variety which is rust resistant. Heading occurs during late May or early June which is about a week later than common timothy. Richmond, Toro, and Mariposa are early maturing (about 10 days before Climax) varieties which exhibit relatively rapid regrowth after harvest. Mohawk matures at about the same time as Climax but produces a slightly greater proportion of its seasonal yield in the first harvest than Climax. Champlain is a high yielding variety

which matures about 7 days after Climax but has poor seedling vigor.

Timothy Establishment

The best seeding time is before Aug. 1 in northern New York, Aug. 15 in southern New York and northern Pennsylvania and Sept. 1 in southern Pennsylvania.

Timothy can be successfully established in either spring or late-summer seedings. However, fall seedings are more successful because the cooler weather during the fall is more suitable for timothy growth, and weeds are less of a problem. Timothy can be slow to establish and may fail when weed competition is severe during establishment. Grass weeds are especially harmful. Small grain companion crops can be used in spring seedings, but should not be used for late-summer seedings. Oats are the most common companion crop, but early removal for silage or by grazing is necessary to reduce competition for light and moisture. A small grain and field pea companion crop may provide too much competition when establishing an alfalfa- timothy mixture.

If a late-summer seeding is planned, prepare the seedbed 2 to 4 weeks ahead of seeding, if possible. This will allow the soil to become firm and provide an opportunity to accumulate seedbed moisture.

The best stands of timothy are obtained when sown not deeper than 1/2 inch in a well- prepared, firm seedbed. A firm seedbed is essential to the successful establishment of small- seeded grasses such as timothy. A firm seedbed allows greater regulation in seeding depth, holds moisture better, and increases seed to soil contact. Proper seeding depth can be accomplished with band seeders equipped with press wheels. Other seeding methods can be used, but chances of obtaining thick stands and vigorous growth in the seeding year are reduced. Cultipacker seeders and grain drills work well if the seedbed is firm and the seed is covered to a depth not exceeding 1/2 inch. Roll or cultipack after seeding with grain drills not equipped with press wheels or after broadcast seeding. Caution must be used not to bury the seed after broadcast seeding.

Timothy should be seeded at 8-10 lb. per acre when seeded alone. When seeded in a mixture with a legume reduce the timothy seeding rate.

Mixtures of cool-season grass species are generally not recommended for hay or silage production because of the difficulty of managing grass mixtures (e.g. proper harvest to obtain high quality and persistence when the grass maturities are different). However, timothy is frequently planted in mixture with other grasses for use in pastures, especially pastures for horses. A pasture mixture that has performed well in Pennsylvania is 8 lb. of Kentucky bluegrass plus 4 lb. each of smooth

bromegrass and timothy and 1 lb. of white clover. This mixture can serve as a good pasture for horses throughout much of the summer.

Timothy Harvest Management

The spring growth of timothy passes through the typical stages of grass development, tillering, jointing (stem elongation), heading, flowering and seed formation. Flowering heads are commonly produced in the summer aftermath growth, in contrast to most perennial cool-season grasses which produce seed heads only during the spring growth. Initial flowering in the spring does not usually occur until late May in southern Pennsylvania and June in northern Pennsylvania and New York, depending on the variety and location in the state.

Timothy is a hay-type forage grass, with relatively few basal leaves below the cutting height. It is easily weakened by frequent cutting or grazing. This is due to its limited storage of energy reserves in the corms, its production of few basal leaves to support regrowth after harvest and its upright growth habit which is generally dominated by a single stem.

Timothy is relatively tolerant of pre-joint harvest in early to mid-May but is adversely affected by harvesting during the jointing stage in mid May. In addition, harvesting at early heading reduced timothy yields and persistence, compared to harvesting at either early or late bloom. Harvesting the spring growth of timothy at early heading reduced first harvest yield and there is generally no increase in yield of subsequent harvests to compensate for this loss. In Pennsylvania, timothy makes relatively little yield after the first harvest because of its intolerance to the hot and dry conditions that prevail during summers. More summer yield can be expected in New York, where moisture and temperature are more favorable for summer growth of timothy. Quality of timothy is among the highest of cool- season grasses when vegetative, but decreases very rapidly as reproductive growth is initiated.

Under grazing management, timothy should not be allowed to progress very far into jointing before grazing. Delaying grazing will reduce the stored energy reserves and ultimately reduce timothy persistence. Grazing in the spring can begin when the timothy is 3-4 inches tall. Timothy will tolerate moderate continuous grazing but rotational grazing with a minimum recovery period of 3 weeks will improve timothy production and persistence.

Timothy Fertility

Fertility needs at seeding should be determined by soil test. Soil pH between 6.0-7.0 is best for timothy. In the absence of a soil test, assuming a medium-fertility soil, plow down 0-45- 135 lb. per acre and

apply 20-20-20 lb. per acre at seeding (banded if possible). If timothy is seeded with a legume, eliminate nitrogen application at seeding.

Timothy is responsive to N fertilization whenever the legume content in the stand is less than 30%. Split applications of 100 to 150 lb. nitrogen per acre annually will generally produce yield increases of 1 to 1.5 tons per acre. Nitrogen fertilization results in increased leaf area, leaf size, tillering, and crude protein content. However, high nitrogen applications, greater than 200 lb per acreper year, can reduce storage of energy reserves and reduce persistence. Apply 50 to 60 lb. of N per acre in the spring when the timothy greens up and additional applications of 50 lb. per acre after each cut.

Application of other fertilizers should follow soil test recommendations. Timothy requires a high level of fertility for maximum production. Potassium fertilizer is important to maximize the legume yield in a timothy-legume mixed stand.

Timothy Summary

Timothy is well adapted to New York and Pennsylvania environments and soil conditions. It is winter hardy and offers little competition to a legume in the mixture. However, timothy is intolerant of cutting during jointing or early- heading. This intolerance makes harvest management for high quality in a alfalfa mixture difficult because the alfalfa will generally be ready to harvest before the timothy. Management systems which include harvesting at early-heading in combination with high N fertilization rates, consistently reduce timothy stands. Timothy is the hay of choice for horse owners and can also serve as a horse pasture.

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Growing Warm Season Grasses

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Characteristics & Adaptation of Big Bluestem & Switchgrass

Native, perennial warm-season grasses such as switchgrass (Panicium virgatum L.) and big bluestem (Andropogon gerardi Vitman) grow primarily during the warm part of the summer. They produce well compared to cool-season grasses during the hot and dry weather of July and August, and on soils with low moisture holding capacity, pH, and phosphorus.

Although recognized as a summer component of a pasture system, warm-season grasses can be harvested and stored as hay. Primary growth (65-75%) of the warm-season grasses is in mid-summer and can be used to complement a cool-season grass forage program by providing additional forage during the summer. Their establishment and management requirements are quite different from cool-season grasses and first time users must pay special attention to the details of managing these grasses. When managed properly, warm-season grass hay can provide good quality forage, especially for beef cattle. In digestibility trials conducted at Penn State over a three-year period, warm-season grasses were 65 percent digestibile and orchardgrass was 68 percent digestible. Two warm-season grasses that are adapted to Pennsylvania are switchgrass and big bluestem.

Adapted Big Bluestem & Switchgrass Varieties

Switchgrass is a tall growing, bunch grass which tolerates poorly drained soils, flooding, and perched water tables better than other warm- season grasses. With proper management, stands in Pennsylvania have remained productive for 20 years. Varieties of switchgrass used in Pennsylvania are Blackwell, Cave-In-Rock, and Trailblazer. Blackwell and Cave-In-Rock are highly productive varieties that head in early and mid summer, respectively. Trailblazer is a variety that was selected for increased digestibility and palatability.

Big bluestem is a tall growing, bunch grass that is more drought tolerant than other warm- season grasses and thus is better adapted to excessively drained soils with low water-holding capacity. Niagara is a variety especially adapted to Northeast conditions. Forage quality of Niagara is good and it is tolerant to leaf spot. Niagara matures early in the summer.

Big Bluestem & Switchgrass Establishment

Warm-season grasses grow best on deep, well-drained soils. However, if they must be seeded in a poorly drained site, switchgrass is more tolerant of poorly drained soils than big bluestem. Both switchgrass and big bluestem have been established on low fertility and low pH (4.6) soils without adding lime or fertilizer. However, warm-season grasses establish faster on low fertility soils when fertilizer is applied.

Warm-season grasses should be seeded alone either on a conventional, tilled seedbed or no-tilled into grain stubble between mid-April and mid-May. Later seedings are slower to establish, yield less, and have more weed infestation the year after seeding. Successful spring seedings have also been made by no-tilling warm- season grasses into a small grain crop that has been killed with a herbicide. Good seed soil contact is very important for establishment of warm- season grasses, therefore, a tilled seedbed should be free of weeds, fine-textured, and firm. Plowing, disking, harrowing, and cultipacking generally are required. Band seed to a depth of 1/2 inch with a drill equipped with press wheels. If broadcast seeded or drilled without press wheels, rolling or cultipacking after seeding is necessary to assure a good firm seedbed.

Switchgrass seed is hard and smooth and can be handled without special drills. Big bluestem seed is chaffy and will not flow well unless it has been debearded, a process which removes the chaff and hair from this seed. Use debearded big bluestem seed to avoid seeding problems. Switchgrass and bluestem seeding rates of 8-10 and 10-12 lb per acre, respectively, of pure live seed is recommended for vigorous stand establishment. Pure live seed is easily calculated as (% germination x % pure seed)/100. Most attempts to establish and manage a switchgrass or big bluestem mixture with either alfalfa or red clover have not been successful. The legume dominates the mixture within two years. However, resent research has shown that legumes can be maintained in a stand with warm-season grasses if the legume and grass are seeded in alternate rows and harvested in the spring based on the warm- season grass.

Under ideal conditions, warm-season grasses can establish and reach a

height of 5 ft in the year of establishment. However, it generally takes two years to reach their maximum growth potential because of slow germination and seedling growth. Stands which appear poor at the end of the first year usually develop into good stands the second year. It is important to evaluate the stands at the end of the seeding year. If there are at least 1 to 3 seedlings per square foot in September, the stand is adequate.

Weeds can be very detrimental in the seeding year because of the slow growth of warm season grass seedlings. Because warm-season grass seedlings are poor competitors with weeds, sites with severe perennial weed problems such as quackgrass or broadleaf weeds should be avoided. Following recommended establishment procedures can help reduce weed pressures. If plowing and disking is done early, weeds can be allowed to germinate and then eliminated with a contact herbicide or a light harrowing or disking before seeding. Mowing weeds to reduce shading may be beneficial and should be done at a height above the grass seedlings and not later than early August. Broadleaf weeds can be controlled with herbicides when the grasses are seedlings. Refer to the Pennsylvania Agronomy Guide for current herbicide recommendations and label restrictions.

Big Bluestem & Switchgrass Harvest Management

The seeding year stand should not be harvested unless there is unusually good growth and the stand is vigorous. Established plants should be cut or grazed when they are 18 to 24 inches in height (late boot stage). Leave a 4 to 6 inch stubble for rapid regrowth. Live weight gains of 2.5 pounds per day have been obtained when steers grazed warm-season grasses head emergence. While warm-season grasses are normally harvested twice or grazed for a short period of time during the late summer, they produce relatively high yields. Enough time should be allowed for at least 12 inches of fall regrowth before frost. Plants can be harvested after frost without damage to them.

Removal of dead stubble in December will increase grass yields during the following growing season. This can be done with grazing animals but these animals will need protein supplement during the grazing period.

Big Bluestem & Switchgrass Fertility

While warm season grasses are good producers on low fertility soils, adequate P and K will increase stand vigor and production when these nutrients are low in the soil. Determine lime and fertility needs by a soil test. Lime is not necessary if soil pH is above 6.0. In the absence of a soil test, apply 0-60-60 per acre. Nitrogen is not recommended to use at

establishment because it leads to increased competition from weeds. However, on sites with low fertility, good weed control, and a good stand of grass, apply 25 to 30 pounds of nitrogen per acre.

Maintain a pH of 6.0 or higher. Apply phosphorus and potash based on soil test. On established stands, apply 75 pounds nitrogen per acre annually in May when plants are less than 8 inches tall. Do not apply nitrogen in early spring.

Pests of Big Bluestem & Switchgrass

Normally, a well managed, vigorous stand should not have a broadleaf weed problem. However, thin stands may require some weed control. For chemical control of broadleaf weeds, refer to the Agronomy Guide. Perennial cool- season grasses that may invade warm-season grass stands can be somewhat controlled by spring grazing.

Insects normally are not a problem on warm-season grasses. However, leaf spot can be a problem on big bluestem. Use a resistant or tolerant variety to avoid this problem.

Big Bluestem & Switchgrass Summary

Warm-season grasses such as big bluestem and switchgrass can provide forage for animals throughout the summer months when cool-season grasses become less productive. Warm-season grasses establish relatively slow, however, if they are properly managed, a stand of warm-season grasses can last for many years. Because of the expense and difficulty in establishment, these grasses should be established as permanent sod pastures or hay fields. Warm-season grasses are not as well suited for crop rotation as the cool-season forage crops.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

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  The publisher, John Wiley & Sons :
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Frequently Asked Questions:

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Periodicals:

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Growing White Clover

Frequently Asked Questions Other Information Sources Return to Forage Crops

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Characteristics of White Clover

White clover (Trifolium repens L.) is a short- lived, perennial which can reseed itself under favorable conditions. It grows rapidly and spreads via stolons. White clover has a shallow root system which make it intolerant of droughty soils. It grows best during cool, moist weather on well-drained, fertile soils with a pH between 6 and 7. Pure stands of white clover are not usually planted because of their low growth habit and associated low yield. However, they make high quality pastures in mixture with a grass and fix nitrogen for use by the grass.

Adapted White Clover Varieties

The various types and varieties of white clover are undistinguishable from each other except for their size. Ladino and Regal are varieties of white clover which have leaf stems (petioles) that grow taller than other white clover varieties. Because of this taller growth habit these varieties are often referred to as large type white clovers. Dutch or common white clovers have slightly shorter petioles than the large white clover types. White clovers with the shortest petioles are classified as small clovers. The names of these small clovers frequently contain the words "wild white". These small white clovers yield less than the large types but persist better under heavy continuous grazing.

White Clover Establishment

White clover can be "frost seeded" (in early spring when the soil is still honeycombed with frost) into existing grass pastures to improve pasture production and quality. This seeding technique requires that the seeding be done while the soil contains frost. Delaying seeding until mid-morning when the soil has become slippery on the surface will result in poor stand establishment. White clover can also be no-till

seeded into existing grass pastures.

Seeding white clover-grass mixtures into a conventionally prepared seedbed is also an excellent method of establishment. Do not plant deeper than 1/4 inch when seeding. Press wheels or cultipacking used in conjunction with or after band seeding will improve the seed-soil contact and the chances of obtaining a good stand. To obtain a proper seeding depth, the seedbed should be firm. This can be accomplished by cultipacking before seeding.

Fluid seeding (planting in a fertilizer solution) of white clover onto a well-prepared, firm, fine seedbed can also be successful. Cultipacking before fluid seeding to make a firm seedbed and after fluid seeding to insure good seed-soil contact will improve stand establishment. Fluid seeding requires special equipment, therefore a custom applicator is recommended.

Seeding rates of white clover into an existing grass pasture should be 2-4 lb. per acre. White clover seeds are relatively small and one pound of seed contains about 800,000 seeds. Therefore the seeding rates for white clover appear low relative to other forages. Hay or silage mixtures which contain white clover should also contain a red clover to increase the potential yield.

White Clover Harvest Management

Harvest management of white clover for hay or silage production is generally based on the grass in mixture with the clover since white clover constitutes such a small proportion of the total forage and its quality remains relatively high at maturity. Harvest should be dictated by the harvest schedule which maximizes grass performance.

Pasture mixtures which contain a legume offer many advantages but also require more careful management than pure grass pastures. Advantages of having white clover or any legume in a pasture mixture is that forage quality is improved over a pure grass pasture and the stand requires less nitrogen application because of the legume N contribution.

White clover can be grazed continuously or rotationally. It can be grazed to a height of about 1 inch without serious damage to the stand. However, closely grazed white clover plants must be allowed to recover. If rotationally grazed with a tall-growing grass, the pastures should be grazed at intervals which do not allow the grass to excessively shade the white clover. On predominantly white clover pastures, bloat can be a problem.

White Clover Fertility

Lime and fertilizer needs of white clover should be determined by soil testing before planting. For best results the soil pH should be between 6 and 7. Starter fertilizer application of up to 20-60-20 lb. per acre will often assist in white clover establishment. If the soil test calls for nutrients in excess of this amount, they should be applied prior to seeding and incorporated into the seedbed. If white clover is to be seeded into an established winter grain, topdress applications of nitrogen to the small grain should not be made.

Clover stands should be fertilized annually according to soil test recommendations. In the absence of a soil test and assuming a medium-fertility soil, apply 0-60-145 lb. per acre. When white clover makes up less than 30% of a white clover-grass mixture, apply 30 to 50 lb. of N per acre to enhance grass production.

White Clover Summary

White clover is a low-growing forage legume which is predominantly used in pasture mixtures with grasses. It will improve forage quality above a pure grass stand and supply nitrogen for grass growth. White clover can tolerate close grazing but persists best if allowed a period to recover. Its contribution to the total forage yield in a mixed stand is generally relatively small but its overall contribution to forage quality and nitrogen for the grass makes it an excellent legume for pasture mixtures.

Related web pages:

- None identified.

