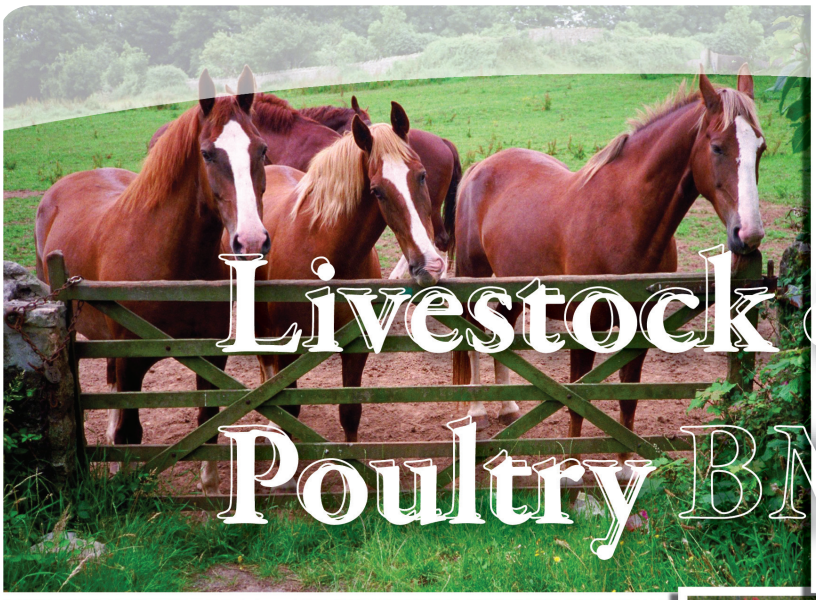
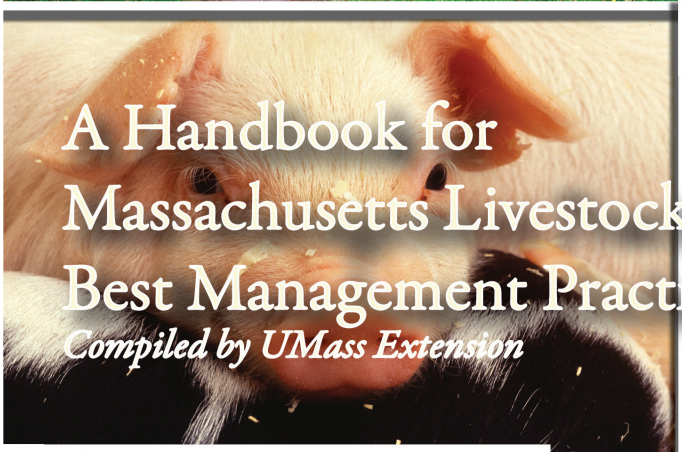


Livestock & Poultry BMPs



A Handbook for Massachusetts Livestock & Poultry Best Management Practices

Compiled by UMass Extension

Massachusetts Department of Agricultural Resources

UMassAmherst Outreach UMass Extension

Massachusetts

January 5, 2009

Dear Massachusetts Agriculturalist:

Welcome to the 2009 Edition of the Massachusetts Best Management Practices Handbook for livestock and poultry production (except dairy farms). This publication is the result of a joint project involving the Massachusetts Department of Agricultural Resources, the Massachusetts Farm Bureau Federation, and UMass Extension programs at the University of Massachusetts, Amherst.

Best Management Practices (BMP) are an industry-driven effort to maintain agricultural production in a profitable, environmentally-sensitive and sustainable manner. BMPs are not meant to be regulatory, as every farm operation and site is different and may require special practices. But BMPs are meant to provide guidance as to practices that can be implemented on *most* Massachusetts livestock and poultry operations.

BMPs are an evolving tool to provide producers with the latest guidance to benefit their operation. They will change, and be updated, as practices and technology change. We hope that you will use this manual as a resource, and guidance in the complicated decision-making process that you follow every day on your farm.

Best wishes for a successful growing season!

Sincerely,

Douglas W. Petersen, Commissioner
MA Department of Agricultural Resources

Alex P. Dowse, President
MA Farm Bureau Federation, Inc.

Nancy Garrabrants, Director
UMass Extension

Livestock & Poultry BMPs

A Handbook for Livestock and Poultry Best Management Practices

This handbook is a cooperative publication of the Massachusetts Farm Bureau Federation, University of Massachusetts Extension, and the Massachusetts Department of Agricultural Resources.

First edition published, December, 2008.

Please direct requests for copies and inquiries to:

Massachusetts Farm Bureau Federation
466 Chestnut Street
Ashland, MA 01721

Project Participants:

UMass Authors:
Stephen Herbert
Masoud Hashemi
Sarah Weis
Jacqueline Carlevale
Kenneth Miller
Carrie Chickering-Sears
Randall Prostak
Zachary Zenk
Katie Campbell-Nelson

Reviewed by:
Douglas Gillespie
Robert Borawski
Thomas Cross
John Paine
Matthew Parsons
LA Pomeroy

Massachusetts Department of Agricultural Resources

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Massachusetts

Livestock, Poultry, Equine Advisory Committee

Dear Committee Member:

Thank you for your willingness to participate in the **Livestock, Poultry, and Equine Advisory Committee**. The Crops, Dairy, Livestock, Equine team of UMass Extension has generated about 50 BMP fact sheets which must be reviewed by the advisory committee.

I am planning for a two-hour meeting (11:30 – 1:30) at the **UMass Crops and Animal Research and Education Center Farm** in South Deerfield. Please let me know if you are available on the following dates:

Tuesday, September 23

Wednesday, September 24

Thursday, September 25

I shall be grateful if you reply to this e-mail by Thursday September 18th. Many thanks,

Masoud Hashemi

Livestock and Poultry BMP Handbook

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Housing and Working Facilities for Sheep

Introduction:

Sheep can acclimate to stiff weather conditions with no shelter if they have access to forage, water and protection from the wind. It is recommended that housing be available when lambing occurs during the winter months. Housing usually improves the number of live lambs per ewe. During the summer months, shelter is generally not required although some breeds will seek shade to be protected from the heat.

Housing facilities for sheep do not need to be elaborate or expensive. Old sheds and barns can be excellent housing and usually can be easily renovated to improve the management of the operation. There are many alternatives other than the typical barn for shelter such as calf hutches, fabric structures, and easy built inexpensive sheds. The most important features of any structure are that they provide easy management, enable wet and wind free conditions and good ventilation.

Structures should provide:
-easy management
- shelter from inclement weather
- good ventilation

Space requirements:

Space requirements for sheep accommodations must be calculated to determine how many sheep can be housed in a given area. Feeder space, handling space (i.e. for shearing), as well as floor space for pens, should be considered in developing the design. One advantage of having multiple numbers of pens is being able to separate the nutritional needs of each group of sheep. Ewes and lambs should not be in the lambing pen for more than 5 days, therefore pens may be needed depending on the number of ewes. Generally, a maximum of six ewes per lambing pen is recommended. The number of ewes paired with single or multiple lambs should be considered so that they may be placed in separate pens with appropriate rations. The recommended pen space for various management groups in the flock is:

- Ewes for flushing - 10 to 14 sq. ft/head
- Ewes with lambs - 16 to 20 sq. ft/pair
- Weaned lambs (market lambs or replacements) - 8 to 10 sq. ft/head
- Lambing pens - 16 sq. ft/pen
- Rams (180-300 lb.) - 20-30 sq. ft/head
- Feeder Space - 9 to 20 inches/head depending on size, shorn or unshorn, breed, pregnancy and the number of times fed per day
- Creep feeder – 8 to12 inches/opening/lamb

Sheep respond very poorly to crowded conditions. Provide enough space per sheep in a given area.

Reference: Sheep Housing Design Criteria (PSU 92), James W. Hilton, Penn State College of Agriculture Sciences and Cooperative Extension

Considerations when planning:

When planning the design for housing following behavior instincts of sheep should be taken into consideration to enable safe handling and moving and limits needed labor. Some of these are:

- Sheep do not like to be enclosed in a tight environment.
- Sheep prefer to move from a darkened area towards a lighter area.
- Sheep prefer to move to flat areas.
- Sheep prefer to move in the facilities in a consistent direction.
- Sheep will stop forward movement when they see sheep moving in the opposite direction.
- Sheep will move faster through a long, narrow pen or area rather than through a square pen.
- Sheep will move more willingly toward an open area than toward what looks like a dead end.