Electronic mailing lists:

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Suggested references:

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- Alternative Agriculture: Committee of the Role of Alternative Farming Methods in Modern Production Agriculture - by National Research Council - List: $30.25 - Publication Date:

September 1989
Book News, Inc., 01/01/90:
Eleven case studies explore how alternative farming systems have been adopted--and with what economic results--on farms of various sizes producing different crops across the country. Annotation copyright Book News, Inc. Portland, Or.

- Making Hay - by Verlyn Klinkenborg - Publication Date: October 1997 - List: $14.95
The New York Times Book Review, Christopher Lehmann-Haupt :
Mr. Klinkenborg has achieved a terse idiom that amounts almost to Middle Western rural poetry.... what is most admirable about Making Hay is that it memorializes a way of life we take for granted. Its language celebrates both the changes and permanence of modern farming, its earthiness and ethereality.

- Biodiversity and Wheat Improvement - by A.B. Damania (Editor) - Publication Date: March 1994 - List: $165.00
The publisher, John Wiley & Sons :
A multidisciplinary group of leading scientists present articles regarding research in areas crucial to the conservation, evaluation and utilization of biodiversity in wild relatives and old forms of wheat. The recommendations and conclusions will prove useful to further research on a topic which is rapidly gaining importance in the efforts to meet the growing demands for increased food production.

- Crop Production : Evolution, History, and Technology - by C. Wayne Smith - Publication Date: November 1995 - List: $71.50
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One of the nation's leading agronomists presents an outstanding resource that deals with the agronomy of the eight major grain, fiber and oilseed row crops produced in the U.S. Each crop listed includes a structured discussion of the types of cultivars: its history, uses and processing, how to plant and grow the crop, pests and other problems and the harvesting, grading and marketing processes.

- Acid Soil and Acid Rain (Research Studies in Botany and Related Applied Fields, No. 10) - by Ivan R. Kennedy - Publication Date: May 1992 - List: $165.00
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Examines the basic chemical processes involved in acidification in order to better assess their long-term effects on the status of soils, the health of plants and other living species that depend on

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This text considers grazing management from the viewpoint of the ecology of grazing systems and focuses on the interrelationships between plant and animal populations which affect the stability of such systems, and the output of animal products from them. Relates the steps in the production process to the grassy surface characteristics that influence plant and animal behavior and uses these relationships to create a practical framework for management decisions.

- Legumes of Africa - by J.M. Lock - Publication Date: December 1989 - List: $45.00

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- None identified.

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Frequently Asked Questions:

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Characteristics of White Clover

White clover (Trifolium repens L.) is a short- lived, perennial which can reseed itself under favorable conditions. It grows rapidly and spreads via stolons. White clover has a shallow root system which make it intolerant of droughty soils. It grows best during cool, moist weather on well-drained, fertile soils with a pH between 6 and 7. Pure stands of white clover are not usually planted because of their low growth habit and associated low yield. However, they make high quality pastures in mixture with a grass and fix nitrogen for use by the grass.

Adapted White Clover Varieties

The various types and varieties of white clover are undistinguishable from each other except for their size. Ladino and Regal are varieties of white clover which have leaf stems (petioles) that grow taller than other white clover varieties. Because of this taller growth habit these varieties are often referred to as large type white clovers. Dutch or common white clovers have slightly shorter petioles than the large white clover types. White clovers with the shortest petioles are classified as small clovers. The names of these small clovers frequently contain the words "wild white". These small white clovers yield less than the large types but persist better under heavy continuous grazing.

White Clover Establishment

White clover can be "frost seeded" (in early spring when the soil is still honeycombed with frost) into existing grass pastures to improve pasture production and quality. This seeding technique requires that the seeding be done while the soil contains frost. Delaying seeding until mid-morning when the soil has become slippery on the surface will result in poor stand establishment. White clover can also be no-till seeded into existing grass pastures.

Seeding white clover-grass mixtures into a conventionally prepared seedbed is also an excellent method of establishment. Do not plant deeper than 1/4 inch when seeding. Press wheels or cultipacking used in conjunction with or after band seeding will improve the seed-soil contact and the chances of obtaining a good stand. To obtain a proper seeding depth, the seedbed should be firm. This can be accomplished by cultipacking before seeding.

Fluid seeding (planting in a fertilizer solution) of white clover onto a well-prepared, firm, fine seedbed can also be successful. Cultipacking before fluid seeding to make a firm seedbed and after fluid seeding to insure good seed-soil contact will improve stand establishment. Fluid seeding requires special equipment, therefore a custom applicator is recommended.

Seeding rates of white clover into an existing grass pasture should be 2-4 lb. per acre. White clover seeds are relatively small and one pound of seed contains about 800,000 seeds. Therefore the seeding rates for white clover appear low relative to other forages. Hay or silage mixtures which contain white clover should also contain a red clover to increase the potential yield.

White Clover Harvest Management

Harvest management of white clover for hay or silage production is generally based on the grass in mixture with the clover since white clover constitutes such a small proportion of the total forage and its quality remains relatively high at maturity. Harvest should be dictated by the harvest schedule which maximizes grass performance.

Pasture mixtures which contain a legume offer many advantages but also require more careful management than pure grass pastures. Advantages of having white clover or any legume in a pasture mixture is that forage quality is improved over a pure grass pasture and the stand requires less nitrogen application because of the legume N contribution.

White clover can be grazed continuously or rotationally. It can be grazed to a height of about 1 inch without serious damage to the stand. However, closely grazed white clover plants must be allowed to recover. If rotationally grazed with a tall-growing grass, the pastures should be grazed at intervals which do not allow the grass to excessively shade the white clover. On predominantly white clover pastures, bloat can be a problem.

White Clover Fertility

Lime and fertilizer needs of white clover should be determined by soil testing before planting. For best results the soil pH should be between 6 and 7. Starter fertilizer application of up to 20-60-20 lb. per acre will often assist in white clover establishment. If the soil test calls for nutrients in excess of this amount, they should be applied prior to seeding and incorporated into the seedbed. If white clover is to be seeded into an established winter grain, topdress applications of nitrogen to the small grain should not be made.

Clover stands should be fertilized annually according to soil test recommendations. In the absence of a soil test and assuming a medium- fertility soil, apply 0-60-145 lb. per acre. When white clover makes up less than 30% of a white clover-grass mixture, apply 30 to 50 lb. of N per acre to enhance grass production.

White Clover Summary

White clover is a low-growing forage legume which is predominantly used in pasture mixtures with grasses. It will improve forage quality above a pure grass stand and supply nitrogen for grass growth. White clover can tolerate close grazing but persists best if allowed a period to recover. Its contribution to the total forage yield in a mixed stand is generally relatively small but its overall contribution to forage quality and nitrogen for the grass makes it an excellent legume for pasture mixtures.

Related web pages:

- None identified.

Electronic mailing lists:

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General Aquaculture

Frequently Asked Questions Other Information Sources Return to Aquaculture Contents

Frequently Asked Questions:

- Aquaculture Overview
- Markets
- Marketing

Other Information Sources:

- Related web pages
- Commercial suppliers
- Electronic mailing lists
- Suggested references
- Periodicals

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Aquaculture Overview

Aquaculture -- the raising of fish and fish feed -- has been practiced in various forms in Western Canada for more than half a century. Prior to the 1970's the world protein shortage and raising prices for fish products created widespread interest in the industry, particularly among farmers.

In 1973 the Product Development Section of Alberta Agriculture commissioned a consulting firm to study the potential for aquaculture in Alberta. The study concentrated on different systems of raising rainbow trout and their application to Alberta. It concluded that a net return of $1,266 (total annual cost of production) was needed to break even when loose rearing 10,000 trout. With a gross return of $6,000 breaking even was not a concern. Profit from cage rearing and raceway rearing 110,000 trout was 21% and 23% as a percentage of sales, respectively. In 1973 game fish farming was a profitable business. This study provides a great overview for 1973, but a recent study is needed.

This study is an effort to provide an overview for aquaculture in Alberta for the 1990's. It will attempt to illustrate that raising rainbow trout can be a profitable and viable business. Whenever someone spends capital for a particular project, he does so for a profitable return.

Alberta supports at least four government hatcheries located near Coldlake, Calgary, Coleman and Caroline. There are a number of game fish farms abroad Alberta. In 1995 there were approximately 50-60 commercial and 2500-3000 private (including production and recreational ponds) sites. Wayne Wood Fresh Fish (Edmonton) and other slaughter plants near Lac La Biche, Calling Lake and Slave Lake process fish. Currently fish are processed at $1.10/kg ($0.50/lb.).

Markets

Markets for freshwater fish for human consumption are well established in both Canada and the United States. The demand for fish will continue as the world's fishery industry continues to deplete the ocean's supply. In 1972 Canadian fish farmers sold nearly 486.4 thousand kg (1.07 million pounds) of fish. About 72.2% of Canadian sold fish was sold for human consumption and that nearly 11% of this was produced in Alberta's 'pot hole' lakes. In the United States per capita consumption of fish has substantially increased from about 5 Kg (11 pounds) in 1968 to 7Kg (15.4 pounds) in 1986. While in Canada, the amount of food dollars spent by a household on fish, increased by 18% from 1974 to 1984. Canada's fish consumption reached 4.5 kg/year/capita (10-11pounds) in 1976 and 2.25 kg (5 pounds) on the prairies. One Western Canadian wholesaler of freshwater fish located here in Alberta had experienced a 260% increase in business since opening in 1987. Their annual sales nearly reached $1 million in 1990. This clearly indicates the remarkable growth in the freshwater fish industry in our prairie province, Alberta.

In 1972 western producers obtained $2.75/Kg ($1.25/pound) for whole dressed (gutted and cleaned) trout). In 1990, prices for whole dressed trout were $4.50/Kg ($2.00/pound) sold to large distributors, while the prairie market experienced high demand for pansize trout pricing $5.00/Kg ($2.25/pound) to the retail market. Billingsgate Fish Company (Edmonton) Ltd. (1995) sell trout for nearly $11.00/kg ($5.00/pound).

Marketing

Trout can be marketed in four different ways:

- brokering
- selling to a wholesaler
- selling direct to local individuals and establishments
- or by running a 'U-fish' type operation (pond operations)

Deciding which will be the best for your particular operation may be determined by such factors as:

- number of trout raised
- proximity to a population base
- other operation in the area
- the estimated final market weight of the trout.

Brokering fingerling trout is a profitable and relatively easy method of entering the rainbow trout rearing business. A broker essentially

purchases fingerlings to stock local ponds and tanks. Purchasing trout by the 10,000s reduces the price per fish enabling the broker to buy cheap trout. He now has the ability to add a price mark up to include transportation, facilities and profit, and resell the fingerlings to individuals only requiring a few hundred trout.

An easy way to market tank or pond raised trout is selling market size trout to a wholesaler. This wholesaler may distribute the trout to a major chain of stores or to individual stores. Market size trout are sold to wholesalers where ever they set up a gathering point. Large volumes of trout can be transported to these single gathering points, trout producers do not need to be located near a major population base.

Selling to local or specialized markets requires greater marketing skills; however, the rewards pay off over the long run. Dealer licenses must be obtained from the provincial government Fish and Wildlife division before trout can be legally sold to individuals, grocery stores and restaurants. Only fish of top quality with top quality flavor are accepted. Trout damaged during harvesting, having a muddy taste or of unusual size will have to be marketed by another means. Damaging the reputation of your operation and trout quality can be irreparable.

A U-fish operation is a business where people come to the pond and catch their own fish on a line and hook. This operation can be profitable alone, but is more so when combined with other home based businesses such as U-pick gardens, craft shops or campgrounds. A U-fish businesses can be run seasonally or year round. One can charge fishermen at a flat rate, by a certain price per centimeter (inch) or kilogram (pound) or by combining the two.

Related web pages:

- A link to the National Agricultural Library providing information relating to aquaculture: http://www.nal.usda.gov/afsic/afsaqua.htm

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Commercial suppliers:

- None identified.

Electronic mailing lists:

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Suggested references:

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- African Inland Fisheries, Aquaculture and the Environment - by K. Remane (Editor), Food and Agriculture Organization of the United Nations - Hardcover - Publication date: August 1997 - Price information not available.
- Aquaculture : The Farming and Husbandry of Freshwater and Marine Organisms - by John E. Bardach - Paperback - Publication date: December 1, 1995 - List: $74.95
- Aquaculture and Water Resource Management - by Donald J. Baird (Editor) - Hardcover Publication date: September 1, 1996 - List: $110.00
- Aquaculture in the United States : A Historical Survey - by Robert R. Stickney, Robert Stickeny - Hardcover - Publication date: January 1, 1996 - List: $64.95
  The publisher, John Wiley & Sons:
  A provocative look at the past, present and future of a troubled industry. Describes how public opinion has changed from viewing aquaculture as a friend of the environment to considering it an enemy. Presents the conflict between what is technically possible and what is economically and environmentally sound. Explains why aquaculture is thriving outside the U.S. but is facing difficulties in this country.
- Aquaculture Sourcebook : A Guide to North American Species - by Edwin S. Iversen, Kay K. Hale - Hardcover - Publication date: September 1992 - List: $67.95
- Hydrology and Water Supply for Pond Aquaculture - by Kyung H. Yoo, Claude E. Boyd Hardcover - Publication date: October 1, 1994 - List: $99.95
  Book News, Inc., 10/01/94:
  A text for a course in water supply for aquaculture or for individual study. The volume is divided into two parts. Part I, Hydrology, Morphology, and Soils, is concerned with hydrological phenomena that affect pond design, construction, and management. Part II, Design of Water Supply and Pond Systems, deals primarily with engineering techniques used in design and construction of pond aquaculture facilities. Annotation copyright Book News, Inc. Portland, Or.
- Introduction to Aquaculture - by Matthew Landau - Hardcover -

Publication date: September 1, 1991 - List: $76.49
The publisher, John Wiley & Sons:
Although the science of aquaculture has been around for centuries, it has only recently attained popularity. This textbook introduces a wide spectrum of aquaculture-related subjects. Topics covered include the history of aquaculture, water quality and sources, culture systems, economics, law, engineering, chemistry, biology and more.
Book News, Inc., 01/01/92:
Introductory text for a college or university course covers a wide spectrum of aquaculture-related topics and, because many different fields play a part in aquaculture, includes sections on history, economics, law, engineering, chemistry and biology. No assumptions are made about the background or education of the reader. Annotation copyright Book News, Inc. Portland, Or.

- Principles of Aquaculture - by Robert R. Stickney - Hardcover - Publication date: March 1994 - List: $84.95
The publisher, John Wiley & Sons:
Based on the author's previous work, Principles of Warmwater Aquaculture, this text updates and expands upon the basic principles of aquaculture. Encompasses a wider diversity of aquatic animals including coldwater fishes. Focuses on the practical aspects of water quality, feeding and nutrition, reproduction, breeding, diseases and operations. Deals with the environmental, social and economic aspects of aquaculture. Many of the examples feature species of both sport and commercial interest.
Book News, Inc., 06/01/95:
A text that presents the underlying principles of aquaculture and provides examples that underscore the principles and demonstrate the variability that exists among species of culture organisms. It extends the scope of Stickney's Principles of Warmwater Aquaculture (Wiley, 1979) to encompass a wider variety of aquatic animals, including such coldwater fishes as trout and salmon. The emphasis is on species being reared around the world by commercial aquaculturists. Annotation copyright Book News, Inc. Portland, Or.

- Principles of Warmwater Aquaculture - by Robert R. Stickney - Hardcover - Publication date: April 1, 1979 - List: $84.95
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in the United States. The concepts can also be applied to animals reared for laboratory use. Includes a comprehensive bibliography to the literature.

- Sustainable Aquaculture - by John E. Bardach (Editor) - Hardcover - Publication date: May 1, 1997 - List: $69.95
- Better Trout Habitat : A Guide to Stream Restoration and Management - by Christopher J. Hunter - Publication Date: November 1991 - List: $30.00
- Handbook of Trout and Salmon Diseases - by Ronald J. Roberts, C. Jonathan Shepherd - Publication Date: July 1997 - List: $110.00
- Fish Health Blue Book, Number 4 : Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens - by John C. Thoesen (Editor) - Publication Date: June 1992 - List: $82.50
- Handbook of Nutrient Requirements of Finfish - by Robert P. Wilson - Publication Date: August 1991 - List: $179.00

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A U-fish operation is a business where people come to the pond and catch their own fish on a line and hook. This operation can be profitable alone, but is more so when combined with other home based businesses such as U-pick gardens, craft shops or campgrounds. A U-fish businesses can be

run seasonally or year round. One can charge fishermen at a flat rate, by a certain price per centimeter (inch) or kilogram (pound) or by combining the two.

Related web pages:

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Catfish Contents

Return to Aquaculture Contents

We have identified many fine books in the suggested reference sections of our individual subject pages, however, if there is another book you are looking for you can use the search box below. This will allow you to search directly with Amazon.com.

Raising Catfish

Frequently Asked Questions Other Information Sources Return to Catfish Index

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Catfish farming in the United States has experienced tremendous growth in the past twenty years. Production has increased from 5 million lbs in 1972 to nearly 500 million lbs in 1992. The majority of production is concentrated in the Mississippi Delta region with an estimated 125,000 acres of ponds. Channel catfish is the most widely cultured catfish species. Catfish farms in Florida differ greatly from the large, established operations in the leading catfish producing states. Approximately 95% of Florida catfish producers have less than 20 acres of ponds and view aquaculture as an alternate means of supplementing their income.

Catfish production is capital intensive and involves many risks and has been described as one of the most management intensive forms of farming. In addition to the high entry cost, Florida producers are faced with the many growing pains of a young industry. Among these are higher production costs associated with a small scale of operation and limited developed infrastructure. Additionally, market conditions are influenced by large producers and processors which pose new challenges for small producers in finding their market niche.

Proactive Pond Management

In the southern U.S., many catfish farms are managed to maximize production with high stocking (5 - 10 thousand/acre) and feeding (75 - 150 pounds/acre/day) rates. Typically, seasonal feeding rates are increased on these farms until mechanical aeration is necessary. Often, therapeutants are required to manage the disease and parasite problems which accompany or follow these poor water quality periods.

Important steps for implementing proactive management follow.

- Grade your fingerlings. Using graded 7 - 8 inch fingerlings (75 - 130 pounds per thousand), in annual production systems, helps to ensure improved feed conversion and fewer under sized fish at harvest. Small fingerlings have difficulty competing with large fingerlings for food throughout the growing season. Despite the higher initial cost for larger fingerlings, they are more cost effective than smaller fingerlings.
- Fewer harvest size fish (40%) were produced from mixed size fingerling classes (8, 6, and 4 inch) than from single size 8 inch (93%) or 6 inch (49%) fingerling classes.
- Stock 3000 - 3600 catfish per acre. Higher stocking rates may be possible with this management method but are unproven at this time.
- Stock fathead minnows (10 pounds per acre). Fathead minnows should provide polyculture benefits similar to those from bighead carp. Fatheads feed on periphyton, zooplankton, insects, waste feed and detritus. This behavior will help to moderate plankton blooms and organic waste loading. Fatheads can also provide additional food for catfish and extra farm income, if bait markets are established. Four, hardwood loading pallets per acre will provide adequate spawning structures for the fatheads.
- Use high quality feed. Using a nutritionally complete, 36% protein, floating ration is an important component in proactive pond management. Feed must provide complete nutrition with maximum conversion efficiency. Extra protein is needed to ensure rapid growth without reducing water quality. Lower quality feeds often have poorer conversion efficiency, which results in more waste products.
- Use reduced feeding rates. Many commercial catfish producers feed to satiation (all the feed the fish will eat) daily or use a feeding schedule based on estimated fish weight (3 - 5% of fish body weight per day). This feed rate amounts to 75 - 150 pounds/acre/day through much of the peak growing season. Heavy reliance on mechanical aeration often follows the obligatory water quality problems associated with this traditional management method. Mortality from diseases such as Enteric Septicemia of Catfish (ESC) also increases dramatically at high feeding rates. These problems combined with higher feed conversion rates result in reduced profit potential for many growers.
- Feed input can be increased gradually as the water warms and when the fish eat the feed within 5 - 10 minutes. Feed rates, during the peak growing season, can range from 20 - 40 pounds/acre/feed day. This feed rate can produce market size catfish (1.0 - 1.25 pound average) in 180 - 220 days without

aeration or disease problems.

- Spread feed evenly. It is very important to scatter feed over as much of the pond as possible when using reduced feeding rates. Otherwise, aggressive, larger fish will "hog" the feed and reduce feed efficiency. If your feed application system is limited to a small area of the pond, divide the feed into two or more feeding passes. Catfish will learn your feeding patterns, so occasionally reverse or alter your pattern, to provide an opportunity for all fish to obtain feed.
- Avoid overfeeding. Feed input is the primary pond control mechanism a catfish producer has once the pond is stocked. Catfish need adequate food for growth and health. However, fat, overfed catfish are not more healthy than catfish fed in efficiently managed systems. In most ponds with ESC outbreaks, the largest fish are infected initially. At what feeding rate does overfeeding begin? Uneaten feed collecting on the pond edge is a sure sign of overfeeding. Also, even if all the feed is eaten promptly, the fish may be overfed. When consumed feed isn't efficiently converted into tissue, the fish are overfed.

Waste products from catfish which are efficiently converting feed to tissue will enrich the pond with nutrients, resulting in plankton blooms. Food conversion efficiency in catfish goes down when they eat more than necessary for optimal growth. When the catfish are overfed, these additional waste products stimulate the development of large, unmanageable plankton populations. Nutrient and/or oxygen requirements of one or more of the populations may exceed the supply rate, resulting in a crash. Nutrient concentrations may reach toxic levels before these populations can recover. Aeration and therapeutants may be required to limit the onset of fish disease or mortality.

It is very unlikely that all your ponds can be fed at the same maximum rate. The most reliable way to determine your maximum feeding rate is to monitor water quality for each pond. Daily dissolved oxygen (DO) and temperature, and regular (weekly or bi-weekly) alkalinity, pH, total ammonia nitrogen (TAN), and nitrite-nitrogen measurements are critical to develop a production profile for each pond. This water chemistry profile coupled with daily and extended weather forecasts can help you avoid or lessen the effects of critical water quality problems, and, improve profit potential through increased feed conversion efficiency and reduced aeration expenses. Water quality test kits, which can perform these tests for fish farmers, cost approximately $175 - $200. Time requirements for daily DO measurements will average 10 - 15 minutes/pond/day.

Organic debris accumulates on pond bottoms as a result of any catfish production. Drying and stirring this debris helps to oxidize organic

wastes and may help curtail chronic disease problems. Seining efficiency should improve also when the pond bottom is reflattened. Make sure to repack the pond bottom before refilling.

Wastewater guidelines prohibit discharge of pond bottom sludge to streams. Pond bottom sludge may be applied to fields or gardens as long as it cannot contaminate streams.

After cleaning, adding ag lime can improve the production potential of most ponds by increasing their buffering capacity. In ponds with total alkalinity of 60 mg/l or less, 1 - 2 tons per acre are recommended. For ponds with total alkalinity of 60 - 100 mg/l, 1 ton per acre is sufficient. If a pond leaks badly, liming isn't cost effective. As you record and maintain information on your ponds, you can determine the quantity and frequency of liming required for each pond. Ag lime may be purchased from most agri-chemical dealers or from highway construction companies.

What to Observe

Average early morning (6 - 8 A.M.) DO concentrations will decline slowly through the spring to summer period, even though the day to day concentrations may fluctuate. During this period, morning pond temperatures and your feeding rate will slowly increase. Once pond temperatures begin to stabilize, trends in DO concentrations become very important. When morning DO decreases consistently for 3 - 5 days (3.0, 2.3, 1.8 mg/l, for example) consider this a significant trend and reduce feed input. When the morning DO concentration returns to pre-decline levels, increase feed input by 10%/day to original levels. Skip feeding on days when morning DO is less than 1.8 mg/l.

A rapid increase in morning DO concentrations, when weather conditions are stable, indicates that an algal bloom has begun. Increasing feed inputs during these periods will usually result in a serious water quality event if the bloom crashes.

A weather forecast predicting cloudy (overcast), cool or stormy weather can be expected to result in declining DO in many ponds, especially those with dense algal blooms. Reducing feeding rates as a weather front approaches can soften the impact on DO, and, nutrient concentrations and plankton populations. Despite the reduced feed inputs, plankton populations can still crash if you push the pond limits during poor weather conditions. Your ponds should recover within a day or two if you have not been overfeeding. Be sure to measure DO and TAN frequently during these difficult periods. Keep a record of these measurements for future reference.

Proactive pond management helps to prevent reliance on mechanical aerators. If your pond develops a DO problem, use your aerator. As soon as weather or pond conditions improve, stop aerating and allow the pond to recover normally.

Abrupt changes in pH and alkalinity usually indicate major changes have, or, are occurring in the pond phytoplankton (algae) populations. As algal population carbon requirements exceed available carbon dioxide levels, algae will use carbon from the pond buffer supply and alkalinity will decline. Reduce feeding for a few days to allow algal populations and alkalinity time to stabilize. Heavy rains can also cause alkalinity to decline. In either case, alkalinity should stabilize at or near previous levels; if not, add ag lime as needed.

As feeding rates and pond temperatures increase, TAN and nitrite-nitrogen levels will increase. When you reach the target feeding rate (25 - 40 pounds/acre/day), TAN and nitrite-nitrogen levels should stabilize near 0.4 - 1.0 mg/l and 0.002 - 0.3 mg/l, respectively. However, ponds which are highly enriched from years of accelerated production may have nutrient levels outside, usually above, these ranges. At this point, changes in nutrient concentration indicate changes in algal or bacterial populations if weather conditions are stable. Algae use ammonia readily when sunlight is available. If feed rates are constant, an increase in TAN concentration usually means that algal populations are declining. Weather changes that affect DO concentration, will affect TAN concentration also, because algae are the primary DO contributors/users and TAN users.

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Frequently Asked Questions:

- Catfish Farming
- Proactive Pond Management

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- Aquaculture and Water Resource Management - by Donald J. Baird (Editor) - Hardcover Publication date: September 1, 1996 - List: $110.00
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- Principles of Aquaculture - by Robert R. Stickney - Hardcover - Publication date: March 1994 - List: $84.95
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Processed Catfish

Frequently Asked Questions Other Information Sources Return to Catfish Contents

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Processed Catfish - Product Forms, Packaging, Yields & Product Mix

The catfish industry in the United States has gone through tremendous growth during its 25-year history. Total water acreage for catfish production has increased from over 56,000 acres in 1980 to over 130,000 acres in 1988. Like production, the catfish processing industry has also increased dramatically to keep up with rapid changes in supply and demand. Round weight (live weight of fish delivered for processing) processed in 1980 in the U.S. was approximately 46.5 million pounds. By 1988, this number increased to over 295 million pounds, a 534 percent increase in 8 years. Producer sales (farm value) for food-size catfish totaled over $249 million for 1988.

Initially, catfish processing developed to help alleviate problems associated with overproduction of farm-raised channel catfish. In the 1960s, most of the water acreage was used to produce catfish for fee-fishing and for live hauling to replenish other fee-fishing ponds. As the live-haul market reached a saturation point in the late 1960s and early 1970s, established producers moved into processing. In 1987, more than 80 percent of production was marketed through commercial processors. Almost 190 million pounds of catfish were consumed in 1987 through various markets, resulting in a per capita consumption of over .75 pounds. This is a 23 percent increase from 1986 levels.

Product forms

A traditional product form of processed catfish is the whole dressed fish. This is a catfish that has been headed, gutted and skinned (HGS). However, a growing percentage of sales is generated when the dressed fish is further processed into a variety of cuts or forms, including:

- Regular fillets
- Shank fillets (regular fillet with the belly flap or nugget removed)
- Fillet strips
- Nuggets (belly flaps and other fillet trim)
- Steaks.

All these forms are marketed fresh and frozen, and many are now sold breaded. Processors also sell rounds–eviscerated catfish with the head still on.

During the latter part of the 1980s, specialty products have made their way into the marketplace. Whole dressed catfish and fillets, coated or marinated with flavors and spices such as lemon-butter, cajun and mesquite, can be found in the seafood section of numerous grocery stores.

Another product favorite in certain sections of the United States is "bloody" whole dressed fish or fillets. This is whole dressed fish that does not go through the wash before it is packaged, thus giving it a bloody or "just killed" appearance.

Offal, the by-product of catfish processing, should also be considered when discussing catfish forms. Offal is sent to rendering plants for further processing into fish meal and fish oil (ingredients used in animal feed), or it is ground, cooled, and then sold to pet food companies as an ingredient in canned pet food.

Packaging

Catfish products are sold by processors to institutional and retail markets. The majority of catfish products are packaged and delivered fresh (ice packed), individually quick frozen (IQF) or chill packed.

The fresh product is packaged in a variety of ways to meet specifications of the customers. For example, whole dressed fish, shank fillets, regular fillets, steaks, strips and nuggets may be packaged in one or more polybags on ice in a wax-coated corrugated box. Fish, especially whole dressed fish, may be placed directly on ice and then covered with ice. When customers request ice pack, the fresh product is placed in wax-coated corrugated boxes with holes at the bottom of the side panels to allow for drainage as the ice melts. Dry pack boxes do not have drainage holes. Depending on the product form, net weight in the boxes may run 10,15, 20 or 30 pounds. However, each box is often packaged with 30 pounds of product and 20 pounds of ice. If the product is going to be placed in a retail package at grocery stores, label inserts are also included in the corrugated boxes.

The chill pack process consists of lowering the temperature of the product to between 25 and 30° F to form a crust-freezing effect. Products such as whole dressed fish, fillets (including marinated fillets), nuggets and strips are often packaged and shipped chill packed and then sold through retail outlets as fresh fish. This process extends shelf life, protecting the fish until it is thawed. The product is packaged in styrofoam trays, with soaker pads on the bottom, and covered with a polyfilm. Trays are then placed in corrugated boxes without ice and stored or shipped in cold-storage form. Net weights of the boxes vary according to product form and customer requirements; however, basic net weights are 10,15, 20 and 30 pounds. The boxed trays are then placed on pallets and moved into a blast freezer for a short period of time to achieve the crust freeze. They are then held in the cooler for shipment.

Frozen product forms may be individually quick frozen (IQF) by equipment such as spiral or tunnel freezers or individually frozen through a blast freeze process and ice-glazed. The majority of large processors use the IQF process. Products sold frozen include whole dressed fish, fillets, nuggets, strips, steaks and formed products.

Breaded products, such as whole dressed fish, fillets, strips, nuggets and formed products, are also sold frozen. The individually frozen products are placed in polybags and packed in corrugated boxes with net weights usually of 10 and 15 pounds. In some cases, the frozen product is placed loose in the corrugated box, and later packaged in styrofoam trays for retail outlets. Breaded products may also be packaged in 2 l/2-pound polybags and 5-pound polybags and placed in 20-pound and 40-pound master cartons, respectively. This size package is popular with frozen food retail outlets. Sealed, printed polybags containing breaded products ranging from 2 to 4 pounds are purchased by wholesale outlets for consumers. Breaded products are also sold, as are other fish products, in printed cartons in the retail freezer case.

One of the new further processed catfish items is the enrobed product. This process consists of coating a product, especially fillets with a seasoning and oil base mixture and then individually freezing it. The enrobed fillets are then packed in clear plastic trays that contain individual compartments to keep the products from touching. Trays are usually packed according to fillet size, such as 4, 5 or 7 ounces, and are then placed in a polybag in a corrugated box. Normally, there are five trays with a total of 20 fillets to the box; however, this may vary according to the processor.

Yields and product mix

The yield from catfish processing is determined, to a large extent, by

the product forms to which the processor is keying his marketing strategy. Further processing of catfish results in lower yields and more waste, so the processor's cost per pound of salable product increases accordingly. This factor, along with the marketing strategy of the processor and current consumer demands (the major factor), helps to determine the product mix for individual processors.

A live fish dressing yield of 62 percent is assumed. As further processing occurs, a whole dressed fish is assumed to yield 70 percent fillets or 90 percent steaks. Fifty percent of the whole dressed fish is further processed into fillets, steaks and nuggets. Of this amount, 5 percent is converted to steaks and the remaining 95 percent to fillets. The amount of fillets can further be broken down, with 20 percent remaining as regular fillets and 80 percent being further processed into nuggets and shank fillets.

From an input of 10,000 pounds of live fish, a total of 5,301 pounds, or 53 percent of the live weight, is converted into salable product. The catfish components of further processed items, such as breaded, marinated and enrobed product forms, are included in the percentages

Data includes fresh and frozen products. For many years, sales of fresh products exceeded frozen. In 1985 a turning point in the industry occurred when the majority of sales came from frozen products. In 1987, frozen products represented 52 percent of sales by commercial processors. In recent years sales of whole catfish have been declining, from 46 percent of total sales in 1986 to 43 percent in 1987. On the other hand, sales have increased for value-added products such as breaded pieces and nuggets.

Consumption

Per capita consumption of catfish products has increased significantly over the last decade. A share of this increase has resulted from intensive marketing efforts within the industry. But rapid changes in consumption patterns and an apparent desire for new and exciting food products have been equally important. This is evidenced by the introduction of over 8,000 new food products each year. The catfish industry has recognized these trends and has introduced value-added products to keep abreast of consumer demands.

In 1987 consumers ate approximately 190 million pounds of catfish, equivalent to .75 pounds per capita (a 23 percent increase from 1986). It is apparent that new products and new product forms of catfish are being accepted in the marketplace.While this trend is indicative of a growing market for catfish products, additional research and development are needed to insure that quality products are introduced year after year. Products that meet the expectations of health-conscious,

nutritionally informed consumers.

Product Quality and Quality Control

Unlike the red meat and poultry processing industries, catfish processing does not fall under the regulations of the United States Department of Agriculture (USDA). Before a catfish processor begins operation, however, he must contact local county health officials to comply with county health regulations and to obtain a health permit. Catfish processing operations also must adhere to standards set forth by the Good Manufacturing Practice Code of Federal Regulations, Title 21, Part 110, and are subject to announced and unannounced inspections by the Food and Drug Administration (FDA).

As in other industries, the catfish industry considers quality a number one priority. Without a quality product, sales of catfish products would quickly decrease. In order to maintain a quality product and promote consumer confidence, the major commercial catfish processors have contracted voluntarily with National Marine Fisheries Service (NMFS) to have their plants inspected. NMFS is an agency service of the National Oceanic and Atmospheric Administration (NOAA), an agency of the United States Department of Commerce (USDC). Federal inspectors with the NMFS perform unbiased, official inspections of plants, procedures and products for firms that pay for these services. The inspectors issue certificates indicating quality and condition of the catfish products.

The NMFS voluntary inspection program provides for the inspection of products and facilities and the grading of products.