Housing designs:

The Pennsylvania State College of Agricultural Sciences, Cooperative Extension has a full listing of plans for sheep housing and portable shelters, in addition to plans for fencing, feeders, and other management equipment. These plans are of a historical nature but they do offer useful designs and provide ideas for adopting existing barns and sheds to a sheep operation. It is useful to note the location of the feed racks and feed room, the creep feeding area and the lambing pens in a housing area. These particular locations will help lessen the labor needed to manage the flock. It is also important to contact the appropriate building inspector in the region to be sure that the structures being built meet the required building standards, safety codes and qualifies for all the necessary permits. Talking to an experienced builder or contractor can help ensure that the facility and equipment of the building is suitable for the cost, relevant to the size and intensity of the operation. Access to the web site for these plans is:
http://www.abe.psu.edu/extension/ip/IP725-24.pdf

Resources:

Alton, Ian and McCutcheon, Bill. 2002. Evaluating Farm Resources and Sheep Production System. Ontario Sheep Marketing Association

http://www.public.iastate.edu/~mwps_dis/mwps_web/sh_plans.html

http://www.sheepandgoat.com/housing.html

For more information visit www.umass.edu/cdl

Factsheets in this series were prepared by Stephen Herbert, Masoud Hashemi, Carrie Chickering-Sears, and Sarah Weis in collaboration with Ken Miller, Jacqui Carlevale, Katie Campbell-Nelson, and Zack Zenk.

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Rabbit Housing

Introduction:

Make plans for housing before you purchase your rabbits. Housing can be a cage in the garage, a hutch in the backyard or a special building with cages for a number of animals.

The first step is to decide how many rabbits you want to raise and for what purpose. Check with local rabbit breeders to find out about the different breeds and market for rabbits.

Consider climate, conditions, use, and cost when deciding on your housing.

Best Management Practices:

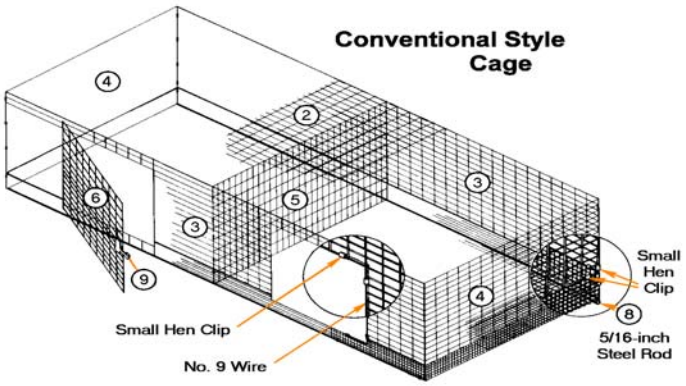
Once you decide what use that you are going to raise your rabbits for then it is time to start mapping out the housing requirements. The best homemade rabbit cages are built of welded wire. Wire cages are more durable than wooden cages and are less expensive in the long run. Wire cages reduce the incidence of disease because they are easier to clean and disinfect. Wood is not recommended for cage construction since rabbits gnaw on wood. It absorbs water and urine, making good sanitation more difficult. If you do use wood, avoid treated wood because it may be harmful.

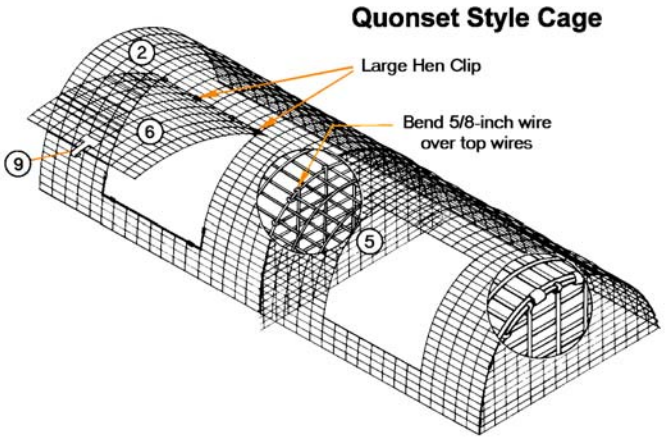
Clean cages with one cup of chlorine bleach in a gallon of water. A clean cage and equipment help to prevent diseases.

The basic cage used in most rabbitries is 30" deep x 36" long x 18" high.
Most have rectangular sides (conventional style), but some have rounded tops (quonset style). Doors may be hinged at the top, sides or bottom.

The size of the cage varies with the size of the breed:

- Small breeds – 24"x24"x16" cage (ie. American Fuzzy Lop, Mini Lop or Rex, Dutch, or Netherland Dwarf)
- Medium breeds – 30"x30"x18" cage (ie. Rex, English or French Angora, or American Sable)
- Large breeds – 48"x30"x18" (ie. Flemish Giant, New Zealand, or Checkered Giant)





Materials needed:

Conventional
1 pc. 36x78-in wire
1 pc. 30x72-in wire
2 pc. 15x72-in wire
2 pc. 15x30-in wire
1 pc. 18x30-in wire
2 pc. 16x18-in wire
---
2 pc. 72-in sections of 5/16-in steel rod for floor
2 door latches

Quonset
1 pc. 36x78-in wire
1 pc. 48x72-in wire
---
2 pc. 18x30-in wire
1 pc. 21x30-in wire
2 pc. 18x20-in wire
3 pc. No. 12 gal. wire
2 pc. 72-in sections of 5/16-in steel rod for floor
2 door latches

Fasteners:
(common to both styles)
100 small hen-cage clips
25 large hen-cage clips
30 No. 101 hog rings
2 pc. 24-in No. 9 galvanized wire

The floor is made of 16-gauge welded wire with ½x½ or ½x1-inch grid openings.

CONSTRUCTION:

These cages are most easily constructed in units of two cages. Lay out the floor first by removing a 3x3-inch section from each corner of the flooring. Bend up a 3-inch section along each side of the floor. Secure the floor sides together using small hen-cage clips to prevent young bunnies from falling from the cage. Attach the steel rods to the front and rear edges of the floor using hog rings. The partition and ends of the quonset cage are best shaped using a pattern. Allow a 5/8-inch section of the wires to extend beyond the pattern. Bend these wires around a No. 12 edging wire. Position the ends and partition on the floor and fasten them using small hen-cage clips. Attach the front and back sides of the conventional cages to the bent-up flooring. Do not fasten the front section to flooring in the area where the doors will be located. Fasten sides to the partition and ends. Lay the top of the quonset cages over the floor, ends and partition. Fasten to the front and rear of the flooring using small hen-cage clips spaced every five inches. Raise the center partition and fasten to the top. Repeat the process with each end section. Cut the door openings in the front side of each cage. Each opening should be 2-inches smaller than the doors in height and width. File all sharp protruding wires. Attach the doors using large hen cage clips as hinges. Attach the No. 9 wire around the door openings using the large-size clips. Install the door latch to complete the cage. The cages can be suspended from an overhead support using six strands of No. 12 galvanized wire. Attach a wire to each corner of the individual cages for proper support.

Detailed housing plans for rabbits can be found at the Mississippi State
Extension link at
http://www.msstate.edu/dept/poultry/rab-6360a.pdf

Basic Equipment

Water Containers – ceramic crocks, bottle-tube waterers and automatic waterers are all good for use in your rabbit cage. Key is that rabbits need clean, fresh water at all times.

Grain Containers – metal self feeder with a screened bottom. Can be purchased at livestock supply companies or your local grain store.

Nest Box – Provide a nest boxes for does before they give birth.

You can make ten kindling boxes from a single 4' x 8' sheet of 3/4" plywood. Be sure you have the means to transport a sheet of plywood home before starting this project! But, to make things easier, this cutting layout allows for the sheet to be cut into two 4' x 4' pieces

You need the following tools: an electric rotary saw, a screwdriver or drill (recommended) with both screwdriver bit and regular bit just smaller than the screws you will use, a hammer, and pliers. A table saw is handy for making some of the cuts, but is not necessary. You will also need 120 screws (we used #10, 1-3/4", but other sizes will work), fence staples, and 1/2" x 1" (or 1/2" x 1/2") metal wire mesh. You may need some sandpaper if you have rough edges.

The next part goes a little easier with a partner. Set up two side pieces parallel to each other about ten inches apart with the solid 16" edge on the bottom. Place the back against the taller two edges with the 8" edge vertical and the 10" edge along the bottom and forming the top edge of the back . Using two screws per side, securely screw the back onto the sides. We found it was a lot easier to pre-drill before screwing the pieces together. (Note, if your pieces aren't cut exactly perfectly, don't worry, just make sure to line up the top edges so that the top piece fits--the mesh bottom is more forgiving.) Next, screw on the front piece to the shorter two edges of the nest box sides. Use two screws per side. Pre-drill for the screw holes. Now place the top on the higher edges of the sides and attach with four screws, pre-drilling for ease of assembly.

Bottom Mesh - Cut ten pieces of metal mesh 9-1/2" x 16". Use fence stables every three or four inches to attach the bottom to the nest box. Voila! You are finished.

Consideration:

Does and bucks should not be kept in the same cage. The only time should be during breeding season. The doe is taken to the buck's cage for mating. The doe is left long enough for the mating to occur. Remate the doe in 8 to 12 hours to increase litter size and conception rate. A mature buck may be mated to one or two does daily and serve a total of 10 to 20 does.

Additional Information on Rabbit Housing:

- Mississippi State University Extension Service, Rabbit Housing Plans,
Website:
http://msucares.com/livestock/small_animal/plans.html
2007.

Rabbit Equipment- Superior Rabbits and Equipment, Superior, WI. Phone: Toll free 866-292-7118 Email suprarabbit4@aol.com
Website: http://www.superiorrabbits.com/

For more information visit www.umass.edu/cdl

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Housing and Working Facilities for Goats

Introduction:

Goats by nature are very tolerant of all kinds of weather and can adapt to many different styles of housing, some of which can be simple and inexpensive. Despite their hardiness, when goats are under extreme wet and drafty conditions for long periods of time they are vulnerable to respiratory infection and hypothermia. For that reason ideal housing should keep goats dry and protected from such conditions. Goats usually seek cover from rain, snowy conditions, and hot sunny weather. Their production of meat and milk is not effected when the temperature is between 0 and 55° F. The most important time for housing, however, is during winter months when the does are kidding. Choosing ideal housing depends on the purpose of the goat operation; whether it is for meat, milk, or fiber, or just to enjoy having a goat.

The two principal categories for housing design are **open housing** and **confinement housing**. Open housing, or loose housing, allow goats to have protection from weather conditions while giving them open access to pasture. Confinement housing contains the goats totally within the structure and often includes a separate area for exercise which is outside and adjacent to the building. Any system should have the ability to separate groups of animals such as milking does, dry (non-lactating) does, newborn kids, growing kids, and bucks. Whichever type of housing used it is vital to know all the rules and regulations with respect to location, design, and type of operation. Also, appropriate building permits should be obtained. Speaking with an experienced builder or contractor can help to ensure the facility and equipment of the building is suitable for the cost; considering the size and intensity of the operation.

Many already existing structures can be turned into housing for goats provided they meet density, age and breed requirements.

Best Management Practices:

Open Housing

Open sided structures or sheds for loose housing are appropriate for goats in most conditions and provide a more natural environment for the animal. There are many types of structures used for open housing such as three-sided pole barns, framed sheds, and many types of movable or temporary structures such as calf-hutches or hoop greenhouses.

Advantages	Disadvantages
Less expensive to build.	More bedding is usually required.
Easier access to machinery for manure removal.	Boss goats can be a problem due to their ability to intermingle freely with other goats.
Freedom of movement allows for weight gain from exercise.	
Excellent air circulation and quality.	

Recommendations

- To minimize draft, the open portion of the structure should face the south, or away from prevailing winds. In extreme weather conditions the open side can be made smaller, provided the number of goats does not limit the required space in the enclosure.
- Creating a bedded pack by adding more bedding on top of the existing bedding reduces the frequency of manure removal. A bedded pack can stay dry and warm but it is important to clean out periodically. Wet bedding can cause formation of harmful gases, odors, bacteria, parasites, and worms.

- Adding clean gravel over dirt floors helps keep bedding drier. Use at least four inches of bedding material on a sloped gravel floor when starting a bedded pack.
- The required floor space for the bedded area in lose or open housing should be at least 10 – 15 sq. ft. per mature goat. An additional 25 sq. ft. should be provided per goat for exercise either in or outside of the structure. Separate pens for kidding should provide a minimum of 4 ft. by 5 ft. bedded area.
- The area for water and feeding troughs should be separate from the bedded area to prevent contamination of the feed from fecal material which can be a source of parasites.

Simple and Inexpensive Open Housing

Photo: John. C. Porter, Extension Professor and Dairy Specialist, UNH Cooperative Extension

Confinement Housing

Existing old barns and buildings can be easily renovated for excellent goat housing. Management of the herd and maintenance of the building is usually more complex but sometimes easier than with an open housing system.

Advantages
Improved conditions from inclement weather for humans
More supervised management
Less bedding is used
Easier access in order to handle individual animals

Disadvantages
New construction is expensive
Animals need to be turned out to exercise
Frequent removal of spoiled bedding
Ventilation system needed and checked frequently

Recommendations

- An outdoor lot is not an absolute requirement but it is beneficial to have a separate space for exercise, which should provide a minimum of 25-sq. ft. per animal.
- Having good ventilation is essential. Inadequate air exchange can cause respiratory problems from an accumulation of respiration gases, volatile gases from manure, dust, and mold from excessive moisture. There are many different designs for ventilation for both cold housing and warm housing. Primary types of ventilation are natural ventilation, a mechanical system, or both. (See resources section below)
- Walls and ceiling must be free of condensation. Install proper insulation and ventilation up to code. Sunlight coming through south facing windows provides a source of Vitamin D for the goats and helps with drying and warmth in the winter. During summer months the windows can be removed to help increase air exchange. Recommended window space is one to two feet for each goat being housed.
- Goats in confinement barns require 15-sq. ft. per animal if in pens. Individual stalls should be at least six-sq. ft. and equipped with feeders and water.
- Free-stall and tie-stall housing, similar to the types used in bovine dairy operations, are designed for goats. (See resources section below)

Confinement housing

Photos: John. C. Porter, Extension Professor and Dairy Specialist, UNH Cooperative Extension

Resources:

The Pennsylvania State College of Agricultural Sciences, Cooperative Extension has a full listing of plans for goat housing, feeders, and other management equipment including milking parlors. These plans are of a historical nature but do offer useful designs and ideas for adapting existing barns and sheds to a goat operation. This resource can be found at http://www.cas.psu.edu/

http://www.age.psu.edu/extension/ip/IP728-26.pdf

Although related to bovine dairy facilities, this article provides good information on natural ventilation systems. It can be accessed at

http://www.age.psu.edu/extension/ip/IP728-26.pdf

For more information visit www.umass.edu/cdl

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Poultry Housing

Introduction:

Chickens are easy to keep practically anywhere provided they have access to several essentials such as fresh air, food, water, space, and protection from harsh weather and predators. There are three main questions you must address prior to building a coop which will help orient your design. What breed will you raise? What stage will you start; eggs, chicks, or mature? And finally, will you have a portable (free ranged flock) or fixed housing? The style of housing you build greatly depends on these three factors. Don't forget to check building requirements in your area. For small-scale production, coops can easily be fashioned from already existing buildings, or from other rather inexpensive materials. The coops can be as simple or as elaborate as you desire. Talk with people in your community who have chickens; they are probably happy to share their knowledge with you. Also, begin with a design that has already proven to be effective.

Most losses of chicken are due to predation. Design with this in mind. Secure any openings and lock chickens up at night.

Best Management Practices:

Housing Facilities for Mature Poultry

- Build the coop on high, well-drained area.
- Face the front of the coop, all windows, and run (if incorporating one) to the south.
- Have doors opening inward.
- Use sliding windows so birds cannot roost.
- Use building materials that are easy to clean, and will not rot quickly.
- Slope the floor toward the door to prevent puddling.
- Lay pallets, or some kind of covering, in muddy areas.
- Lock up chickens at night to prevent theft.

Portable Coops vs. Permanent Coops

A portable coop is a coop that has a bottomless floor and is moved as needed either by hand (skids are incorporated into the design) or by a tractor (the term "chicken tractor" is used), allowing chickens to forage for their food and take in fresh air. The coops are dragged around to new areas of grass depending on how destructive your chickens are to the grass, how much manure is produced, and the size of the coop. This design is highly recommended for broiler chickens and not for hens. If you are going to be raising hens and would like them to range, a nesting unit will have to be built. Depending on your climate, careful detail to insulation is needed in both extreme hot and cold conditions.

Proper ventilation will help to ensure healthy birds.

A permanent coop on the other hand is ideal if you have limited space, a large operations, or limited time for management. Benefits of building a fixed house are mainly due to the versatility in choosing building materials that are sturdier. A larger house can be built to accommodate harsh weather conditions, more chickens, and ensure easement of chores. The size of the house can be increased and added amenities like electricity can be supplied. If there is a desire to range the chickens, make sure to provide clean and new range as the old one becomes messy. Proper ventilation and insulation must be provided. Larger houses sometimes mean more openings for potential threat from predators; take this into consideration when designing the coop.

Overall design goals of a portable coop:

- Easy to move.
- Does not harm chickens when moved.
- Withstands high winds.
- Protects from predators and harsh weather.
- Low maintenance cost.
- Enables chores to be done proficiently.
- Sustains the needs of growing birds.

Overall design goals of a permanent coop:

- Insulated efficiently.
- Potential openings are tightly secured to prevent predation.
- Proper ventilation provided.
- House is sturdy enough to sustain inclement weather.
- Adequate space provided.
- Sustains the needs of growing birds.

The following are general requirements for all coops:

Adequate Space

Birds need an ample amount of space for exercising, nesting, and roosting. Cramped conditions lead to disease. If chickens are kept inside, they need more space, if kept outside, they need less space. Overall, approximately 2-10 sq ft. of space per bird is needed; the exact space requirements are determined by the type of bird raised.

Nesting Boxes

Chickens need their privacy when laying their eggs. Wouldn't you? Incorporate nests boxes in a separate area away from others. One box for every four birds is enough; they will share and sometimes even lay in the cozy corner not utilizing the boxes. The dimensions should be slightly larger than your birds. A slanted roof (to deter buildup of manure) should be placed over the nest boxes to ensure comfort and privacy to the birds.