Inspection is the examination of seafood (catfish) products by a U. S. Department of Commerce inspector or a cross-licensed State or U.S. Department of Agriculture inspector. They determine whether the product is safe, clean, wholesome and properly labeled. The equipment, facility and food-handling personnel must also meet established sanitation and hygienic standards. Products that pass inspection can display the federal inspection statement, "Packed Under Federal Inspection" or PUFI mark on the label and/or carton. Grading is the added step after inspection in which the quality level is determined. Only products that have an established grade standard can be graded. Industry uses the grade standards to buy and sell products. Consumers, however, rely on grading as a guide to purchasing products of high quality. Graded products can bear a U.S. grade mark which shows their quality level. The "U.S. Grade A" mark indicates that the product is of high quality, that it is uniform in size, practically free of blemishes and defects, in excellent condition, and has good flavor and odor.

In addition to the contract inspection mentioned above, USDC performs

other services. On request or on a regular contract basis, USDC conducts lot inspections of products to determine if they meet specifications of the party (buyers, brokers, distributors, etc.) that requested the inspection. USDC also has consultation services and provides assistance in specification development, label review, and analytical tests on products.

Detailed information regarding inspection requirements can be found in the Federal Standard Sanitation Standards for Fish Plants, FED-STD-369, August 2, 1977. Additional information regarding inspection and standards for products is in the Code of Federal Regulations Title 50, parts 260 and 267. Products may have the Inspection Mark and the Grade Shield or both of these symbols, depending upon the degree of inspection effort performed and the grade of the product.

In early 1988 The Catfish Institute (TCI), in cooperation with the USDC and the NMFS, began a voluntary inspection program to insure and promote quality catfish products. Processors who meet the criteria set by this program are able to use TCI'S registered trademarks, the Mississippi Prime name and logo, on their catfish products. To be able to use these trademarks, a processor must be licensed by TCI and can process only grain-fed channel catfish delivered live to the plant. The plant must be USDC certified as a "Sanitarily Inspected Fish Establishment". Weekly inspections to maintain this certification are required. In addition, weekly unannounced lot inspections by USDC are mandatory. Evaluation of the processor includes maintaining high standards reflected by average monthly inspection scores and product testing to monitor the flavor, appearance and texture as well as to test levels of quality control at the processing plant.

In addition to Federal inspection, major commercial catfish processors have in-house quality assurance programs and are often inspected by quality assurance staffs from various customers.

Catfish processing quality control begins at the pond before the fish are harvested for processing. Off-flavor catfish is a major source of concern to catfish producers and processors. This condition is usually generated by minute amounts of chemicals produced from algae imbalance. Ideally, flavor checks on fish to be processed are done by qualified personnel 1 week before harvest, 1 day before harvest, and on the day of harvest.

Basic procedures for quality control

The following is an overview of basic quality control procedures for catfish processing plants. Commercial processors with high quality catfish products have quality assurance programs that cover these areas in more detail.

- Fish should be checked for pesticide, herbicide and heavy metal residue, as well as diseases and off-flavor.
- Holding tanks that are used to store live fish prior to processing should be kept free of algae growth, and proper levels of dissolved oxygen should be maintained. High quality water should be used.
- Proper cleaning procedures, including heading, eviscerating and skinning, should be conducted at all times. Periodic checks should be made at every location during the processing day.
- Proper offal removal procedures should be carefully monitored and maintained.
- A proper chilling procedure, using the latest chilling techniques, should be used to reduce and then maintain the temperature of the catfish at 38°F throughout processing.
- All surfaces in contact with the fish should be sanitary and not have contact with the floor.
- Fish dropped on floor should be handled in a proper manner using correct washing methods.
- Temperature of fish products to be frozen should be reduced to 0°F as quickly as possible and promptly stored in a freezer at -10 to -20°F.
- All work-in-process fresh inventory should be promptly iced and stored at approximately 34°F.
- Every effort should be made to keep bacteria counts low. Routine monitoring of product and equipment is encouraged.
- Frozen product should be stored properly in freezer.
- Freezer stock should be rotated regularly.
- Proper clean-up in plant is essential
- Product should be checked throughout the processing operation with regard to weight, size, visual appearance, proper temperature and correct packaging.
- Value added products should be checked on line routinely to insure proper percentages of breading, glaze, marinade, etc.
- Product recall procedures, including proper coding of a product, should be used.

With the assistance of U.S. Department of Commerce inspection programs and in-depth quality assurance programs, today’s commercial catfish processors are providing the consumer with quality catfish products.

Further Processing and Trends in the Industry

In many respects, the rapidly growing catfish processing industry has paralleled the more established poultry processing industry. For many years, dressed poultry was only a commodity product. When fast foods became convenient and popular, poultry made its first thrust into the further processing area.

Although no national catfish chain rivals poultry product outlets, during the past few years many catfish "houses" or restaurants have served breaded catfish to the consumer.

Breaded, uncooked catfish fillets and whole fish emerged as the initial further processed product. Most of these products contain 20 to 30 percent cornmeal breading and usually are sold as a raw product to the institutional market. Sizes usually range from 3 to 7 ounces for fillets.

One potential product is a formed portion controlled product that is exact in shape, size and weight. This product is breaded and is excellent for school lunch programs. Products can be offered in 1 to 5 ounce portions. Breaded fillet strips also have been a popular item for fast food outlets or restaurants.

A recent entry to the further processed area is an enrobed catfish product. The enrobing medium usually consists of vegetable oil or oil/water coatings that are applied to fillets which are then frozen. Many flavors and types have been presented, including lemon-butter, cajun and blackened. These types of coatings provide an up-scale catfish product suitable for baking or broiling at "white tablecloth" restaurants. Combinations of light coatings and bread crumbs are also available.

The use of phosphates as a processing aid has provided another area for new further processed products. The injector has provided a means of carrying flavors and spices to the core of catfish fillets. Products, such as lemon-butter, hot and spicy, and smoked fillets, can be prepared with this technology. Another method of carrying spices and flavors into the catfish is vacuum marination. Marination provides a vehicle to carry spices and flavors of larger particle size and heavier coatings to the surface and interior of fillets.

Many of the further processed catfish products have been packaged with suitable companion products such as hushpuppies. Presently, no fully cooked, frozen catfish products are being prepared. Products of this nature have potential in the future.

Minced catfish, deboned from the skeletal frames after filleting, offers several opportunities for further processing. The minced meat is formed into patties and breaded. These patties have been successful for school lunch programs. The catfish mince can be frozen in 16-pound blocks for making breaded fish sticks, gumbo, or any product requiring fish in the recipe. Surimi has been successfully made from minced catfish.

A stuffed catfish fillet is almost certain to make an entrance into the marketplace. Stuffings could include crab and shrimp flavored surimi, shrimp stuffing, cornbread stuffing and many others.

Another opportunity for further processed products is the use of minced catfish in conjunction with other seafood products such as shrimp. Minced catfish often can be used in lieu of surimi. An example would be a formed, breaded shrimp product containing shrimp pieces and deboned catfish.

Related web pages:

- A link to the National Agricultural Library providing information relating to aquaculture: http://www.nal.usda.gov/afsic/afsaqua.htm

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Commercial suppliers:

- None identified

Electronic mailing lists:

- None identified.

Suggested references:

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The chill pack process consists of lowering the temperature of the product to between 25 and 30° F to form a crust-freezing effect. Products such as whole dressed fish, fillets (including marinated fillets), nuggets and strips are often packaged and shipped chill packed and then sold through retail outlets as fresh fish. This process extends shelf life, protecting the fish until it is thawed. The product is packaged in styrofoam trays, with soaker pads on the bottom, and covered with a polyfilm. Trays are then placed in corrugated boxes without ice and stored or shipped in cold-storage form. Net weights of the boxes vary according to product form and customer requirements; however, basic net weights are 10,15, 20 and 30 pounds. The boxed trays are then placed on pallets and moved into a blast freezer for a short period of time to achieve the crust freeze. They are then held in the cooler for shipment.

Frozen product forms may be individually quick frozen (IQF) by equipment such as spiral or tunnel freezers or individually frozen through a blast freeze process and ice-glazed. The majority of large processors use the IQF process. Products sold frozen include whole dressed fish, fillets, nuggets, strips, steaks and formed products.

Breaded products, such as whole dressed fish, fillets, strips, nuggets and formed products, are also sold frozen. The individually frozen products are placed in polybags and packed in corrugated boxes with net weights usually of 10 and 15 pounds. In some cases, the frozen product is placed loose in the corrugated box, and later packaged in styrofoam trays for retail outlets. Breaded products may also be packaged in 2 l/2-pound polybags and 5-pound polybags and placed in

20-pound and 40-pound master cartons, respectively. This size package is popular with frozen food retail outlets. Sealed, printed polybags containing breaded products ranging from 2 to 4 pounds are purchased by wholesale outlets for consumers. Breaded products are also sold, as are other fish products, in printed cartons in the retail freezer case.

One of the new further processed catfish items is the enrobed product. This process consists of coating a product, especially fillets with a seasoning and oil base mixture and then individually freezing it. The enrobed fillets are then packed in clear plastic trays that contain individual compartments to keep the products from touching. Trays are usually packed according to fillet size, such as 4, 5 or 7 ounces, and are then placed in a polybag in a corrugated box. Normally, there are five trays with a total of 20 fillets to the box; however, this may vary according to the processor.

Yields and product mix

The yield from catfish processing is determined, to a large extent, by the product forms to which the processor is keying his marketing strategy. Further processing of catfish results in lower yields and more waste, so the processor's cost per pound of salable product increases accordingly. This factor, along with the marketing strategy of the processor and current consumer demands (the major factor), helps to determine the product mix for individual processors.

A live fish dressing yield of 62 percent is assumed. As further processing occurs, a whole dressed fish is assumed to yield 70 percent fillets or 90 percent steaks. Fifty percent of the whole dressed fish is further processed into fillets, steaks and nuggets. Of this amount, 5 percent is converted to steaks and the remaining 95 percent to fillets. The amount of fillets can further be broken down, with 20 percent remaining as regular fillets and 80 percent being further processed into nuggets and shank fillets.

From an input of 10,000 pounds of live fish, a total of 5,301 pounds, or 53 percent of the live weight, is converted into salable product. The catfish components of further processed items, such as breaded, marinated and enrobed product forms, are included in the percentages

Data includes fresh and frozen products. For many years, sales of fresh products exceeded frozen. In 1985 a turning point in the industry occurred when the majority of sales came from frozen products. In 1987, frozen products represented 52 percent of sales by commercial processors. In recent years sales of whole catfish have been declining, from 46 percent of total sales in 1986 to 43 percent in 1987. On the other hand, sales have increased for value-added products such as breaded pieces and nuggets.

Consumption

Per capita consumption of catfish products has increased significantly over the last decade. A share of this increase has resulted from intensive marketing efforts within the industry. But rapid changes in consumption patterns and an apparent desire for new and exciting food products have been equally important. This is evidenced by the introduction of over 8,000 new food products each year. The catfish industry has recognized these trends and has introduced value-added

products to keep abreast of consumer demands.

In 1987 consumers ate approximately 190 million pounds of catfish, equivalent to .75 pounds per capita (a 23 percent increase from 1986). It is apparent that new products and new product forms of catfish are being accepted in the marketplace.While this trend is indicative of a growing market for catfish products, additional research and development are needed to insure that quality products are introduced year after year. Products that meet the expectations of health-conscious, nutritionally informed consumers.

Product Quality and Quality Control

Unlike the red meat and poultry processing industries, catfish processing does not fall under the regulations of the United States Department of Agriculture (USDA). Before a catfish processor begins operation, however, he must contact local county health officials to comply with county health regulations and to obtain a health permit. Catfish processing operations also must adhere to standards set forth by the Good Manufacturing Practice Code of Federal Regulations, Title 21, Part 110, and are subject to announced and unannounced inspections by the Food and Drug Administration (FDA).

As in other industries, the catfish industry considers quality a number one priority. Without a quality product, sales of catfish products would quickly decrease. In order to maintain a quality product and promote consumer confidence, the major commercial catfish processors have contracted voluntarily with National Marine Fisheries Service (NMFS) to have their plants inspected. NMFS is an agency service of the National Oceanic and Atmospheric Administration (NOAA), an agency of the United States Department of Commerce (USDC). Federal inspectors with the NMFS perform unbiased, official inspections of plants, procedures and products for firms that pay for these services. The inspectors issue certificates indicating quality and condition of the catfish products.

The NMFS voluntary inspection program provides for the inspection of products and facilities and the grading of products.

Inspection is the examination of seafood (catfish) products by a U. S. Department of Commerce inspector or a cross-licensed State or U.S. Department of Agriculture inspector. They determine whether the product is safe, clean, wholesome and properly labeled. The equipment, facility and food-handling personnel must also meet established sanitation and hygienic standards. Products that pass inspection can display the federal inspection statement, "Packed Under Federal Inspection" or PUFI mark on the label and/or carton. Grading is the added step after inspection in which the quality level is determined. Only products that have an established grade standard can be graded. Industry uses the grade standards to buy and sell products. Consumers, however, rely on grading as a guide to purchasing products of high quality. Graded products can bear a U.S. grade mark which shows their quality level. The "U.S. Grade A" mark indicates that the product is of high quality, that it is uniform in size, practically free of blemishes and defects, in excellent condition, and has good flavor and odor.

In addition to the contract inspection mentioned above, USDC performs other services. On request or on a regular contract basis, USDC conducts lot inspections of products to determine if they meet

specifications of the party (buyers, brokers, distributors, etc.) that requested the inspection. USDC also has consultation services and provides assistance in specification development, label review, and analytical tests on products.

Detailed information regarding inspection requirements can be found in the Federal Standard Sanitation Standards for Fish Plants, FED-STD- 369, August 2, 1977. Additional information regarding inspection and standards for products is in the Code of Federal Regulations Title 50, parts 260 and 267. Products may have the Inspection Mark and the Grade Shield or both of these symbols, depending upon the degree of inspection effort performed and the grade of the product.

In early 1988 The Catfish Institute (TCI), in cooperation with the USDC and the NMFS, began a voluntary inspection program to insure and promote quality catfish products. Processors who meet the criteria set by this program are able to use TCI'S registered trademarks, the Mississippi Prime name and logo, on their catfish products. To be able to use these trademarks, a processor must be licensed by TCI and can process only grain-fed channel catfish delivered live to the plant. The plant must be USDC certified as a "Sanitarily Inspected Fish Establishment". Weekly inspections to maintain this certification are required. In addition, weekly unannounced lot inspections by USDC are mandatory. Evaluation of the processor includes maintaining high standards reflected by average monthly inspection scores and product testing to monitor the flavor, appearance and texture as well as to test levels of quality control at the processing plant.

In addition to Federal inspection, major commercial catfish processors have in-house quality assurance programs and are often inspected by quality assurance staffs from various customers.

Catfish processing quality control begins at the pond before the fish are harvested for processing. Off-flavor catfish is a major source of concern to catfish producers and processors. This condition is usually generated by minute amounts of chemicals produced from algae imbalance. Ideally, flavor checks on fish to be processed are done by qualified personnel 1 week before harvest, 1 day before harvest, and on the day of harvest.

Basic procedures for quality control

The following is an overview of basic quality control procedures for catfish processing plants. Commercial processors with high quality catfish products have quality assurance programs that cover these areas in more detail.

- Fish should be checked for pesticide, herbicide and heavy metal residue, as well as diseases and off-flavor.
- Holding tanks that are used to store live fish prior to processing should be kept free of algae growth, and proper levels of dissolved oxygen should be maintained. High quality water should be used.
- Proper cleaning procedures, including heading, eviscerating and skinning, should be conducted at all times. Periodic checks should be made at every location during the processing day.
- Proper offal removal procedures should be carefully monitored and maintained.
- A proper chilling procedure, using the latest chilling techniques, should be used to reduce

and then maintain the temperature of the catfish at 38°F throughout processing.

- All surfaces in contact with the fish should be sanitary and not have contact with the floor.
- Fish dropped on floor should be handled in a proper manner using correct washing methods.
- Temperature of fish products to be frozen should be reduced to 0°F as quickly as possible and promptly stored in a freezer at -10 to -20°F.
- All work-in-process fresh inventory should be promptly iced and stored at approximately 34°F.
- Every effort should be made to keep bacteria counts low. Routine monitoring of product and equipment is encouraged.
- Frozen product should be stored properly in freezer.
- Freezer stock should be rotated regularly.
- Proper clean-up in plant is essential
- Product should be checked throughout the processing operation with regard to weight, size, visual appearance, proper temperature and correct packaging.
- Value added products should be checked on line routinely to insure proper percentages of breading, glaze, marinade, etc.
- Product recall procedures, including proper coding of a product, should be used.

With the assistance of U.S. Department of Commerce inspection programs and in-depth quality assurance programs, today's commercial catfish processors are providing the consumer with quality catfish products.

Further Processing and Trends in the Industry

In many respects, the rapidly growing catfish processing industry has paralleled the more established poultry processing industry. For many years, dressed poultry was only a commodity product. When fast foods became convenient and popular, poultry made its first thrust into the further processing area.

Although no national catfish chain rivals poultry product outlets, during the past few years many catfish "houses" or restaurants have served breaded catfish to the consumer.

Breaded, uncooked catfish fillets and whole fish emerged as the initial further processed product. Most of these products contain 20 to 30 percent cornmeal breading and usually are sold as a raw product to the institutional market. Sizes usually range from 3 to 7 ounces for fillets.

One potential product is a formed portion controlled product that is exact in shape, size and weight. This product is breaded and is excellent for school lunch programs. Products can be offered in 1 to 5 ounce portions. Breaded fillet strips also have been a popular item for fast food outlets or restaurants.

A recent entry to the further processed area is an enrobed catfish product. The enrobing medium usually consists of vegetable oil or oil/water coatings that are applied to fillets which are then frozen. Many flavors and types have been presented, including lemon-butter, cajun and blackened.

These types of coatings provide an up-scale catfish product suitable for baking or broiling at "white tablecloth" restaurants. Combinations of light coatings and bread crumbs are also available.

The use of phosphates as a processing aid has provided another area for new further processed products. The injector has provided a means of carrying flavors and spices to the core of catfish fillets. Products, such as lemon-butter, hot and spicy, and smoked fillets, can be prepared with this technology. Another method of carrying spices and flavors into the catfish is vacuum marination. Marination provides a vehicle to carry spices and flavors of larger particle size and heavier coatings to the surface and interior of fillets.

Many of the further processed catfish products have been packaged with suitable companion products such as hushpuppies. Presently, no fully cooked, frozen catfish products are being prepared. Products of this nature have potential in the future.

Minced catfish, deboned from the skeletal frames after filleting, offers several opportunities for further processing. The minced meat is formed into patties and breaded. These patties have been successful for school lunch programs. The catfish mince can be frozen in 16-pound blocks for making breaded fish sticks, gumbo, or any product requiring fish in the recipe. Surimi has been successfully made from minced catfish.

A stuffed catfish fillet is almost certain to make an entrance into the marketplace. Stuffings could include crab and shrimp flavored surimi, shrimp stuffing, cornbread stuffing and many others.

Another opportunity for further processed products is the use of minced catfish in conjunction with other seafood products such as shrimp. Minced catfish often can be used in lieu of surimi. An example would be a formed, breaded shrimp product containing shrimp pieces and deboned catfish.

Related web pages:

- A link to the National Agricultural Library providing information relating to aquaculture: http://www.nal.usda.gov/afsic/afsaqua.htm

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Commercial suppliers:

- None identified

Electronic mailing lists:

- None identified.

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- Hydrology and Water Supply for Pond Aquaculture - by Kyung H. Yoo, Claude E. Boyd Hardcover - Publication date: October 1, 1994 - List: $99.95
  Book News, Inc., 10/01/94:
  A text for a course in water supply for aquaculture or for individual study. The volume is divided into two parts. Part I, Hydrology, Morphology, and Soils, is concerned with hydrological phenomena that affect pond design, construction, and management. Part II, Design of Water Supply and Pond Systems, deals primarily with engineering techniques used in design and construction of pond aquaculture facilities. Annotation copyright Book News, Inc. Portland, Or.
- Introduction to Aquaculture - by Matthew Landau - Hardcover - Publication date: September 1, 1991 - List: $76.49
  The publisher, John Wiley & Sons:
  Although the science of aquaculture has been around for centuries, it has only recently attained popularity. This textbook introduces a wide spectrum of aquaculture-related subjects. Topics covered include the history of aquaculture, water quality and sources, culture systems, economics, law, engineering, chemistry, biology and more.
  Book News, Inc., 01/01/92:
  Introductory text for a college or university course covers a wide spectrum of aquaculture-related topics and, because many different fields play a part in aquaculture,

includes sections on history, economics, law, engineering, chemistry and biology. No assumptions are made about the background or education of the reader. Annotation copyright Book News, Inc. Portland, Or.

- Principles of Aquaculture - by Robert R. Stickney - Hardcover - Publication date: March 1994 - List: $84.95
  The publisher, John Wiley & Sons:
  Based on the author's previous work, Principles of Warmwater Aquaculture, this text updates and expands upon the basic principles of aquaculture. Encompasses a wider diversity of aquatic animals including coldwater fishes. Focuses on the practical aspects of water quality, feeding and nutrition, reproduction, breeding, diseases and operations. Deals with the environmental, social and economic aspects of aquaculture. Many of the examples feature species of both sport and commercial interest.
  Book News, Inc., 06/01/95:
  A text that presents the underlying principles of aquaculture and provides examples that underscore the principles and demonstrate the variability that exists among species of culture organisms. It extends the scope of Stickney's Principles of Warmwater Aquaculture (Wiley, 1979) to encompass a wider variety of aquatic animals, including such coldwater fishes as trout and salmon. The emphasis is on species being reared around the world by commercial aquaculturists. Annotation copyright Book News, Inc. Portland, Or.
- Principles of Warmwater Aquaculture - by Robert R. Stickney - Hardcover - Publication date: April 1, 1979 - List: $84.95
  The publisher, John Wiley & Sons:
  Provides the basic concepts and techniques required to rear warmwater animals in both fresh and marine environments and under controlled or semi-controlled conditions. Utilizes examples from various species to demonstrate how specific general principles can be applied throughout the field. Focuses on commercially important species that are being or can be reared in the United States. The concepts can also be applied to animals reared for laboratory use. Includes a comprehensive bibliography to the literature.
- Sustainable Aquaculture - by John E. Bardach (Editor) - Hardcover - Publication date: May 1, 1997 - List: $69.95
- Better Trout Habitat : A Guide to Stream Restoration and Management - by Christopher J. Hunter - Publication Date: November 1991 - List: $30.00
- Handbook of Trout and Salmon Diseases - by Ronald J. Roberts, C. Jonathan Shepherd - Publication Date: July 1997 - List: $110.00
- Fish Health Blue Book, Number 4 : Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens - by John C. Thoesen (Editor) - Publication Date: June 1992 - List: $82.50
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Periodicals:

- None identified.

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Channel Catfish

Frequently Asked Questions Other Information Sources Return to Catfish Contents

Frequently Asked Questions:

Other Information Sources:

Warning:

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Channel Catfish - Life History and Biology

Channel catfish, Ictalurus punctatus (Rafinesque), is the most important species of aquatic animal commercially cultured in the United States. It belongs to the family Ictaluridae, order Siluriformes. Members of the order Siluriformes are found in fresh and salt water worldwide. There are at least 39 species of catfish in North America, but only six have been cultured or have potential for commercial production. They are the blue catfish, Ictalurus furcatus (LeSueur); the white catfish, Ictalurus catus (Linnaeus); the black bullhead, Ictalurus melas (Rafinesque); the brown bullhead, Ictalurus nebulosus (LeSueur); the yellow bullhead, Ictalurus natalis (LeSueur); and the flathead catfish, Pylodictis olivaris (Rafinesque).

Channel catfish were originally found only in the Gulf States and the Mississippi Valley north to the prairie provinces of Canada and Mexico, but were not found in the Atlantic coastal plain or west of the Rocky Mountains. Since then channel catfish have been widely introduced throughout the United States and the world.

Physical Characteristics

Like all native North American catfish, a channel catfish has a body that is cylindrical in cross-section and lacks scales. Fins are soft-rayed except for the dorsal and pectoral fins which have sharp, hard spines that can inflict a nasty, painful wound if a catfish is handled carelessly. An adipose fin (lacking rays) is located on the back between the dorsal and caudal fins. One conspicuous characteristic of all catfish is the presence of barbels around the mouth. The barbels are arranged in a definite pattern with four under the jaw and one on each tip of the maxilla (upper jaw).

The channel catfish is the only spotted North American catfish with a deeply forked tail. There are 24-29 rays in the anal fin. They are generally olivaceous to blue on the back, shading to the off-white ventrally.

Their color, to a large extent, is dictated by the color of the water they inhabit. In clear water they may appear almost black, while in muddy water they may be a light yellow. Young channel catfish are irregularly spotted on their sides, but the spots tend to disappear in the adults.

Habitat

In natural waters channel catfish live in moderate to swiftly flowing streams, but they are also abundant in large reservoirs, lakes, ponds and some sluggish streams. They are usually found where bottoms are sand, gravel or rubble, in preference to mud bottoms. They are seldom found in dense aquatic weeds. Channel catfish are freshwater fish but they can thrive in brackish water.

Channel catfish generally prefer clear water streams, but are common and do well in muddy water. During the day they are usually found in deep holes wherever the protection of logs and rocks can be found. Most movement and feeding activity occurs at night just after sunset and just before sunrise. Young channel catfish frequently feed in shallow riffle areas while the adults seem to feed in deeper water immediately downstream from sand bars. Adults rarely move much from one area to another and are rather sedentary, while young fish tend to move about much more extensively, particularly at night when feeding.

Feeding

Feeding can occur during day or night, and they will eat a wide variety of both plant and animal material. Channel catfish usually feed near the bottom in natural waters but will take some food from the surface. Based on stomach analysis, young catfish feed primarily on aquatic insects. The adults have a much more varied diet which includes insects, snails, crawfish, green algae, aquatic plants, seeds and small fish. When available, they will feed avidly on terrestrial insects, and there are even records of birds being eaten. Fish become an important part of the diet for channel catfish larger than 18 inches total length, and in natural waters fish may constitute as much as 75 percent of their diet.

Channel catfish primarily detect food with their sense of taste. Taste buds are found over the entire external surface of catfish as well as inside the mouth, pharynx and gill arches. They are most numerous on the barbels and gill arches. In clear water, eyesight can be an important

means of finding food. However, in turbid water, taste is the primary way catfish locate food. The organ of smell (olfactory organs) may play some role, but this has not been well established. The olfactory organs are found in the nostrils (nares) which are located on top of the head just in front of the eyes.

Age and growth

Channel catfish grow best in warm water with optimum growth occurring at temperatures of about 85° F (29.4° C). With each 18° F (10° C) change in temperature there is a doubling or halving of their metabolic rate. This means that within limits, their appetite increases with increasing water temperatures or decreases with decreasing water temperatures.

In natural waters, the average size channel catfish caught by fishermen is probably less than 2 to 3 pounds, but the world record of 58 pounds was caught in Santee Cooper Reservoir, South Carolina, in 1964. The size and age that channel catfish reach in natural waters depends on many factors. Age and growth studies have shown that in many natural waters channel catfish do not reach 1 pound in size until they are 2 to 4 years old. One study in the Lake of the Ozarks, Missouri, found that channel catfish did not reach a size of 13 inches total length until they were 8 years old. The maximum age ever recorded for channel catfish is 40 years, whereas most commercially raised catfish are harvested before they are 2 years old. In production ponds, the growth rate of channel catfish is determined by water temperature; length of time held at different water temperatures; quantity and quality of food fed; palatability, or taste of food; frequency of feeding; water quality, etc. Most farm-raised catfish are harvested at a weight of 11/4 pounds at an age of about 18 months.

Water quality

Water quality preferences and limitations for wild channel catfish are not any different from those of farm-raised channel catfish. The lethal oxygen level for both wild and farm-raised catfish is about 1.0 ppm, and reduced growth occurs at oxygen concentrations of less than 4 ppm. Channel catfish, in natural waters, are no more tolerant of high levels of ammonia and nitrites than are farm-raised catfish, but are seldom exposed to lethal concentrations of either ammonia or nitrite.

Respiration

Like other animals, channel catfish need oxygen to live. They use

oxygen for energy production and to help build all the various parts of the body. However, oxygen is at most only about 25 percent as abundant in water as in the air. To get oxygen, fish must expend more energy than air-breathers. Fortunately, fish have well developed breathing organs, the gills. Although catfish live in the water, gills serve essentially the same functions as our lungs--to take oxygen from the external environment and to rid the body of toxic gaseous waste, carbon dioxide (CO_2). Water passes over the gill surface where oxygen diffuses into the blood and carbon dioxide diffuses out.

The gills of channel catfish are located on each side of the head and they are covered by a protective movable flap of skin called the gill flap or operculum. There are four gills on both sides of the head, each consisting of a double row of slender gill filaments.

These filaments are supported by a flexible white gill arch. Each side of the filament has many thin, small cross plates called lamellae. It is across the gill lamellae that the important respiratory gases are exchanged. Each gill and gill filament has a rich supply of blood vessels which carries blood from the heart to the gills and then throughout the fish. The lamellae have spaces through which blood rapidly percolates. Oxygen that is picked up at the gill lamellar surface is carried throughout the body in the blood. Waste carbon dioxide is also carried in the blood for release into the water at the lamellar surface.

A fish breathes by sucking water in through the mouth where it flows directly over the gill filaments and across the lamellae. Blood channeled through the heart has a low oxygen concentration, but at the gill lamellae surface it passes near water high in oxygen. By simple diffusion, oxygen crosses the gill surface and enters the blood where it is carried throughout the fish. Respiration of this type is called counter-current exchange. Simple diffusion of oxygen through the gill lamellae and into the blood occurs because the gill lamellae are extremely thin.

Carbon dioxide is released from fish in much the same way oxygen is taken in - by counter-current exchange. Blood high in carbon dioxide is channeled through the heart to the gills where it comes in close contact with water low in carbon dioxide. By simple diffusion, carbon dioxide is then released into the water.

Depending on the needs of the fish, the rate of breathing may be variable. Fish that are stressed or are pursued by a predator have a greater oxygen demand than fish at rest. Similarly, if the oxygen concentration in the water is low, a fish has to breathe faster if it is to meet all of its oxygen requirements. During normal respiration only about 60 percent of the gill surface is used for gas exchange. During increased respiratory demands, up to 100 percent of the gill surface may be used.

It is easy to see that any alteration in gill structure or function can be dangerous to catfish. Any increase in the thickness of the gill lamellae will decrease the efficiency of gas diffusion. If the gills become swollen or puffy oxygen and carbon dioxide transfer is decreased. Gills can become thickened following exposure to ammonia, certain vitamin deficiencies or to long-term parasite or bacterial infestations. Any type of toxic agent which damages the gill filaments or lamellae will also affect the efficiency of gas exchange. Finally, if a fish is anemic or has brown blood disease, even though the gills are not damaged and there is adequate oxygen in the water, the blood may not be able to carry enough oxygen to ensure survival.

Spawning

Channel catfish spawn when the water temperature is between 75° and 85° F (23° to 30° C) with about 80° F (27° C) being optimum. Wild populations of catfish may spawn as early as late February or as late as August depending on the location. The length and dates of the spawning season vary from year to year depending on the weather and area, but peak spawning time in Mississippi usually occurs in May.

Channel catfish are cavity spawners and will spawn only in secluded, semi-dark areas. In natural waters male catfish will build a nest in holes in the banks, undercut banks, hollow logs, log jams or rocks. It is this behavior that necessitates the use of spawning containers in order to successfully spawn channel catfish in commercial ponds

The male selects and prepares the nest by fanning out as much mud and debris as possible. He will then defend this location against any intruder until spawning is completed and the fry leave the nest. The female is attracted to the nest and spawning occurs within the nest with eggs being laid in a gelatinous mass on the bottom. After the eggs are laid, the male takes over and cares for the eggs by constantly fanning them with his fins to provide aeration and to remove waste products given off by the developing eggs.

Females spawn only once a year, producing about 3,000 to 4,000 eggs per pound of body weight, while the males may spawn more than once. In wild populations, males seldom spawn more than once a year, but in hatcheries where the eggs are removed from the spawning container soon after being laid, males may spawn 3 or 4 times; and there is a record of one male spawning nine females in one season. Channel catfish usually become sexually mature at 3 years of age, although some may spawn when 2 years old. In wild populations they may not spawn until after the age of 5 years. Channel catfish weighing as little as 3/4 of a pound may spawn if old enough, whereas farm-raised catfish usually weigh in excess of 2 pounds when they spawn. After the eggs

are laid they will usually hatch in 5 to 10 days depending on water temperature. At 78° F (26° C) the eggs will hatch in about 8 days. For each 2° F (1° C)rise in temperature above 78° F, subtract 1 day, and for each 2° F (1° C) fall in temperature below 78° F, add 1 day to get the approximate length of time required for hatching. Water temperatures below 65° F (18° C) and above 85° F (30° C) will reduce hatching success. Newly hatched fry have a large yolk sac which contains the nourishment they need for the next 2 to 5 days until they are fully developed and are ready to start feeding. After the yolk sac is absorbed, the fry take on their typical dark color and will begin to swim-up looking for food. At first swim-up, fry will gulp air to fill their swim bladders which helps them maintain and regulate their buoyancy.

Related web pages:

- A link to the National Agricultural Library providing information relating to aquaculture: http://www.nal.usda.gov/afsic/afsaqua.htm

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Commercial suppliers:

- None identified.

Electronic mailing lists:

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Periodicals:

- None identified.

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Channel Catfish - Life History and Biology

Channel catfish, Ictalurus punctatus (Rafinesque), is the most important species of aquatic animal commercially cultured in the United States. It belongs to the family Ictaluridae, order Siluriformes. Members of the order Siluriformes are found in fresh and salt water worldwide. There are at least 39 species of catfish in North America, but only six have been cultured or have potential for commercial production. They are the blue catfish, Ictalurus furcatus (LeSueur); the white catfish, Ictalurus catus (Linnaeus); the black bullhead, Ictalurus melas (Rafinesque); the brown bullhead, Ictalurus nebulosus (LeSueur); the yellow bullhead, Ictalurus natalis (LeSueur); and the flathead catfish, Pylodictis olivaris (Rafinesque).

Channel catfish were originally found only in the Gulf States and the Mississippi Valley north to the prairie provinces of Canada and Mexico, but were not found in the Atlantic coastal plain or west of the Rocky Mountains. Since then channel catfish have been widely introduced throughout the United States and the world.