Roosts

Practically anything can be turned into a roost, where the animal can sleep. Some of the best roosts are large sticks laid across the coop. Another example is an old step ladder, which provides several resting places. Manure will build up around roosts. A pan with wire mesh may be placed underneath to catch feces, allowing for quick manure clean up and less smell.

Walls

Most people use a wood frame construction. Experimenting with different materials can lead to unstable coops. Vertical 2 by 4 studs are sufficient with some type of sheathing, either planks or plywood attached on the outside. If not constructed tightly enough, the walls should be insulated depending on the climate.

Floors

The media used for flooring is a matter of preference. Place soft bedding, such as wood shavings, on top of flooring to lessen strain on chicken's feet. Provide a scratching area to ease the cleanup of manure and decrease smell.

Dirt- is cheap and easy, but difficult to remove manure. If the soil is not permeable, it will turn into mud, creating a muddy mess that will harbor pathogens and bacteria. Prior to implanting a dirt floor, perform a test. Dig a small hole in your chosen site, add water and see what happens. If the water does not permeate through the soil, then a dirt floor is not your best option.

Wood- can be bought or salvaged from the dump, provided it is in good condition and not treated with chemicals. 1-2'' thick of wood should be sufficient. Joists are needed for underneath the planks to support the wood. The wood will eventually rot.

Concrete-is a great choice for a permanent coop. It is easy to clean, impervious to rodents, and acts as a barrier to cleaver predators. Concrete is the most expensive and requires the most effort.

Predators

Use common sense when building your coop. Place locks and heavy, tight wire fencing around the coop. Keep poultry confined with a covered fence. Any openings, such as a window or door, should have heavy-gauge mesh wiring. Predators are sneaky and intelligent animals that have no problem squeezing through any small opening. Automatic, battery powered doors have been shown to be very effective as well as time saving. A timer may also be incorporated with this system.

Outside runs- protect your birds by burying a mesh wire fence at least 12'' into the ground. This will impede predators from digging under the fence. An electric fence may be place around the coop and run to ensure more protection. Eliminate attacks from avian species, such as hawks and other birds-of-prey alike by avoiding perches, such as window sills, and covering runs with mesh wire or netting

Fresh Water and Food

Waters and feeders, if not foraging, should be placed throughout the facility. On warm days, place water outside to avoid increased moisture inside the coop. Make sure the water containers are oriented in a way that the birds will not defecate in them and make a mess. The height of food and water containers should not be lower than the birds' back.

Let There Be Light

If raising egg layers, make sure there is adequate light all year round. Windows should be placed on the south side of the coop. This will ensure proper ventilation in the summer months and light and warmth during the winter months. Lights should be installed to maximize production. Hens require at least 15 hours of "daylight", and will usually lay one egg every 25 hours. Hens exposed to decreased hours of light will go into a molt and quit laying.

Weather Control

High Winds- Build portable housing close to the ground, with sturdy enforcements and tie-downs. The tie-downs in particular will secure the frame of the house. This is a very important preventative measure to employ.

Heat- As mentioned before, windows, cupolas, and insulation should be installed. Fans may also be of use, if in the means of your budget.

Cold- Insulation should be installed and possible electric heaters if your climate permits.

Ventilation

Proper ventilation ensures fresh air to the birds. Chickens are unable to sweat; they start to pant like a dog around 95 degrees F. They give off moisture, heat, and carbon dioxide as they breathe, and as manure mixes with litter, more moisture and ammonia are released. If levels of moisture and ammonia build-up, airborne pathogens are released, causing health problems. To increase air flow, windows should be installed along the south or east side, away from prevailing winds. Well ventilated coops must also have appropriate insulation to prevent moisture accumulation on the walls and ceiling. When installing windows, make sure there are no flat surfaces for the birds to sit on, for they will defecate there.

Resources:

Auburn University
http://www.aces.edu/poultryventilation/

Automatic Doors
http://www.chicken-house.co.uk

Banks, Stuart. 1979. *The Complete Handbook of Poultry-Keeping*. Van Nostrand Reinhold Company. N.Y.

Clauer, Phillip J. "Small Scale Poultry Housing". Virginia Tech Cooperative Extension.
www.ext.vt.edu/pubs/poultry/factsheets/10.html

www.downthelane.net

Plamondon, Robert. "Range Poultry Housing". Appropriate Technology Transfer for Rural Areas.
http://www.attra.org/attra-pub/PDF/poulthous.pdf

http://www.poultryconnection.com/

This link is not updated but does have excellent references to specific housing plans.
http://www.poultryhelp.com/link-housing.html

Rossier, Jay. 2002. *Living with Chickens: Everything You Need to Know to Raise Your Own Backyard Flock.* The Lyons Press, CT.

University of Minnesota. "Small-Scale Poultry Housing.".http://www.ansci.umn.edu/poultry/resources/housing_small-scale.htm

For more information visit www.umass.edu/cdl

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Bedding Options for Livestock and Equine

A comfortable and clean animal is happy, healthy, and fully producing.

Introduction:

In general, bedding for an animal must be comfortable, clean, and absorbent. There are several materials, both organic and inert, that may be used for bedding, and most may be used for all types of livestock. When organic materials are used, ammonia volatilization is reduced, improving the air in the housing facility. Bedding, as with other aspects of livestock management, can be manageable through proper care and attention. In the case of milking, pregnant, nursing, or very young livestock, specific attention to bedding is required. These four categories of animals are the most susceptible to disease. With milking animals, because the udders are in such close contact with the bedding, environmental pathogens, mainly ones that cause mastitis are of major concern. Comfort is another crucial aspect of bedding because discomfort of an animal leads to sores and other ailments. The breed and age of animal, housing, flooring, and population density will dictate the type and amount of bedding needed. For example the foaling season is especially important with equine.

Considerations in choosing bedding:

Labor- How time consuming is the overall management (obtaining the material, dispersing it into areas of use, cleaning, and disposal).
Availability- How feasible is it to obtain material? Are there other uses for the bedding material and will that play a factor into the economics of that specific material? Evaluate source of material to ensure cleanliness.
Expense- Buy bedding at the most economical time, in a particular season, at harvest time or, in the case of sawdust, during the mills busiest period. Purchasing a year's supply of bedding may be economical given a proper storage facility is available.
Manure management system- Does the material chosen fit into your current manure system? If not, can alteration be made to either the system or material chosen? Wood products can create a problem for waste management especially in the case of composting because of their high carbon to nitrogen (C: N) ration.

Type of Use- Consider the situation under which the bedding will be utilized. Is the bedding going to be used for normal day-to-day bedding, bedding for milking or pregnant animals, or for mothers with new born animals?

Five Bedding Characteristics:
Know bedding limitations in order to efficiently and effectively manage it.

Develop an environment that simulates the animal's natural habitat.

Comfort-Materials should contribute to the overall comfort of the animal by providing a dry, cushioned place which encourages resting. A well rested animal will increase its overall productivity.

Moisture Content-Organic matter has better moisture absorption capacity than inorganic material. Moisture directly increases the level of microbial activity in the bedding, leading to harmful levels of environmental pathogens. Moist materials also adhere to animals making the cleaning of the animal more difficult, especially in the case of animals with coarse hair. Turning bedding improves ventilation and can reduce moisture.

Cleanliness- Materials should always remain free of any chemicals, sharp objects, molds, dust, and excess moisture. Clean soiled bedding areas at first sign of trouble.

Inert-Ideally, bedding should not sustain bacterial growth, but organic matter such as straw, wood shavings, and paper byproducts do. Materials should not be palatable to animals. Increased changing of bedding is needed if organic materials are incorporated.

Particle Size-Is a much-overlooked aspect of bedding, but probably the most effective if used properly. Organic matter of smaller particle size will encourage bacterial growth, thus shortening the effectiveness of the bedding materials. Comfort becomes a factor when using inorganic substances such as sand. Large sand particles can cause discomfort and sometimes create wounds, though finer sand can be used successfully. Very fine particles such as sawdust will stick to the skin and teat ends exposing them to higher concentrations of bacteria.

Types of Bedding:

Straw- This soft, dry by-product of small grains is commonly used. It is easy to handle, carbonaceous for a compost pile, and readily available in most areas. Ensure that the straw is not palatable. Mainly check to see that seed is not available for consumption. It has good absorbency.

Hay- Is cut and dried legumes and/or grasses. Most commonly used for feed, poorer quality may be used for bedding purposes. Ensure that the quality is not palatable so animal(s) will not consume it. Never use old hay, as it may give off dust that could result in respiratory damage. Hay is one of the more expensive beddings. It is quite absorbent and once soiled, begins to decompose quickly producing an odor.

Wood Shavings- Have proven to be satisfactory bedding providing comfort and ample absorbency. Shavings must be purchased, so setting up an account with a reputable lumber yard may prove to be economical. When dealing with any outfit it is extremely important to specify its use and make sure it is clean. Be cautious as to the type of wood; some woods, like cherry, can be toxic.