Physical Characteristics

Like all native North American catfish, a channel catfish has a body that is cylindrical in cross-section and lacks scales. Fins are soft-rayed except for the dorsal and pectoral fins which have sharp, hard spines that can inflict a nasty, painful wound if a catfish is handled carelessly. An adipose fin (lacking rays) is located on the back between the dorsal and caudal fins. One conspicuous characteristic of all catfish is the presence of barbels around the mouth. The barbels are arranged in a definite pattern with four under the jaw and one on each tip of the maxilla (upper jaw).

The channel catfish is the only spotted North American catfish with a deeply forked tail. There are 24-29 rays in the anal fin. They are generally olivaceous to blue on the back, shading to the off-white ventrally.

Their color, to a large extent, is dictated by the color of the water they inhabit. In clear water they may appear almost black, while in muddy water they may be a light yellow. Young channel catfish are irregularly spotted on their sides, but the spots tend to disappear in the adults.

Habitat

In natural waters channel catfish live in moderate to swiftly flowing streams, but they are also

abundant in large reservoirs, lakes, ponds and some sluggish streams. They are usually found where bottoms are sand, gravel or rubble, in preference to mud bottoms. They are seldom found in dense aquatic weeds. Channel catfish are freshwater fish but they can thrive in brackish water.

Channel catfish generally prefer clear water streams, but are common and do well in muddy water. During the day they are usually found in deep holes wherever the protection of logs and rocks can be found. Most movement and feeding activity occurs at night just after sunset and just before sunrise. Young channel catfish frequently feed in shallow riffle areas while the adults seem to feed in deeper water immediately downstream from sand bars. Adults rarely move much from one area to another and are rather sedentary, while young fish tend to move about much more extensively, particularly at night when feeding.

Feeding

Feeding can occur during day or night, and they will eat a wide variety of both plant and animal material. Channel catfish usually feed near the bottom in natural waters but will take some food from the surface. Based on stomach analysis, young catfish feed primarily on aquatic insects. The adults have a much more varied diet which includes insects, snails, crawfish, green algae, aquatic plants, seeds and small fish. When available, they will feed avidly on terrestrial insects, and there are even records of birds being eaten. Fish become an important part of the diet for channel catfish larger than 18 inches total length, and in natural waters fish may constitute as much as 75 percent of their diet.

Channel catfish primarily detect food with their sense of taste. Taste buds are found over the entire external surface of catfish as well as inside the mouth, pharynx and gill arches. They are most numerous on the barbels and gill arches. In clear water, eyesight can be an important means of finding food. However, in turbid water, taste is the primary way catfish locate food. The organ of smell (olfactory organs) may play some role, but this has not been well established. The olfactory organs are found in the nostrils (nares) which are located on top of the head just in front of the eyes.

Age and growth

Channel catfish grow best in warm water with optimum growth occurring at temperatures of about 85° F (29.4° C). With each 18° F (10° C) change in temperature there is a doubling or halving of their metabolic rate. This means that within limits, their appetite increases with increasing water temperatures or decreases with decreasing water temperatures.

In natural waters, the average size channel catfish caught by fishermen is probably less than 2 to 3 pounds, but the world record of 58 pounds was caught in Santee Cooper Reservoir, South Carolina, in 1964. The size and age that channel catfish reach in natural waters depends on many factors. Age and growth studies have shown that in many natural waters channel catfish do not reach 1 pound in size until they are 2 to 4 years old. One study in the Lake of the Ozarks, Missouri, found that channel catfish did not reach a size of 13 inches total length until they were 8 years old. The maximum age ever recorded for channel catfish is 40 years, whereas most

commercially raised catfish are harvested before they are 2 years old. In production ponds, the growth rate of channel catfish is determined by water temperature; length of time held at different water temperatures; quantity and quality of food fed; palatability, or taste of food; frequency of feeding; water quality, etc. Most farm-raised catfish are harvested at a weight of 11/4 pounds at an age of about 18 months.

Water quality

Water quality preferences and limitations for wild channel catfish are not any different from those of farm-raised channel catfish. The lethal oxygen level for both wild and farm-raised catfish is about 1.0 ppm, and reduced growth occurs at oxygen concentrations of less than 4 ppm. Channel catfish, in natural waters, are no more tolerant of high levels of ammonia and nitrites than are farm-raised catfish, but are seldom exposed to lethal concentrations of either ammonia or nitrite.

Respiration

Like other animals, channel catfish need oxygen to live. They use oxygen for energy production and to help build all the various parts of the body. However, oxygen is at most only about 25 percent as abundant in water as in the air. To get oxygen, fish must expend more energy than air-breathers. Fortunately, fish have well developed breathing organs, the gills. Although catfish live in the water, gills serve essentially the same functions as our lungs--to take oxygen from the external environment and to rid the body of toxic gaseous waste, carbon dioxide (CO_2). Water passes over the gill surface where oxygen diffuses into the blood and carbon dioxide diffuses out.

The gills of channel catfish are located on each side of the head and they are covered by a protective movable flap of skin called the gill flap or operculum. There are four gills on both sides of the head, each consisting of a double row of slender gill filaments.

These filaments are supported by a flexible white gill arch. Each side of the filament has many thin, small cross plates called lamellae. It is across the gill lamellae that the important respiratory gases are exchanged. Each gill and gill filament has a rich supply of blood vessels which carries blood from the heart to the gills and then throughout the fish. The lamellae have spaces through which blood rapidly percolates. Oxygen that is picked up at the gill lamellar surface is carried throughout the body in the blood. Waste carbon dioxide is also carried in the blood for release into the water at the lamellar surface.

A fish breathes by sucking water in through the mouth where it flows directly over the gill filaments and across the lamellae. Blood channeled through the heart has a low oxygen concentration, but at the gill lamellae surface it passes near water high in oxygen. By simple diffusion, oxygen crosses the gill surface and enters the blood where it is carried throughout the fish. Respiration of this type is called counter-current exchange. Simple diffusion of oxygen through the gill lamellae and into the blood occurs because the gill lamellae are extremely thin.

Carbon dioxide is released from fish in much the same way oxygen is taken in - by counter-current exchange. Blood high in carbon dioxide is channeled through the heart to the gills where it comes in close contact with water low in carbon dioxide. By simple diffusion, carbon dioxide is then

released into the water.

Depending on the needs of the fish, the rate of breathing may be variable. Fish that are stressed or are pursued by a predator have a greater oxygen demand than fish at rest. Similarly, if the oxygen concentration in the water is low, a fish has to breathe faster if it is to meet all of its oxygen requirements. During normal respiration only about 60 percent of the gill surface is used for gas exchange. During increased respiratory demands, up to 100 percent of the gill surface may be used.

It is easy to see that any alteration in gill structure or function can be dangerous to catfish. Any increase in the thickness of the gill lamellae will decrease the efficiency of gas diffusion. If the gills become swollen or puffy oxygen and carbon dioxide transfer is decreased. Gills can become thickened following exposure to ammonia, certain vitamin deficiencies or to long-term parasite or bacterial infestations. Any type of toxic agent which damages the gill filaments or lamellae will also affect the efficiency of gas exchange. Finally, if a fish is anemic or has brown blood disease, even though the gills are not damaged and there is adequate oxygen in the water, the blood may not be able to carry enough oxygen to ensure survival.

Spawning

Channel catfish spawn when the water temperature is between 75° and 85° F (23° to 30° C) with about 80° F (27° C) being optimum. Wild populations of catfish may spawn as early as late February or as late as August depending on the location. The length and dates of the spawning season vary from year to year depending on the weather and area, but peak spawning time in Mississippi usually occurs in May.

Channel catfish are cavity spawners and will spawn only in secluded, semi-dark areas. In natural waters male catfish will build a nest in holes in the banks, undercut banks, hollow logs, log jams or rocks. It is this behavior that necessitates the use of spawning containers in order to successfully spawn channel catfish in commercial ponds

The male selects and prepares the nest by fanning out as much mud and debris as possible. He will then defend this location against any intruder until spawning is completed and the fry leave the nest. The female is attracted to the nest and spawning occurs within the nest with eggs being laid in a gelatinous mass on the bottom. After the eggs are laid, the male takes over and cares for the eggs by constantly fanning them with his fins to provide aeration and to remove waste products given off by the developing eggs.

Females spawn only once a year, producing about 3,000 to 4,000 eggs per pound of body weight, while the males may spawn more than once. In wild populations, males seldom spawn more than once a year, but in hatcheries where the eggs are removed from the spawning container soon after being laid, males may spawn 3 or 4 times; and there is a record of one male spawning nine females in one season. Channel catfish usually become sexually mature at 3 years of age, although some may spawn when 2 years old. In wild populations they may not spawn until after the age of 5 years. Channel catfish weighing as little as 3/4 of a pound may spawn if old enough, whereas farm-raised catfish usually weigh in excess of 2 pounds when they spawn. After the eggs are laid they will usually hatch in 5 to 10 days depending on water temperature. At 78° F (26° C) the eggs

will hatch in about 8 days. For each 2° F (1° C)rise in temperature above 78° F, subtract 1 day, and for each 2° F (1° C) fall in temperature below 78° F, add 1 day to get the approximate length of time required for hatching. Water temperatures below 65° F (18° C) and above 85° F (30° C) will reduce hatching success. Newly hatched fry have a large yolk sac which contains the nourishment they need for the next 2 to 5 days until they are fully developed and are ready to start feeding. After the yolk sac is absorbed, the fry take on their typical dark color and will begin to swim-up looking for food. At first swim-up, fry will gulp air to fill their swim bladders which helps them maintain and regulate their buoyancy.

Related web pages:

- A link to the National Agricultural Library providing information relating to aquaculture: http://www.nal.usda.gov/afsic/afsaqua.htm

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Dietary Effects on Channel Catfish

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Dietary Effects on Channel Catfish

Catfish diets must provide enough energy, protein, vitamins and minerals in the proper proportions for fast, efficient growth and health maintenance. Choosing the right feed plays an important role in determining the productivity and profitability of aquaculture operations. But, producers aren't the only people who are interested in diet quality. Certain characteristics of the diet influence the quality of catfish products during processing and storage. As a result, catfish processors, wholesale marketers and retailers also depend on proper feed quality to yield desirable results.

Effects of dietary protein

Because excess fat decreases the dress-out yield and potential shelf-life of processed catfish, questions regarding the impact of diet composition on product quality have arisen. Research projects evaluated the effects of dietary protein content on body composition of various sized catfish in different production systems.

Catfish grown in ponds

At Kentucky State University, fingerlings stocked in intensively managed ponds were fed commercial-type diets containing 34 or 38 percent protein to satiation once or twice daily. At the end of 170 days the fish weighed an average of 1 pound. Results of this experiment indicated that neither feeding frequency nor protein content of the diet within this range affected growth or important body composition characteristics such as fat content or fillet yield.

In an Auburn University study, fingerlings were fed commercial-type diets containing 26, 32 or 36 percent protein for 125 days on either a

restricted basis or to satiation. Dressing percentage increased as dietary protein was increased from 26 to 32 percent, but then decreased as protein concentration was increased to 36 percent. Whether fed on a restricted basis or to satiation, body fat decreased as the diet's protein level increased. Body fat content of fish fed to satiation was higher than those fed on a restricted basis, suggesting that feeding rate does influence important body composition variables.

Another study conducted at Auburn University measured the effects of feeding commercial-type diets containing 24,28,32,36 or 40 percent protein to fingerlings in ponds. Fingerlings were fed to an average of 1 pound in 151 days. They were fed to satiation once daily during the growing season. Dressing percentage increased as dietary protein was increased from 24 to 36 percent, but decreased when increased to 40 per-cent. Fat content in fillets decreased, while protein and moisture increased when dietary protein was increased.

These studies suggest that fillet yield may improve as dietary protein is increased up to 36 percent, and that feeding to satiation may increase body fat concentrations. However, the same studies suggest that producers can save money without sacrificing weight gain by feeding diets that contain much less than 36 percent protein. These trade-offs between economic savings and potential changes in product quality deserve further attention, especially if fat content and other body composition characteristics are proven to reduce the quality and consumer acceptance of catfish products.

Catfish grown in cages

Cage culture offers an opportunity to produce fish in ponds that may be poorly suited for conventional pond culture because of their size, depth or the presence of other fish. However, successful cage culture also provides unique management challenges to the producer.

A study conducted at Kentucky State University focused on the nu-tritional needs of fingerling channel catfish stocked in cages. Fish in cages were fed to satiation once or twice daily for 105 days with complete, commercial-type feeds containing either 34 or 38 percent protein.

Body composition of fingerlings in this study was not affected by feeding frequency or dietary protein level. Fish grew faster on the higher protein diet, and fish fed twice daily had a higher dressing percentage than those fed only once per day.

Third-year fish in ponds

Little information is available regarding how diet affects the growth or body composition of third-year fish. Studies conducted at Auburn

University and Kentucky State University measured the effects of feeding commercial-type diets containing various concentrations of protein to third-year catfish in ponds. Results of these studies indicate that, although body fat decreases when dietary protein is increased, fish growth and dressing percentage were unaffected. It remains unclear whether diets containing more than 32 percent protein improve the quality of fillets from third-year fish enough to justify the accompanying higher feed costs.

Supplementing amino acids in catfish diets

Amino acids are the building blocks of protein; they are essential for good fish growth and weight gain. Several research projects have focused on the effects of specific amino acid supplements in catfish diets. These studies were conducted with catfish fingerlings in aquaria maintained under optimum conditions.

Lysine is one of ten amino acids that must be provided by the diet; it is also the least abundant amino acid in many feedstuffs. As a result, extra care must be taken to provide enough lysine when formulating catfish diets containing a large percentage of protein from plant sources. Also, lysine supplementation above requirement levels has been shown to reduce body fat of some terrestrial animals. Researchers at Texas A&M University compared diets that contained either 25 or 30 percent protein from soy isolate or casein and gelatin, and either 0 or 0.5 percent supplemental lysine. Fingerlings fed diets with protein from casein and gelatin gained more weight than those fed diets containing soy-based protein. Also, fish fed soy-based diets contained more lipid and less protein than those fed the casein-based diet.

Supplemental lysine improved protein conversion efficiency and feed efficiency of catfish fed soy-based diets, but not of those fed casein-based diets. Fish fed a 30 percent protein soy-based diet without added lysine performed better than those fed a 25 percent protein soy-based diet with extra lysine. However, supplemental lysine did not influence body composition characteristics at any protein level.

Results suggest that both the source and concentration of dietary protein impact catfish performance, and that supplemental lysine does not influence body composition.

Carnitine is a naturally-occurring compound that animals typically produce from lysine. Some research suggests that providing supplemental carnitine in the diet increases the quality of processed animal products by reducing fat content. A study conducted at the University of Georgia compared the benefits of feeding diets that contained 0.1 percent carnitine and 1.1, 1.4 or 1.7 percent lysine. Feeding diets that included both supplemental carnitine and lysine

proved most beneficial. When carnitine was added to diets containing lysine close to or above the required dietary level (1.4 and 1.7 percent, respectively), fat content in the viscera and dark muscle tissue decreased and whole-fish protein levels increased.

Results indicate that feeding high-quality diets supplemented with carnitine may reduce body fat content.

Effects of vitamin fortification

Improved storage quality depends on management practices during grow-out, as well as procedures carried out during and after processing. Storage quality of poultry and some kinds of fish has been improved by feeding diets that increased concentrations of vitamin E in muscle tissues prior to processing. Vitamin E, and similar synthetic products, are called antioxidant because they help reduce lipid oxidation and maintain the freshness of products during storage.

Researchers at Texas A&M Univer-sity evaluated the benefits of adding synthetic and natural antioxidants to channel catfish diets. Fingerling catfish were fed experimental-type diets that satisfied all known requirements and contained one of two concentrations of vitamin E (60 or 240 mg/kg), either alone, or in combination with one of four synthetic antioxidants. None of the synthetic antioxidants affected weight gain, feed efficiency, survival or tissue composition. Fillet samples from fish receiving each diet were frozen at -10°F for six months. The TBA number, a measure of rancidity caused by oxidation, was determined for fillets to assess how stability during frozen storage was affected by diet composition. Fish fed the higher level of vitamin E had reduced TBA numbers, but synthetic antioxidants did not affect this measure of storage quality.

Fortification of catfish diets with high levels of vitamin E probably offers an effective means of maintaining fillet stability during frozen storage. Results from another study indicate that maximum benefits from vitamin E supplementation are achieved within 2 weeks of feeding a diet fortified with 1,000 mg vitamin E/kg. Feeding diets fortified with this high level of vitamin E throughout the grow-out period may be unnecessary.

Vitamin C is essential for normal fish growth and has some properties that allow food products to resist oxidation. Rutin, a compound classified as a bioflavonoid, may produce beneficial responses similar to vitamin C when available in the diet. A Texas A&M University study compared diets containing various concentrations of vitamin C and rutin. By the end of eight weeks, no differences in weight gain, feed efficiency or survival due to diet were observed. But, within 10 weeks, fish fed diets without supplemental vitamin C or rutin had developed

deformed spinal columns, external hemorrhages and eroded fins. By week 12, fish receiving supplemental rutin but no vitamin C showed the same symptoms. By the end of 16 weeks all fish that had not received supplemental vitamin C had reduced weight gain and feed efficiency and decreased survival. Rutin had no significant effect on weight gain, feed efficiency or other variables, either alone or when fed with added vitamin C.

According to this study, high concentrations of supplemental vitamin C (1,500 and 3,000 mg/kg) improved the oxidative stability of channel catfish fillets, but supplemental rutin was not beneficial.