Wood chips- This product is a mixture of bark, sawdust, and post peelings. Wood chips may require less repeated additions, and may be cheaper. However, they provide fairly poor comfort and absorbency. Availability may be an issue. Wood chips create a highly damp environment generating mold and mildew, which promote microbial growth. If showing animals, using wood chips is not advised because when moist, color is emitted and may stain the coat of the animals.

Sawdust- Employment is dependent on availability. As new technologies arise, wood byproducts like sawdust are being utilized for other products such as pellets for stoves. It is recommended that the sawdust be kiln-dried to ensure cleanliness and absorbability. Cleaning is fairly easy with this highly absorbent material because soiled spots tend to clump making the disposal easier. When working with sawdust, more attention must be given to the health aspect. Particularly in the case of dairying livestock, the small particles of sawdust tend stick with great ease to udders, encouraging the growth of mastitis causing bacteria.

Sand- This inert material harbors less microbial growth than most organic materials. Sand probably would get a golden star for comfort. Due to its nature, an animal's body is able to conform directly to the material, allowing for an excellent place to rest. Be cautious of the particle size as large particles may cause bruising and abrasions on animals. Although sand is comfortable, it does not absorb well, causing problems of excrement build up on the floor. The disposal of soiled sand has proven to be a great task.

Newspaper- Is abundantly available in some areas, is cost competitive with traditional bedding materials, suitable for all livestock, highly absorbent, long lasting, sterile, dust and weed-free, rapidly decomposes in soil, and is easily incorporated into a manure management system. On an environmental level, utilizing newspaper allows for reduction of landfill space and farm land that would have been used to grow a crop for bedding. Obtaining newspaper may be done by purchasing it ready-made or from a source, such as a recycling center, where the farmer would then need to process it themselves. According to several University of Wisconsin studies, chopped newspaper contains the same, if not slightly less, populations of environmental pathogens, compared to other organic materials. It is recommended that the back third of the stall be cleaned thoroughly every 24 hours, if not more frequently, depending on overall stall conditions. There is no real risk of toxic contamination from the newspaper to animal. The use of heavy contaminants, such as lead, has been significantly reduced since 1985. There have been no known cases of milk or meat contamination from newspaper, although additional research could be required to address this issue. With that said, inquire from the source in which the newspaper is obtained about the type of ink used.

Other-Because bedding is usually a byproduct of a particular industry, check with local industries to see if their byproduct is a safe alternative to the current bedding used. You may want to consult both a veterinarian and livestock professional prior to implementation. Examples of alternative sources

include but are not limited to: corn stubble, cardboard, peanut hulls, and tobacco stems.

Manage Bedding:

Storage
In order to gain the most out of bedding, store it in a dry place, preferably above ground level. This will also help to ensure that your bedding is free of mold, dust, and excess moisture.

Applying and Grooming
Change bedding frequently to decrease bacteria levels. The most heavily contaminated areas are located at the front of the stalls, where the teats most often come in contact. These areas should receive the most attention when cleaning and changing bedding. Although frequent changing of bedding may seem costly, in the long run it will greatly help to decrease bacterial growth.

Alley Cleaning
Concerning lowering bacterial counts, proper care of alley ways is very important. Alley way bacterial counts are attributed to contaminated bedding and therefore care should be given to changing bedding. Keep bedding away from potential messy areas, such as feeding and watering. Keep a manure pile outside of the housing facility, as such piles harbor parasites and flies.

Concentration of Animals
The greater the number of animals you have in a given space, the greater the traffic in and out of stalls, and the more quickly bedding is contaminated with manure, moisture, and bacteria.

Bacteria Levels
Ventilation, barn design, frequent bedding changing/cleaning, proper stall management, as well as weather, influence bacteria levels and the prevalence of environmental mastitis and other illnesses. Bedding materials, especially those that are organic materials, are hosts for environmental pathogens. Because they are in close proximity to udders, bedding materials are considered a substantial source of teat-end exposure to such pathogens. Any bedding material, even sand, if it's not properly managed, can support the growth of harmful microorganisms. Liming may help to increase the pH, killing off acid loving bacteria. Applying dolomitic or pulverized, not agricultural lime which can be harmful to the animals, after a stall has been completely cleaned, will help control bacteria.

Equipment
The processing of bedding materials can be done on the farm using equipment which the farmer already uses, for example, forage harvesters, bale choppers, and tub grinders. Alterations may be needed based on the material and volume needed. Some other common machines, like a wood chipper, can be less expensive and generate more volume in a short period of time, proving more appropriate for smaller farm operations.

Specific Requirements for Livestock:

Goats and Sheep
Sheep and goats do not respond well to treatment, if they become ill, they usually have a very difficult time recovering and often expire. (Gillespie p 541) Therefore, keep your goats and sheep as clean as possible. Specific bedding is dependent on the flooring type. Concrete floors must have ample bedding to supply a comfortable, non-slip resting place. Other floorings, such as wood, require use of highly absorbent materials like wood shaving to prevent urine soaking into the wood. Most types of bedding are appropriate for both sheep and goats. In the concern of coat cleanliness, particularly for sheep, small particle bedding, such as sawdust, is not recommended.

Pigs
These meat producing animals do not require much bedding. Their housing is simple, either indoors or outdoors. With indoor facilities, slatted floors are often used to allow manure to fall through into a catchment, where the manure is then handled as a liquid. This type of system allows for minimal introduction of parasites via manure. Some bedding is used in indoor pens, especially with farrowing pigs. No bedding is required in confinement housing if slotted floors are used.

Pigs emit a lot of moisture, to help expel this, allow for good ventilation and frequent changing of bedding. If kept during the winter, allow for ample comfortable and warming bedding, for pigs do not tolerate cold temperatures well.

Beef Cows
Comfort is a crucial aspect when providing bedding for cows. Because these animals are so large, a soft cushioned material is needed to provide easing of the impact of dropping to the ground. Cow discomfort can lead to ailments such as sore feet, rubbed necks, and swollen hocks. Straw has traditionally been the most commonly used form of bedding for cows. But, with an every growing market of materials, newspaper and sand seem to be the most popular. Two main factors will affect bedding choice. First, the facility in which the cows are housed will influence the type and longevity of bedding and second, the current manure handling system.

Poultry
Materials such as ground corn cobs, chopped straw,

wood shavings, sawdust, or other previously mentioned bedding types may be used. A deep litter system is commonly exercised; four to eight inches. Stir and add litter as needed to prevent compaction and increase ventilation, although your poultry may already take care of this if you feed scratch on top of the litter pile to allow aeration.

Nesting- nesting materials should be observed on a daily basis. Never allow bedding to become caked over or saturated.

TIP: To avoid unnecessary build up of manure, place either a platform or boxed-in pit underneath the roosting area. Remove as needed.

Horses

Horses may not always lie down to sleep, but that does not mean that bedding requirements are treated differently. With horses, many of the previously mentioned materials may be used, although some are more applicable than others. Sawdust, for example, tends to clog in the hooves, causing irritation or removal of moisture. The most commonly used bedding is wood shavings. Pay attention to the area underneath the feet of horses. These large animals need a cushioned surface to alleviate the stress on their joints. If solid floors are used in areas where horses stand the most, then ample bedding or a rubber mat should be provided to supply the horses with a soft and durable surface. The amount of bedding needed is contingent upon the weight of the horse, type of material, and time of year, and floor surface. The average 12 X 12 stall will require two to four bales of clean fresh bedding per week.

Mucking Out- Begin by scraping the top of the bedding for soiled areas. Place all soiled bedding in a designated pile. Continue to sieve through the bedding because heavier wet bedding will fall to the bottom.

It is recommended that after the initial soiled bedding is removed; the top unsoiled layer of bedding is pushed to one side, allowing all bedding underneath to be exposed. Scoop up all remaining bedding that is wet, usually all, and place in a muck pile. Continue this process until the whole area is clean. At this point, the entire bottom layer of bedding should be removed and lime may be applied, just as you would for livestock. Cover with original top layer of bedding and apply new bedding as needed.

CAUTION: If using bedding derived from wood, make sure it does not contain either oak, which causes hooves to heat up or walnut, which contains toxins that cause allergic reactions in horses.

A Few Tips:

-If using an organic material, especially those derived from wood, kiln dried is preferred over green.

-Never exchange bedding between pens of a newly introduced group of animals and animals already on the farm.

-Facilities that are used for gestating animals should be fully cleaned and new bedding replaced often.

-If using a heat source, be very careful not to allow heat to get too close to bedding, since some bedding such as straw, can be highly flammable.

Resources:

ATTRA-

A whole farm management check list can be accessed at: <http://attra.ncat.org/attra-pub/PDF/ruminantcheck.pdf#xml=http://search.ncat.org/texis/search/pdfhi.txt?query=bedding&pr=ATTRAv2&prox=page&rorder=500&rprox=500&rdfreq=500&rwfreq=500&rlead=500&rdepth=0&sufs=0&order=r&cq=&id=48b282f07>

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Price, Steven D, et al.1993. The Whole Horse Catalog. New York: Simon & Shuster.