Dietary impacts on storage quality

Studies at the University of Georgia focused on how dietary protein concentration and packaging method may affect the quality of frozen catfish fillets. Year-2 and year-3 catfish stocked in research ponds were fed diets containing 24,28,32,36 or 40 percent protein to an average harvest weight of 3.3 pounds. Upon processing, fillets were packaged using PVDC film overwrapping, vacuum packaging with Eva bags or vacuum skin packaging and stored at -10°F. Fillets were removed from frozen storage after O, 30 and 90 days for chemical analysis and sensory evaluation. Chemical analyses included pH, TBA number, ammonia and free fatty acid content. A consumer panel evaluated broiled samples for off-flavor, greasiness and texture. Although lower dietary protein increased fillet fat content, it did not directly affect TBA number, pH or sensory attributes. Sensory panelists reported that all fillets became tougher, but greasiness decreased as storage time increased. Packaging treatment did not impact the free fatty acid characteristics of fillets.

Results indicate that lower protein diets may increase the fat content of catfish fillets, but not to a degree that reduces consumer satisfaction. Also, current processing and packaging methods for catfish provide adequate quality protection for up to 3 months of frozen storage.

Another University of Georgia study evaluated the impact of dietary protein on channel catfish stored on ice. Fish were fed to an average size of 3.3 pounds on commercial-type diets containing either 24, 28, 32, 36 or 40 percent protein in production ponds. Fish were processed upon harvest, and fillets were placed on polystyrene trays overwrapped with plastic wrap and stored in drained ice chests.

Sensory and chemical evaluations of iced fillets were conducted after 1,7,14 and 21 days. Catfish fed the lowest-protein diet had more body fat than those fed higher-protein diets, but fillet fat content had no direct effects on free fatty acid content during storage. Also, dietary protein did not affect ammonia concentration, pH, TBA number or bacterial

counts of fillets stored on ice for up to 2 weeks. Sensory panelists reported that the texture of fish fed the 32 percent protein diet was superior to those fed 36 percent protein after 1 day of storage. After 1 week, fish fed 28 percent protein were more greasy than those fed the other diets, but other differences were not detected.

Results suggest that dietary protein does not influence important quality attributes of channel cat-fish fillets, and that fillets can be stored on ice for up to 2 weeks without compromising quality.

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Dietary Effects on Channel Catfish

Catfish diets must provide enough energy, protein, vitamins and minerals in the proper proportions for fast, efficient growth and health maintenance. Choosing the right feed plays an important role in determining the productivity and profitability of aquaculture operations. But, producers aren't the only people who are interested in diet quality. Certain characteristics of the diet influence the quality of catfish products during processing and storage. As a result, catfish processors, wholesale marketers and retailers also depend on proper feed quality to yield desirable results.

Effects of dietary protein

Because excess fat decreases the dress-out yield and potential shelf-life of processed catfish, questions regarding the impact of diet composition on product quality have arisen. Research projects evaluated the effects of dietary protein content on body composition of various sized catfish in different production systems.

Catfish grown in ponds

At Kentucky State University, fingerlings stocked in intensively managed ponds were fed commercial-type diets containing 34 or 38 percent protein to satiation once or twice daily. At the end of 170 days the fish weighed an average of 1 pound. Results of this experiment indicated that neither feeding frequency nor protein content of the diet within this range affected growth or important body composition characteristics such as fat content or fillet yield.

In an Auburn University study, fingerlings were fed commercial-type diets containing 26, 32 or 36 percent protein for 125 days on either a restricted basis or to satiation. Dressing percentage increased as dietary protein was increased from 26 to 32 percent, but then decreased as protein concentration was increased to 36 percent. Whether fed on a restricted basis or to satiation, body fat decreased as the diet's protein level increased. Body fat content of fish fed to satiation was higher than those fed on a restricted basis, suggesting that feeding rate does influence important body composition variables.

Another study conducted at Auburn University measured the effects of feeding commercial-type diets containing 24,28,32,36 or 40 percent protein to fingerlings in ponds. Fingerlings were fed to an average of 1 pound in 151 days. They were fed to satiation once daily during the growing season. Dressing percentage increased as dietary protein was increased from 24 to 36 percent, but decreased when increased to 40 per-cent. Fat content in fillets decreased, while protein and moisture increased when dietary protein was increased.

These studies suggest that fillet yield may improve as dietary protein is increased up to 36 percent, and that feeding to satiation may increase body fat concentrations. However, the same studies suggest that producers can save money without sacrificing weight gain by feeding diets that contain much less than 36 percent protein. These trade-offs between economic savings and potential changes in product quality deserve further attention, especially if fat content and other body composition characteristics are proven to reduce the quality and consumer acceptance of catfish products.

Catfish grown in cages

Cage culture offers an opportunity to produce fish in ponds that may be poorly suited for conventional pond culture because of their size, depth or the presence of other fish. However, successful cage culture also provides unique management challenges to the producer.

A study conducted at Kentucky State University focused on the nu-tritional needs of fingerling channel catfish stocked in cages. Fish in cages were fed to satiation once or twice daily for 105 days with complete, commercial-type feeds containing either 34 or 38 percent protein.

Body composition of fingerlings in this study was not affected by feeding frequency or dietary protein level. Fish grew faster on the higher protein diet, and fish fed twice daily had a higher dressing percentage than those fed only once per day.

Third-year fish in ponds

Little information is available regarding how diet affects the growth or body composition of third-year fish. Studies conducted at Auburn University and Kentucky State University measured the effects of feeding commercial-type diets containing various concentrations of protein to third-year catfish in ponds. Results of these studies indicate that, although body fat decreases when dietary protein is increased, fish growth and dressing percentage were unaffected. It remains unclear whether diets containing more than 32 percent protein improve the quality of fillets from third-year fish enough to justify the accompanying higher feed costs.

Supplementing amino acids in catfish diets

Amino acids are the building blocks of protein; they are essential for good fish growth and weight gain. Several research projects have focused on the effects of specific amino acid supplements in catfish diets. These studies were conducted with catfish fingerlings in aquaria maintained under optimum conditions.

Lysine is one of ten amino acids that must be provided by the diet; it is also the least abundant amino acid in many feedstuffs. As a result, extra care must be taken to provide enough lysine when formulating catfish diets containing a large percentage of protein from plant sources. Also, lysine supplementation above requirement levels has been shown to reduce body fat of some terrestrial animals. Researchers at Texas A&M University compared diets that contained either 25 or 30 percent protein from soy isolate or casein and gelatin, and either 0 or 0.5 percent supplemental lysine. Fingerlings fed diets with protein from casein and gelatin gained more weight than those

fed diets containing soy-based protein. Also, fish fed soy-based diets contained more lipid and less protein than those fed the casein-based diet.

Supplemental lysine improved protein conversion efficiency and feed efficiency of catfish fed soy-based diets, but not of those fed casein-based diets. Fish fed a 30 percent protein soy-based diet without added lysine performed better than those fed a 25 percent protein soy-based diet with extra lysine. However, supplemental lysine did not influence body composition characteristics at any protein level.

Results suggest that both the source and concentration of dietary protein impact catfish performance, and that supplemental lysine does not influence body composition.

Carnitine is a naturally-occurring compound that animals typically produce from lysine. Some research suggests that providing supplemental carnitine in the diet increases the quality of processed animal products by reducing fat content. A study conducted at the University of Georgia compared the benefits of feeding diets that contained 0.1 percent carnitine and 1.1, 1.4 or 1.7 percent lysine. Feeding diets that included both supplemental carnitine and lysine proved most beneficial. When carnitine was added to diets containing lysine close to or above the required dietary level (1.4 and 1.7 percent, respectively), fat content in the viscera and dark muscle tissue decreased and whole-fish protein levels increased.

Results indicate that feeding high-quality diets supplemented with carnitine may reduce body fat content.

Effects of vitamin fortification

Improved storage quality depends on management practices during grow-out, as well as procedures carried out during and after processing. Storage quality of poultry and some kinds of fish has been improved by feeding diets that increased concentrations of vitamin E in muscle tissues prior to processing. Vitamin E, and similar synthetic products, are called antioxidant because they help reduce lipid oxidation and maintain the freshness of products during storage.

Researchers at Texas A&M Univer-sity evaluated the benefits of adding synthetic and natural antioxidants to channel catfish diets. Fingerling catfish were fed experimental-type diets that satisfied all known requirements and contained one of two concentrations of vitamin E (60 or 240 mg/kg), either alone, or in combination with one of four synthetic antioxidants. None of the synthetic antioxidants affected weight gain, feed efficiency, survival or tissue composition. Fillet samples from fish receiving each diet were frozen at -10°F for six months. The TBA number, a measure of rancidity caused by oxidation, was determined for fillets to assess how stability during frozen storage was affected by diet composition. Fish fed the higher level of vitamin E had reduced TBA numbers, but synthetic antioxidants did not affect this measure of storage quality.

Fortification of catfish diets with high levels of vitamin E probably offers an effective means of maintaining fillet stability during frozen storage. Results from another study indicate that maximum benefits from vitamin E supplementation are achieved within 2 weeks of feeding a diet fortified with 1,000 mg vitamin E/kg. Feeding diets fortified with this high level of vitamin E throughout the grow-out period may be unnecessary.

Vitamin C is essential for normal fish growth and has some properties that allow food products to resist oxidation. Rutin, a compound classified as a bioflavonoid, may produce beneficial responses similar to vitamin C when available in the diet. A Texas A&M University study compared diets containing various concentrations of vitamin C and rutin. By the end of eight weeks, no differences in weight gain, feed efficiency or survival due to diet were observed. But, within 10 weeks, fish fed diets without supplemental vitamin C or rutin had developed deformed spinal columns, external hemorrhages and eroded fins. By week 12, fish receiving supplemental rutin but no vitamin C showed the same symptoms. By the end of 16 weeks all fish that had not received supplemental vitamin C had reduced weight gain and feed efficiency and decreased survival. Rutin had no significant effect on weight gain, feed efficiency or other variables, either alone or when fed with added vitamin C.

According to this study, high concentrations of supplemental vitamin C (1,500 and 3,000 mg/kg) improved the oxidative stability of channel catfish fillets, but supplemental rutin was not beneficial.

Dietary impacts on storage quality

Studies at the University of Georgia focused on how dietary protein concentration and packaging method may affect the quality of frozen catfish fillets. Year-2 and year-3 catfish stocked in research ponds were fed diets containing 24,28,32,36 or 40 percent protein to an average harvest weight of 3.3 pounds. Upon processing, fillets were packaged using PVDC film overwrapping, vacuum packaging with Eva bags or vacuum skin packaging and stored at -10°F. Fillets were removed from frozen storage after O, 30 and 90 days for chemical analysis and sensory evaluation. Chemical analyses included pH, TBA number, ammonia and free fatty acid content. A consumer panel evaluated broiled samples for off-flavor, greasiness and texture. Although lower dietary protein increased fillet fat content, it did not directly affect TBA number, pH or sensory attributes. Sensory panelists reported that all fillets became tougher, but greasiness decreased as storage time increased. Packaging treatment did not impact the free fatty acid characteristics of fillets.

Results indicate that lower protein diets may increase the fat content of catfish fillets, but not to a degree that reduces consumer satisfaction. Also, current processing and packaging methods for catfish provide adequate quality protection for up to 3 months of frozen storage.

Another University of Georgia study evaluated the impact of dietary protein on channel catfish stored on ice. Fish were fed to an average size of 3.3 pounds on commercial-type diets containing either 24, 28, 32, 36 or 40 percent protein in production ponds. Fish were processed upon harvest, and fillets were placed on polystyrene trays overwrapped with plastic wrap and stored in drained ice chests.

Sensory and chemical evaluations of iced fillets were conducted after 1,7,14 and 21 days. Catfish fed the lowest-protein diet had more body fat than those fed higher-protein diets, but fillet fat content had no direct effects on free fatty acid content during storage. Also, dietary protein did not affect ammonia concentration, pH, TBA number or bacterial counts of fillets stored on ice for up to 2 weeks. Sensory panelists reported that the texture of fish fed the 32 percent protein diet was superior to those fed 36 percent protein after 1 day of storage. After 1 week, fish fed 28 percent

protein were more greasy than those fed the other diets, but other differences were not detected.

Results suggest that dietary protein does not influence important quality attributes of channel cat-fish fillets, and that fillets can be stored on ice for up to 2 weeks without compromising quality.

Related web pages:

- A link to the National Agricultural Library providing information relating to aquaculture: http://www.nal.usda.gov/afsic/afsaqua.htm

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Processing Channel Catfish

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Processing Channel Catfish

Several steps must be completed in processing channel catfish into a saleable product: receiving and weighing the live fish at the processing plant; holding them alive until needed; then stunning, deheading, eviscerating, skinning, chilling, size grading, freezing or ice packing, packaging, warehousing, icing, and shipping the finished product.

Receiving

Before being purchased for processing, fish are evaluated for quality by experienced tasters. Sample fish are taken from the pond at least three times: normally 2 weeks before harvest, the day before harvest, and the day of harvest. At the pond, fish are loaded into aerated water tanks and transported to the processing facility. The fish are unloaded from the truck into baskets for weighing and then put into an aerated holding vat or directly into the plant. In most cases, fish enter the processing line directly from the trucks and are only held in tanks to keep the plant in operation when fish delivery is delayed

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Deheading

The fish are removed from holding tanks and stunned with electrical cur-rent, which makes them easier and safer to handle by workers. The fish are moved into the processing plant on a distribution conveyor belt. From the distribution conveyor, the stunned catfish drop into a holding bin for each processing line. The first line operator is the lay-up person. This operator positions each catfish in the proper orientation for the band saw operator to remove the head quickly and efficiently. The head is pushed into a chute that routes it to a waste disposal conveyor belt below the band saw, and the carcass proceeds to the evisceration

operation. A good band saw operator can process from 40 to 50 fish per minute. Automatic deheading and eviscerating machines are also being used by most processing plants. Automation does require some size grading of fish for efficient use.

Evisceration

The body cavity is opened by hand with a knife, and viscera are withdrawn by use of a vacuum eviscerator . Viscera are conveyed to the offal collector, and the viscerated carcass proceeds to the skinning operation.

Skinning

The membrane skinner has been the standard industry machine for skinning channel catfish since its introduction. This machine has a rotating roller with sharp "teeth" that present the fish to a sharp blade held in place by spring pressure. Very close tolerances between the blade and roller teeth make it possible to remove only the skin as the fish is passed over the roller. Capacity is abut 12 to 14 fish per minute per operator. Most processors use two operators per machine, so the machine capacity is 24 fish per minute.

Chilling

After deheading, eviscerating and skinning, the whole dressed fish is lightly spray washed and conveyed into the chill tank where it is immersed in a mixture of ice and water. Fish are held in the chill tank from 10 to 30 minutes at a temperature of 38° or less. Fish must be cooled rapidly and held below 40° F to attain low microorganism numbers, good flavor and maximum shelf-life, and to ensure overall quality. It is extremely important to control the microor-ganism buildup (which is directly re-lated to the shelf-life of the fish). Some processors add up to 20 parts per million of chlorine to the chill-tank water or rinse water. Water and ice are added periodically to maintain the proper water level and temperature

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Size grading

When fish exit the chill tank, they are conveyed to a sizing station where they are sorted by weight Small and some medium sized fish are usually processed as whole fish, whereas medium to large fish are typically processed as fillets or steaks. In smaller plants, grading is a hand operation; however, in larger plants some mechanical or electronic

sizing systems are used.

Product form

Catfish of the proper size are sold iced, frozen or pre-breaded in the following forms: whole fish, fillets, steaks, strips and nuggets. Size control of fillets to within 1 to 2 ounce weight increments is essential for marketing of the filleted product. Fish of the appropriate size that will yield the needed fillets are filleted by hand at filleting tables or by automatic filleting machines. The fillets are trimmed to produce the nugget, then sized and either frozen or packed in ice for shipment.

Channel catfish "steaks" are prepared by cutting size-graded fish into cross-section pieces. The steaks are then individually quick frozen or packed in ice and sold in 15-pound boxes.

Freezing

Before freezing, channel catfish products are injected with or tumbled in a polyphosphate solution which acts as an antioxidant and prevents excessive water loss during freezing.

The most important consideration in maintaining excellent quality fish in the frozen state is to insure that they are processed, frozen rapidly, and held at 1 to 10° F or below until used. The temperature of the fish must be reduced from 32° F to 15° F in 30 minutes or less to be considered quick-frozen and to retain the original quality. The channel catfish are individually quick-frozen (1° F) in a tunnel or spiral freezer. Carbon dioxide, liquid nitrogen, or conventional mechanical freezing systems are being used in various plants to freeze channel catfish. The choice of freezing media and machinery is mainly a question of economics. The fish or fish pieces are placed on the in-feed belt to the freezer so they are not touching. The variable speed belt is regulated so that the fish remain in the freeze chamber the required time and are frozen when they exit the tunnel.

Packaging Frozen

When whole frozen fish exit the freezer, they are conveyed through a water bath or sprayer. A coating of ice (glaze) is formed over the fish, which is the first step in packaging. The individual quick-frozen glazed whole fish or fillets are sized and packed in cardboard shipping cases that are lined with polyethylene bags. The whole frozen fish are divided into increments of 2 ounces each and packed into 15-pound boxes. Frozen fillets are packed in 15-pound boxes with fillets divided into lots with a 1 to 2 ounce range.

Whole iced fish are divided into the same size categories as frozen whole fish and packed in ice in 50-pound shipping boxes that contain 30 pounds of fish and 20 pounds of ice. Steaks are packed in 15-pound shipping cartons.