Welcome, Frank. April 2003.“Cow comfort and health through bedding management”. The Manager. <www.dairybusiness.com/northeast/April03/F3%20p26,27,28%20edding%20manage.pdf>

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UMassAmherst Outreach UMass Extension

Basics for Livestock Fencing

Introduction:

The most effective and long lasting fences are planned with correct layout and built with appropriate material and construction. The cost of a properly built fence often returns its value in a short time. It is most important to be aware of any regulations and zoning ordinances that pertain to the type of fence being built. When fences are built near property borders it is essential to know the exact location of the boundary lines.

Types of Fencing:

Physical Barriers

Physical fencing is typically for long term use, so plan the location carefully before building. It consists of enough material, which is sufficiently strong enough to prevent and discourage animals from breaking through. This type of fencing is recommended in areas where animals will be crowded, easily excited, or in areas where you expect to introduce animals not accustomed to being fenced.

Advantages

- If properly constructed, a physical fence requires low maintenance, has a long life span, and is able to withstand severe weather and seasonal conditions.
- Physical barriers can be aesthetic in appearance while providing protection to the animal and holding up against possible damage by the animal. These fences will also reduce the potential liability of property damage or personal injury caused by animals.

Use durable materials to build a fence. The cost of the fence will often return its value in a short period of time.

Disadvantages

- Physical fencing can be more expensive than other types of fencing and often require more labor for construction. They are difficult to relocate, and when damaged they take more time to repair.

Recommendations

There is a vast flexibility of materials for physical fences such as: mesh wire, with many different designs, knots and tensile strength; boards, which can be made from many materials in addition to wood for strength, visibility and appearance; barbed (not for equine) or smooth wire, also with many tensile strengths, durability and visibility and can be electrified or not; treated or untreated posts of various materials and strength; and a variety of accessories. Fencing supplies are continuously improving as new technologies arise. These materials are often less expensive and have more durability and longevity compared to conventional materials. A fence supplier can often offer valuable information regarding the material best suited for the particular fence. Particular materials of fencing may be more suitable to certain species of animals. For example, barbed wire is never recommended for equine. Instead, smooth, such as an electric fence.

Psychological Barriers

Psychological fencing, which is most often an electric fence, is effective by causing a degree of pain to the animal creating reluctance in the animal to approach the fence in the future. The animal is trained to be aware of boundaries in the confined area. Unlike physical fences, psychological fences do require a certain amount of training for the animal, but once an animal has become “fence wise” they are often set for life.

Electric fencing can be used as a permanent fence but is often used for temporary fencing such as when the fence needs to be relocated from leased property or for rotational grazing management.

Advantages

- Electric fences can be considerably less expensive than physical fences, are easier to construct, and relocate.
- Electric fencing is more adaptable to rugged terrain. It can further provide effectiveness when used in combination with physical fences acting as a further barrier from impacts from the animals. Electric fencing is also highly advantageous in prohibiting predators.

Disadvantages

- Electric fencing usually requires more maintenance than physical fences. However, with a proper gauge of hi-tensile wire, the use of compression springs allowing the fence to endure impacts, and well constructed corners and supports; an electric fence can be as low maintenance and last as long as a physical fence.

Recommendations

- Every electric fence needs an energizer. Seek assistance from a fence supplier or fence owner when selecting for a proper energizer. Energizers vary greatly in quality, electrical output, and expense. An inexpensive energizer may incur more cost from the added expenses resulting from failures.
- Energizers require: a suitable electrical output (known as joules), low-residence or low-impedance, proper electrical grounding, and some form of a lightening diverter. A poorly grounded energizer is the most likely reason for electric output failure.
- Solar and battery powered energizers are available when an electrical power source is not. These alternative systems can be limited in relation to electrical output, so it is very important to take into consideration the size of the fence when using these energizers.
- Such as with physical fences, there are lots of different materials which fit the specific use of the fence. This is especially true with temporary fences. Due to the large variety of products available it is highly recommended to speak with an experienced fence supplier in order to determine the appropriate type of fencing.

Best Management Practices:

No two situations are the same when choosing the most suitable type of fence. To prevent damage or loss of animals related to fence failure, plan and build for the worst situation, keeping in mind that animals that are panicked, breeding, or newly weaned are apt to pressure a fence. Hungry animals are likely to confront the effectiveness of a fence. This is especially true with thirsty animals.

Sheep and goats – A good perimeter fence is recommended, especially with sheep, primarily to prevent problems with predators. It is most important to maintain a good electric charge in the system. This is particularly true with sheep because they have heavy wool which insulates them from electrical shock. Because sheep and goats are short in stature, wires must be close to the ground and need to be cleared of vegetation so as to reduce grounding and maintain a good electric charge in the system. Sheep and goats are also of lighter weight than other livestock and do not have as good a contact to the ground so the electrical shock can be limited. Specialized electrified netting materials have been proven very effective for sheep and goats.

Cattle – These larger animals adjust easily to electric fencing and do not need as many wires or wires low to the ground as smaller animals. The age of the animal dictates the number of wires that is best for the fence. It should be noted that when bulls are present the fence should be in good condition. A single wire can be suitable with well trained animals. An electric conducted plastic twine, commonly known as polywire, is easy to erect and remove and is excellent for rotational grazing.

Horses – Are fast moving animals and need a more visible fence than other animals. Electrified tape is more visible than polywire. Horses are also very sensitive to electric shock and can be unpredictable. It is important, therefore, when selecting a fence to take into account that horses can become entangled in the wire and become injured. Speak with a fence expert, particularly one who is familiar with horses.

Others-There are many fencing products specifically designed for animals such as alpaca, llama, and rabbits. Check with your local 4-H club or farmer's supply about fencing for these animals.

Resources:

For all livestock

Forage Utilization for Pasture-Based Livestock Production - Natural Resource, Agricultural, and Engineering Service (Check the NRAES Web Site, WWW.NRAES.ORG, for availability.)

Virginia State University Extension Cooperative has several publications. They can be accessed at:

http://www.ext.vt.edu/pubs/bse/442-132/442-132.html

http://www.ext.vt.edu/pubs/bse/442-131/442-131.html

http://esc.rutgers.edu/

http://pubs.cas.psu.edu/freepubs/pdfs/ub037.pdf

http://www.livestocktrail.uiuc.edu/horsenet/paperDisplay.cfm?ContentID=6727

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For sheep and goats

http://www.sheep101.info/201/fencing.html

http://www.sheepandgoat.com

For horses

Information is available through links and articles at:

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Basics for Livestock and Equine Nutrition

Introduction:

Ruminants are animals whose digestive system contains fermenting microbes that help to digest forage.

The most important aspect in keeping livestock healthy and able to produce is a proper nutritious diet. Cattle belong to a class of animals called ruminants. This group also includes sheep and goats. Ruminants have a digestive system which allows them to efficiently digest and absorb most of their nutrients from forages. There are four compartments in the beginning of the digestive tract, one of which is called the rumen that contains near 50 gals of fluid and ingested forage. The rumen has a large population of microbes, mainly bacteria and some protozoa, which allows for the degradation of the fibrous material in forage. Much of the initial digestion of feed is done by microbes in the rumen. Sheep and goats are also ruminants, but the initial digestive tract compartments are of different proportions and configuration than cattle. They are often referred to as "small ruminants". The horse is a non-ruminant herbivore. These animals do not have a multi-compartmented stomach as cattle do, but are able to consume and digest forage. The cecum and colon, parts of the large intestine, serve the somewhat same purpose for the horse that the rumen does for the cow. Llamas and alpacas are "pseudo-ruminants" because they have three continuous compartments in the fore digestive tract instead of four like ruminants. Swine utilize different types of feed than ruminants, due to the differences in their digestive systems. Swine are monogastrics, meaning they only have one stomach which is similar to that of humans. Usually grains are the main part of a swine's diet. They can eat a portion of their diet from pasture, although the forage from the pasture needs to be of high quality. The diet for livestock is usually referred to as a ration and a balanced ration is the amount of feed that will supply the proper type and proportions of nutrients needed for an animal to perform a specific purpose.

The Six Basic Components of a Ration:

Components of a Ration
Water
Protein
Energy
Fiber
Minerals
Vitamins

Water - Water is often over looked but is the most critical component of any ration. It is essential in allowing most of the physiological functions in the body. Water has been a difficult nutrient to determine the actual requirement for many livestock primarily because water is usually provided free of choice. When water is limited in a ration, the dry matter intake is reduced and the correct amount of nutrients for the animal is restricted.

Protein – Protein is needed for the structuring of muscles, skin, hair and internal organs and is the only food source of nitrogen. Crude protein is the total protein content of a feed. Since proteins contain 16% nitrogen on average, knowing the total amount of nitrogen will determine an approximate amount of protein in the feed. Proteins are composed of amino acids and each protein has a variety of the 22 amino acids in different quantities. Many amino acids are synthesized in the body, but there are eight amino acids that are not synthesized and need to be provided in the ration. These are called essential amino acids. The digestion and absorption of amino acids and nitrogen is different in each species of livestock.

Energy - Energy allows the animal to do physical work. It also provides the ability to grow, lactate, reproduce, and enable other physiological functions such as feed digestion. Energy is not actually a nutrient but a total caloric value of a feed. There are several chemical, mechanical, and mathematical methods to determine feed energy values.

Some of these are called digestible energy, metabolizable energy, net energy, and total digestible nutrients. A total digestible nutrient (TDN) is the energy value most commonly used in simple rations. Each ingredient in a ration has a different digestible energy value and of those values there is a different amount of energy that is metabolized and used in the body**.**

Fiber –Crude fiber is an estimate of structural carbohydrates found in plants and grains. It has a varying amount of digestible material from high to low in cellulose and lignin respectively. Fiber limits the energy value of plants for monogastrics such as pigs, but the microbes in the digestive tracts of the other livestock species mentioned above are capable of utilizing the fiber which provides energy in the ration. Fiber also provides the necessary bulk in the digestive tract and regulates the time of passage of food. This helps to maintain a population of microorganisms which are critical for healthy digestion.

Minerals - Minerals are very much needed for the physiology of structure, metabolic and immune functions in the animal. There are two classifications of minerals. Macro minerals (calcium, phosphorous, sodium, chlorine, magnesium, potassium, and sulfur) are those that are required in the most amounts in a ration compared to minor minerals (iron, copper, molybdenum, manganese, zinc, cobalt, iodine, and selenium, and others) which are needed in less amounts.

Vitamins - Vitamins are similar to minerals in that they take part in many physiological functions, including coenzymes for metabolic functions and antioxidants, which are compounds that help prevent damage to cells. Vitamins are grouped into two categories, fat soluble and water soluble. Many of the important vitamins for forage eating animals are either synthesized by microbes in the digestive system, obtained from sunlight, or are stored in the liver. Many of those vitamins that are not made in the animal are easily provided in adequate amounts in the forage.

The Basics for Livestock Rations:

Every ration will be different depending on species, age, size and weight, gender, stage of reproduction, demands for production or work, and environment. The proper formulation of rations for livestock is dictated by appropriate nutrient requirements for each type of animal under a variety of conditions. The National Academy Press publishes a series of tables about nutrient requirements for livestock. The National Research Council (NRC) compiles the data for these publications which can be purchased or read online from the web site listed below. In addition to knowing the nutrient requirements, it is also necessary to know the nutrient composition of each feedstuff per ration. While the book value forage analysis is good information to compose a proper ration, when possible it is best to sample the individual feedstuff used and have it analyzed. The greatest variation between the book value and the actual value is in forages. Certified forage analyzing laboratories are in the listing of The National Forage Testing Association lists.

Resources:

Nation Academy Press can be accessed at: http://www.nap.edu/topics.php?topic=276

For a list of forage analyzing laboratories go to National Forage Testing Association at: www.foragetesting.org

For more information visit www.umass.edu/cdl

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UMassAmherst Outreach UMass Extension

Sheep Shearing

Introduction:

Nearly all sheep require shearing. Sheep do not have the continuous growing and shedding cycles of many animals. The fleece that keeps the animal warm in winter becomes uncomfortably hot in summer, also tangled and dirty, holding manure, burrs, and other materials the sheep comes into contact with. Spring is the most common season for shearing sheep, though sheep may be sheared at any time as long as there is enough wool to keep the animal warm in winter. Sheep may be sheared before lambing, as the wool quality of the lactating ewes (after lambing) may be reduced. However, timing may be such that the weather is too cold for the shorn animals. Fall shearing may work well, too, if done early enough that the fleece has time to grow for the winter. Timing will, of course, vary according to housing facilities and climate. If sheep are sheared more than once a year, the fibers will be shorter, but the fleece may be cleaner, a bonus if the wool quality is not important. Longer fibers result in higher quality yarn. Note that there are a few "hair sheep" bred for meat or milk that do not require shearing.

Nearly all sheep need to be sheared.

Best Management Practices:

Learning to shear

1. Watch the person who does your shearing. Ask questions.
2. Attend a demonstration at a local farm. These may be found by contacting a local sheep breeders or sheep producers association (See "Massachusetts Sources of Information" below). Your veterinarian may also have information about shearing demonstrations in your neighborhood.
3. Attend a shearing school. These are held in various locations, and are often supported by state Agricultural Extension Services in conjunction with sheep associations. Maine has such a program www.umext.maine.edu/events/wool08/school.htm as does New York www.ansci.cornell.edu/sheep/calendar/shearingschool.html . Shearing schools tend to assume some level of experience, so be sure to find out in advance how your skill level fits into a program of interest. Sometimes agricultural fairs have shearing demonstrations.
4. It is not recommended to attempt shearing alone without having some experience or an experienced helper. Your first goal should be to obtain the fleece without damaging the animal (or yourself). A professional shearer can shear a sheep in a few minutes. A novice may take half an hour. A sheep may be able to cooperate for the short time an experienced shearer may take, but not as long a time as a novice may take.
5. If you've never seen a sheep sheared, watch a video or look at photos www.ansci.cornell.edu/sheep/managesment/wool/shearing/shear.htm to give you an idea of what to expect.

Learn shearing from watching a pro, attending a demonstration or a shearing school.

Finding a shearer

There are professionals who travel around a region shearing sheep. Check the "Sources of Information" below for suggestions on finding a local shearer. It may be difficult to find a professional shearer if you have only a few sheep. A professional can shear 10-20 sheep an hour, so the time cost of transportation may be excessive relative to the value of the work. If you have only a few sheep it may be possible to form a group with nearby sheep owners and contract shearing for the group. Alternatively you can learn to do your own shearing.

Resources:

Cornell Sheep Program . www.ansci.cornell.edu/sheep

Massachusetts 4-H at www.mass4h.org has a sheep program. Young shearers may be interested in shearing a few sheep with a novice owner/shearer.

Neary, Mike, Extension Sheep Specialist at Purdue University. 1995. Be Nice to Your Sheep Shearer in: The Working Border Collie, Inc. May/June 1995.

Pioneer Valley Sheep Breeders' Association at www.pvsba.com
Shawn Thayer, Secretary
160 Bryant Rd
Cummington, MA 01026

State Universities in states with substantial commercial sheep production may have shearing information on their websites. Some of this information may be of interest to those with the smaller flocks of sheep that are more common to New England.

The Dorset Sheep Group at the University of Massachusetts Amherst www.umass.edu/vasci/undergrad/clubs/sheep.htm

The Massachusetts Sheep and Woolcraft Fair at www.masheepwool.org The fair includes shearing demonstrations and is held annually at the Cummington Fairgrounds in Cummington, MA.

Worcester County Sheep Producers Association at www.worcestersheep.com . Their website may not have been updated for some time, but it does have many useful resource listings, including names of wool processors and local-to-Massachusetts shearers, which are still current.

Sheep shearers:

www.Sheepusa.org has listings of shearers. Listings are by state, so check surrounding states if you don't come up with someone local.

For more information visit www.umass.edu/cdl

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UMassAmherst Outreach UMass Extension

Goat Shearing

Introduction:

Goats may be kept for milk, meat, or fiber (or a combination thereof). Both Angora and Cashmere goats are raised for fiber, but differ in both fiber qualities and methods of fiber harvest. Angora goats produce mohair. Fiber from non-Angora goats is Cashmere. Note that rabbits, not Angora goats, produce Angora fiber.

Mohair is produced by Angora goats. Cashmere is produced by non-Angora goats. Fibers and shearing techniques differ for the two.

Best Management Practices:

Angora Goats

Angora goats produce mohair. Most animals produce a relatively coarse outer coat and a finer undercoat. The overcoat will shed rain and the undercoat will provide insulation. Undercoats generally grow in for winter warmth and are shed in the spring. The undercoat provides finer quality fibers. The two types of fiber must be separated at some point in the processing of the fleece. The undercoat dominates, so that relatively little coarse hair will be included in a fleece. However, consideration of the outer, coarser, guard hairs must be included in the overall shearing plan for Angoras. To facilitate fiber sorting, animals with less outer hair may be shorn separately from those with more outer "guard" hair.

Shearing Angora goats

Angora goats are generally sheared twice a year.

1. Unlike sheep, Angora goats are generally sheared twice a year, once in spring before kidding, and once in fall prior to the breeding season. Exact time of shearing will depend on climate and availability of shelter for shorn animals.
2. Undesirable fibers must be separated from the mohair to obtain a high quality product. These are kemp (hollow, short, coarse (itchy) fibers), and medulated fibers which are also coarser than mohair and are hollow or partially hollow. The amount of kemp and medulated fiber varies by individual and age of animal. Young goats tend to have least kemp and older males the most. It is recommended to shear animals with the highest quality fleece first so bundles contain consistent quality fleece.
3. The Texas A&M University website http://sanangelo.tamu.edu/Angora/ provides detailed instructions for shearing Angora goats.