Frozen channel catfish are held at 0° F or below if required by state law in a frozen storage warehouse until shipped. The iced product is usually packed and shipped within 48 hours in refrigerated trucks. It is held at the processing plant in refrigerated storage at 30° F to 38° F until shipped.

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Processing Channel Catfish

Several steps must be completed in processing channel catfish into a saleable product: receiving and weighing the live fish at the processing plant; holding them alive until needed; then stunning, deheading, eviscerating, skinning, chilling, size grading, freezing or ice packing, packaging, warehousing, icing, and shipping the finished product.

Receiving

Before being purchased for processing, fish are evaluated for quality by experienced tasters. Sample fish are taken from the pond at least three times: normally 2 weeks before harvest, the day before harvest, and the day of harvest. At the pond, fish are loaded into aerated water tanks and transported to the processing facility. The fish are unloaded from the truck into baskets for weighing and then put into an aerated holding vat or directly into the plant. In most cases, fish enter the processing line directly from the trucks and are only held in tanks to keep the plant in operation when fish delivery is delayed

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Deheading

The fish are removed from holding tanks and stunned with electrical cur-rent, which makes them easier and safer to handle by workers. The fish are moved into the processing plant on a distribution conveyor belt. From the distribution conveyor, the stunned catfish drop into a holding bin for each processing line. The first line operator is the lay-up person. This operator positions each catfish in the proper orientation for the band saw operator to remove the head quickly and efficiently. The head is pushed into a chute that routes it to a waste disposal conveyor belt below the band saw, and the carcass proceeds to the evisceration operation. A good band saw operator can process from 40 to 50 fish per minute. Automatic deheading and eviscerating machines are also being used by most processing plants. Automation does require some size grading of fish for efficient use.

Evisceration

The body cavity is opened by hand with a knife, and viscera are withdrawn by use of a vacuum eviscerator . Viscera are conveyed to the offal collector, and the viscerated carcass proceeds to the skinning operation.

Skinning

The membrane skinner has been the standard industry machine for skinning channel catfish since its introduction. This machine has a rotating roller with sharp "teeth" that present the fish to a sharp blade held in place by spring pressure. Very close tolerances between the blade and roller teeth make it possible to remove only the skin as the fish is passed over the roller. Capacity is abut 12 to 14 fish per minute per operator. Most processors use two operators per machine, so the machine capacity is 24 fish per minute.

Chilling

After deheading, eviscerating and skinning, the whole dressed fish is lightly spray washed and conveyed into the chill tank where it is immersed in a mixture of ice and water. Fish are held in the chill tank from 10 to 30 minutes at a temperature of 38° or less. Fish must be cooled rapidly and held below 40° F to attain low microorganism numbers, good flavor and maximum shelf-life, and to ensure overall quality. It is extremely important to control the microor-ganism buildup (which is directly re-lated to the shelf-life of the fish). Some processors add up to 20 parts per million of chlorine to the chill-tank water or rinse water. Water and ice are added periodically to maintain the proper water level and temperature

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Size grading

When fish exit the chill tank, they are conveyed to a sizing station where they are sorted by weight Small and some medium sized fish are usually processed as whole fish, whereas medium to large fish are typically processed as fillets or steaks. In smaller plants, grading is a hand operation; however, in larger plants some mechanical or electronic sizing systems are used.

Product form

Catfish of the proper size are sold iced, frozen or pre-breaded in the following forms: whole fish, fillets, steaks, strips and nuggets. Size control of fillets to within 1 to 2 ounce weight increments is essential for marketing of the filleted product. Fish of the appropriate size that will yield the needed fillets are filleted by hand at filleting tables or by automatic filleting machines. The fillets are trimmed to produce the nugget, then sized and either frozen or packed in ice for shipment.

Channel catfish "steaks" are prepared by cutting size-graded fish into cross-section pieces. The steaks are then individually quick frozen or packed in ice and sold in 15-pound boxes.

Freezing

Before freezing, channel catfish products are injected with or tumbled in a polyphosphate solution which acts as an antioxidant and prevents excessive water loss during freezing.

The most important consideration in maintaining excellent quality fish in the frozen state is to insure that they are processed, frozen rapidly, and held at 1 to 10° F or below until used. The temperature of the fish must be reduced from 32° F to 15° F in 30 minutes or less to be considered quick-frozen and to retain the original quality. The channel catfish are individually quick-frozen (1° F) in a tunnel or spiral freezer. Carbon dioxide, liquid nitrogen, or conventional mechanical freezing systems are being used in various plants to freeze channel catfish. The choice of freezing media and machinery is mainly a question of economics. The fish or fish pieces are placed on the in-feed belt to the freezer so they are not touching. The variable speed belt is regulated so that the fish remain in the freeze chamber the required time and are frozen when they exit the tunnel.

Packaging Frozen

When whole frozen fish exit the freezer, they are conveyed through a water bath or sprayer. A coating of ice (glaze) is formed over the fish, which is the first step in packaging. The individual quick-frozen glazed whole fish or fillets are sized and packed in cardboard shipping cases that are lined with polyethylene bags. The whole frozen fish are divided into increments of 2 ounces each and packed into 15-pound boxes. Frozen fillets are packed in 15-pound boxes with fillets divided into lots with a 1 to 2 ounce range.

Whole iced fish are divided into the same size categories as frozen whole fish and packed in ice in 50-pound shipping boxes that contain 30 pounds of fish and 20 pounds of ice. Steaks are packed in 15-pound shipping cartons.

Frozen channel catfish are held at 0° F or below if required by state law in a frozen storage warehouse until shipped. The iced product is usually packed and shipped within 48 hours in refrigerated trucks. It is held at the processing plant in refrigerated storage at 30° F to 38° F until shipped.

Related web pages:

- A link to the National Agricultural Library providing information relating to aquaculture: http://www.nal.usda.gov/afsic/afsaqua.htm

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Commercial suppliers:

- None identified

Electronic mailing lists:

- None identified.

Suggested references:

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Raising Finfish

Frequently Asked Questions Other Information Sources Return to Aquaculture Contents

Frequently Asked Questions:

- History of Aquaculture in Maine

Other Information Sources:

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History of Aquaculture in Maine

Commercial finfish aquaculture began in Maine in 1970 near the midcoast town of Wiscasset. Richard Gower, Evelyn Sawyer, and Gary Towle formed Maine Salmon Farms, the first commercial salmonid pen culture operation on the east coast, and the second in the U.S. They raised rainbow trout and coho salmon in floating net pens and fed them a homemade concoction of shrimp and herring waste from a local fish-meal plant. High water temperatures during the summer and low water temperatures during the winter, particularly the superchill of 1976, were factors in the demise of their business.

Also in the 1970s, Robert Mant started Maine Sea Farms on Cape Rosier. He raised coho salmon and rainbow trout in pens that floated in the flooded pit of a former 300-foot-deep, open-pit, copper and zinc mine. In another part of Penobscot Bay in 1973-74, Spencer Fuller started a Vinalhaven-based company, Fox Island Fisheries, which was probably the first strictly marine pen salmonid operation in the Northeast. By 1975, FullerÕs company was producing 40,000 pounds of fish in Hurricane Sound. The combination of the 1976 superchill, when the seawater temperature at the site dropped to 29.5¡ F., and the low price for fish caused the company to close by 1979.

In 1981, Edward Myers, of Abandoned Farm, Inc. on the Damariscotta River, obtained the first lease from the Maine Department of Marine Resources allowing the culture of salmonids and shellfish at his site. Using 5,000 coho salmon, Myers set up pens about eight miles from the open sea. That winter, water temperatures plummeted to 28¡F. and only 150 fish survived. Myers abandoned finfish cultivation to concentrate on mussels in suspension culture.

By the early 1980s, after a team of researchers from St. Andrews (New Brunswick) Biological Station successfully raised salmon in

Passamaquoddy Bay, pen-rearing techniques were refined, and raising salmon and rainbow trout became a promising new business in Downeast Maine. In Eastport, where the decline of the local herring fisheries made salmon aquaculture a welcomed new industry, Ocean Products Inc. (OPI) was established in 1982. By 1984, the company had 12 pens holding about 63,000 fish, most of which were destined for the Boston market. Some of the fish were also smoked and sold through L.L. Bean's mail-order catalog. A second generation of sea farmers in the Eastport area came mostly from former employees of OPI, from local families formerly involved in herring fishing, or were graduates of an aquaculture training course at Washington County Vocational School. These people formed small, mostly family-run businesses in 1986-87. Their examples were soon followed by subsidiaries of large firms, some of them multinationals including Maine Coast Nordic Enterprises, Sea Farm Lubec, Atlantic Salmon Maine, and Mariculture Products, Ltd.

Currently, 18 companies along the Maine coast, from the Canadian border to Muscongus Bay in the midcoast region, raise about 14 million pounds of salmon each year. Due to declining salmon prices and competition from overseas companies in the mid-1990s, Maine fish farmers and scientists are researching nutrition and feeding methods, predator controls, and alternative species of fish for culture.

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Periodicals:

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Raising Trout

Frequently Asked Questions Other Information Sources Return to Aquaculture Contents

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- Stocking Farm Dams (Ponds) with Trout

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Stocking Farm Dams (Ponds) with Trout

Rainbow trout fry have been introduced to farm dams throughout the South-West of Western Australia for over 25 years. In most stocked dams these fry have grown and survived successfully enough to provide worthwhile fishing. However, trout need very specific water and catchment conditions to grow properly, and many smaller farm dams do not provide these conditions.

Unsuitable dams

Small excavated tank dams, usually 1000m2 (1/4 acre) or less, are generally too small for worthwhile numbers of trout. Because trout feed by sight, very muddy dams are also unsuitable, as are shallow or very clear dams which provide no protection from predatory birds. Similarly turkey nest dams and swept bank or ring dams with limited catchments are even less suitable.

Suitable dams

The best type of dam for growing trout is the creek-line or gully dam characteristic of the more undulating, higher rainfall areas of the South-West. Dams worth growing trout in may also be found further east in the drier, cleared, agricultural area near the Albany Highway, but the rainfall, catchment area and volume of these dams needs to be large enough to maintain a high water level.

High salinity levels do not usually affect trout adversely. Both rainbow and brown trout, being members of the northern hemisphere salmon family (Salmonidae), can tolerate salinity up to the level of sea water, given time to acclimatise, and often grow quite rapidly in these conditions.

Catchments are crucial

Trout are carnivorous, and eat all manner of water and land dwelling insects, crustacea and other small animals. The catchment of the gully dam has a very important influence on the production of trout by determining their food supply. Catchments of native forest or scrub do not usually make for productive fish farms. The high quality drinking water yielded by these catchments is not only generally low in salinity, it is also low in the nutrient content needed as a food base by the small aquatic animals that trout eat. Catchments that are well-grassed and fertilised for grazing pasture are usually the best for growing trout. Cattle should have a limited access lane to the dam for drinking and not be allowed to "pot-hole" the shallow margins and banks, particularly the dam wall.

New gully dams are very productive when the water covers grassed or scrub covered ground. The organic matter, in rotting away, provides the nutrient basis for aquatic food animals to multiply. This effect only lasts for one or two years, after which trout production in forest catchment dams declines very markedly.

Stocking and water fertility

The fertility of the water for producing food animals very largely determines the number of trout to stock and the size they will attain. The point to remember is that trout have enormously flexible growth rates. In one or two rich South-West dams trout nave reached 2kg at the end of their first year of life, and 3kg by two years of age. At the other extreme, in infertile or overstocked dams, fish growth may be stunted, and the trout may not reach fishing size of 30 cm in length in two years.. These trout will also have poor body condition and eating qualities.

Trout survival

The survival of young trout is influenced by two factors. If redfin perch are present, it is a waste of time to stock a dam with trout fry. Redfin multiply to large numbers, eat out the food supply and stunt in size as a consequence, and prey heavily on trout fry. Cormorants (shags) can prey heavily on young fish, too, if the dam water is bare of cover for fish. Natural aquatic weed-beds will provide some cover, but a number of underwater "islands" of logs and large rocks provide far better refuge. Place these where they will least annoy anglers! standing dead trees in the water or near the dam provide roosting spots for cormorants and should be removed or felled.

Stocking rates

For a first time stocking of a pasture catchment gully dam try a planting of 1000 rainbow trout fry per hectare (two plus acres). After 12 months the number and sizes of trout available will allow you to judge the future stocking rate. This rate can then be adjusted to produce a large number of smaller fish, or fewer, larger fish.

Spawning behaviour

To get the best fishing or production out of your stocked trout, it is important to understand the effect that spawning condition can have on your stock, and the effect this may have on the tactics you use to re-stock your dam. In Western Australia trout spawn in June. To do this they need a running stream with a gravel bed. The large yolky eggs (about 2 000 per kg of fish) are laid in holes (redds) dug by the female in the gravel and then covered by her. The eggs hatch and young fish emerge within two months. If you have a good winter creek flowing into the dam males and females, which mature at two years of age, will "run" up the creek searching for suitable gravel. If no gravel is found upstream they will then move ("escape") downstream through the spillway. If the fish can't spawn and remain in the dam, the eggs of the female are reabsorbed, but a new batch is produced in the following year. Energy requirements for producing eggs and searching for spawning grounds decrease the "condition" (fatness) and slow the growth rate of fish.

Managing restocking

In most dams the trout don't spawn so the stock of fish can be controlled easily by fishing and periodically restocking. Generally, after the fist planting of trout fry, fishing should start on, and take advantage of, the good numbers of takeable one year-old fish. Declining numbers of these fish will remain up to four years of age (rainbows don't seem to survive longer in Western Australia even if not fished). Older fish in the dam will prey to some extent on newly introduced fry so restocking every two or three years is usually best, but fishing pressure may require stocking every year. If a number of dams are available stocks can be "out of phase" so that, by, rotation, fishing on 1-2 year old fish can be continually available.

Other restocking options

Although most trout farmers find it most rewarding to fish and restock as described above, in dams where trout do spawn, their spawning behaviour gives you a number of other options for restocking your dam. The first option, particularly important for gully dams which overflow

strongly, is to screen the spillway to prevent escape downstream. Chicken wire should not be used because it blocks badly with leaves and weed. The screen should be made of vertical bars, welded to a frame with 2.5 cm (1 inch) between bars, inclined at 45 towards the top in the downstream direction. The second option is to stock 'triploid' fish. Female triploids are unfertile, though the males ripen each year. "Natural" spawning and restocking by artificially creating the right stream conditions is a third alternative, although few farmers bother with this process because of the time and uncertainty involved. To allow natural spawning, parts of the winter creek need to be widened. If natural water-rounded gravel (anything from pea to football size) is present this will allow the gravel to settle into an area suitable for the female to dig her redds. You can also import suitable gravel for a spawning bed. If natural spawning is successful the results are likely to be uncontrolled, probably annual overstocking of the dam. A fourth choice is to trap spawners by placing a fish trap on the creek, "strip" them of spawn, then return the fish to the dam. Trapping is time-consuming, and the stripping and raising young fry requires considerable expertise. The necessary hatchery facilities for raising young fish from the eggs are also expensive.

Related web pages:

- None identified.

Commercial suppliers:

- None identified.

Electronic mailing lists:

- None identified.

Suggested references:

- None identified.

Periodicals:

- None identified.

This page was last updated on November 15, 2002

Frequently Asked Questions:

- Stocking Farm Dams (Ponds) with Trout

Other Information Sources:

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Warning:

The information contained in these web pages has not been verified for correctness. Some of the information contained herein is hearsay and may not be correct. Use the information from these pages only at your own risk!

Stocking Farm Dams (Ponds) with Trout

Rainbow trout fry have been introduced to farm dams throughout the South-West of Western Australia for over 25 years. In most stocked dams these fry have grown and survived successfully enough to provide worthwhile fishing. However, trout need very specific water and catchment conditions to grow properly, and many smaller farm dams do not provide these conditions.

Unsuitable dams

Small excavated tank dams, usually 1000m2 (1/4 acre) or less, are generally too small for worthwhile numbers of trout. Because trout feed by sight, very muddy dams are also unsuitable, as are shallow or very clear dams which provide no protection from predatory birds. Similarly turkey nest dams and swept bank or ring dams with limited catchments are even less suitable.

Suitable dams

The best type of dam for growing trout is the creek-line or gully dam characteristic of the more undulating, higher rainfall areas of the South-West. Dams worth growing trout in may also be found further east in the drier, cleared, agricultural area near the Albany Highway, but the rainfall, catchment area and volume of these dams needs to be large enough to maintain a high water level.

High salinity levels do not usually affect trout adversely. Both rainbow and brown trout, being members of the northern hemisphere salmon family (Salmonidae), can tolerate salinity up to the level of sea water, given time to acclimatise, and often grow quite rapidly in these conditions.

Catchments are crucial

Trout are carnivorous, and eat all manner of water and land dwelling insects, crustacea and other small animals. The catchment of the gully dam has a very important influence on the production of trout by determining their food supply. Catchments of native forest or scrub do not usually make for productive fish farms. The high quality drinking water yielded by these catchments is not only generally low in salinity, it is also low in the nutrient content needed as a food base by the small aquatic animals that trout eat. Catchments that are well-grassed and fertilised for grazing pasture are usually the best for growing trout. Cattle should have a limited access lane to the dam for drinking and not be allowed to "pot-hole" the shallow margins and banks, particularly the dam wall.

New gully dams are very productive when the water covers grassed or scrub covered ground. The

organic matter, in rotting away, provides the nutrient basis for aquatic food animals to multiply. This effect only lasts for one or two years, after which trout production in forest catchment dams declines very markedly.

Stocking and water fertility

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