Cashmere producing goats

Cashmere comes from the fine underdown produced to varying degree by goats other than Angoras. Cashmere is a finer fiber than mohair. Cashmere production is what defines a Cashmere goat; there is no specific "Cashmere" breed as there is an Angora breed. Most goats produce so little Cashmere as to be commercially insignificant. A productive Cashmere goat may yield 400-500 grams of fiber per year, as little as a tenth of which can be the finer underdown, Cashmere. Cashmere is defined by fiber dimension as being less than 19 microns in diameter and at least 1.25 inches long. Some degree of crimping is desirable, though grading is subjective. Harvesting of Cashmere is quite different from harvesting mohair. Because the coarser guard hairs predominate in a Cashmere goat, the separation of the Cashmere from the guard hair is a highly significant element in Cashmere "harvest".

Cashmere is either sheared or "combed out" once a year at winter's end.

Shearing Cashmere goats

1. Cashmere shearing is not as difficult as shearing sheep. Cashmere goats do tend to be more high strung than Angora goats, and thus more difficult to handle than Angora.

2. Cashmere goats produce significant guard hair as well as the finer Cashmere. Generally less than 20% of total fiber production is Cashmere, though this percentage is quite variable according to individual. The guard hairs, the majority of the fleece, will need to be separated from the Cashmere during processing.
3. Cashmere begins growth around the summer solstice, stops growth around the winter solstice, and is shed in late winter to early spring. Shearing should be done before the animals shed naturally, and can be done as soon as temperatures are warm enough that the goats do not suffer from cold. Climate and level of shelter provided determines timing of shearing.
4. For only a few Cashmere goats, try combing out the Cashmere instead of shearing. An advantage to this method is that you will have fewer coarse guard hairs to sort from the fine Cashmere fibers. A disadvantage is that combing will only be effective when the hairs are beginning to loosen naturally, some Cashmere will already have been lost to shedding.

General Shearing tips

1. A clean animal is much easier to shear than is a dirty animal.
2. It is essential that the goat be dry for shearing.
3. Clipping is easier than shearing, especially for a novice.
4. Avoid cutting the same area twice as maximizing fiber length results in higher quality yarn.

Finding a Shearer:
The fiber goat business in Massachusetts is not large and is confined to relatively small herds. If not doing your own shearing, try looking for a sheep shearer (see below).

Resources:

Drummand, Susan. 2005. *Angora Goats the Northern Way* 5th edition.

Massachusetts 4-H at www.mass4h.org has a goat program. There is also a goat camp held at the Cummington Fairgrounds in Cummington, MA. A contact for Massachusetts 4H information is:
Carrie Chickering-Sears
Director of Community Education in Animal Agriculture
University of Massachusetts Amherst Veterinary & Animal Science Dept.
111 North Maple Street
Hadley, MA 01035
Phone: 413-549-3257
ccsears@umext.umass.edu

More general information about raising goats may be found in the Mass Agriculture in the Classroom winter 2006 newsletter at:
http://www.umass.edu/umext/mac/Newsletters/Winter%202006.htm

Texas A&M University has detailed instructions for shearing Angora goats, as well as information on raising goats.
http://sanangelo.tamu.edu/Angora/

The Massachusetts Sheep and Woolcraft Fair information may be found at www.masheepwool.org . The fair features not only sheep, but other fiber-bearers such as goats and is held at the Cummington Fairgrounds in Cummington, MA.

The New South Wales (Australia) Department of Primary Industries has detailed instructions for shearing Cashmere goats at:
http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/178526/goat-shearing.pdf

University of California, Davis
Small Farm Center
One Shields Ave
Davis, CA 95616-8699
For Angora goats:
http://www.sfc.ucdavis.*edu*/pubs/brochures/Angora.html
For Cashmere goats:
http://www.sfc.ucdavis.edu/pubs/brochures/Cashmeregoats.html

www.sheepusa.org has listings of sheep, alpaca, and llama shearers. Some of these may shear goats as well. Listings are by state, so check surrounding states if you don't come up with someone local.

For more information visit www.umass.edu/cdl

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UMassAmherst Outreach UMass Extension

Llama Shearing

Introduction:

Llamas are native to areas of high altitude and relatively cool climate with low humidity of the south American Andes. Even if you aren't interested in using or selling the fleece, the llama's health will benefit from shearing if you live where summers are hot. Llamas do vary considerably in fleece length and thickness, so the importance and frequency of shearing will depend on the individual animal as well as climate. It is important to leave at least an inch of fiber for protection from weather and sunburn. The need for skin protection varies according to the llama's skin color. Light colored skin needs more sun protection. A llama typically will need 3 inches of undercoat for winter warmth. A llama sheared to one inch in the spring should grow an adequate coat by winter. Here in Massachusetts shearing every year or two is recommended unless the llama has an unusually light coat.

Llamas living where summers are hot need annual shearing.

Best Management Practices:

Shearing systems

Professional llama shearers are not numerous. People who shear sheep sometimes will also shear llamas (as well as alpacas and goats). Check the "Sources of Information" below for suggestions as to how to find a local shearer. It may be more difficult to find a professional shearer if you have only a few animals in need of shearing. Llamas are not generally shorn in such a manner that the fleece is removed in one piece; rather the fleece is separated according to quality as it is removed from the animal. This makes it easier for a novice to work slowly on an animal, even taking a break and finishing the shearing a day later if the animal becomes too nervous.

Learning to shear

Learn shearing by watching if you can.

1. The best way to begin learning to shear is to watch someone who is good at it. Ask questions.
2. Attend a demonstration at a local farm. Llama numbers are increasing in Massachusetts and some sheep operations may have llamas to guard sheep from predators.
3. Your veterinarian may have information about llama shearing or be able to tell you who else owns llamas in your neighborhood.
4. Specific llama shearing instructions may be found at the website http://www.phf-llamas.com/article4.html .

Shearing tips

1. A clean animal is much easier to clip/shear than a dirty one. Clippers will work better, blades will last longer, and a clean fleece will emerge, requiring less pre-processing handling. Clean out loose dirt using a blower. If you have only one or two llamas, wash the animal(s). Remember drying may take a day, and the animal must be dry for shearing.
2. Clipping is easier than shearing. Hand shears or clippers may be used. Dehairing is necessary to give a high quality processed fiber. The itchy coarser guard hairs are processed separately from the finer underdown. Lamas may be shorn with sheep shearing scissors or with electric sheep or dog clippers. Electric clippers are recommended if you have more than a few animals requiring shearing, however scissors are more forgiving of mistakes.

3. For those with time and patience, brushing may remove enough excess hair to keep the llama comfortable. Brushing will also yield vary little guard hair, so less time and effort will be needed to separate the coarse fibers from the fine. This is important if a fine fiber quality is a priority and quantity is of less importance.

Resources:

Massachusetts 4-H at www.mass4h.org does not have a program geared specifically to llamas, but does have sheep and goat programs, which may be of interest to llama owners.

Pioneer Valley Sheep Breeders' Association at www.pvsba.com includes llama owners as well as sheep breeders.
Shawn Thayer, Secretary
160 Bryant Rd
Cummington, MA 01026

The Massachusetts Sheep and Woolcraft Fair at www.masheepwool.org The fair includes llamas as well as sheep and has shearing demonstrations. The Cummington Fairgrounds in Cummington, MA is the site of the fair.

The University of Massachusetts has a Camelid program within the Department of Veterinary and Animal Sciences: http://www.umass.edu/vasci/faculty/purdy/CamelidStudiesProgram.htm

http://www.phf-llamas.com/article4.html . is an article on hand shearing of llamas. Originally found in a *Llamas Magazine* article by Sharon Beacham

www.sheepusa.org has listings of llama as well as sheep shearers. Listings are by state, so check surrounding states if you don't come up with someone local.

For more information visit www.umass.edu/cdl

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Alpaca Shearing

Introduction:

Alpacas are native to high altitude areas with cool climate and low humidity in the South American Andes. They are increasing in numbers in the USA, kept mainly for fiber, but also for companionship. An adult alpaca weighing about 150 lbs produces approximately 4 lbs of high quality (<20 micron diameter) fiber and an equal amount of coarser fiber annually. Alpacas bred specifically for fiber are generally sheared once a year.

Alpacas are native to the Andes.

Best Management Practices:

Shearing Systems

Professional shearers are not numerous. People who shear sheep sometimes will also shear alpacas (as well as llamas and goats). See the section: "Sources of Information" below for suggestions as to how to find a local sheep shearer. It may be more difficult to find a professional shearer if you have only a few animals in need of shearing.

Learning to shear

1. Watch the person who does your shearing. Ask questions.
2. Attend a demonstration at a local farm. There are increasing numbers of alpacas in Massachusetts and the University of Massachusetts Camelid Program runs a shearing school in the spring.
3. Your veterinarian may also have information about alpaca shearing or know someone to contact.

Shearing Tips

1. A clean animal is much easier to clip/shear than a dirty one. The clippers will work better, blades will last longer, and a cleaner fleece will be the result. Clean the looser dirt out using a blower. Some people with only a few animals will wash animals a day before shearing. Others find that cleaning fleece is easier off the animal than on an uncooperative alpaca. Cleaning decisions may also be made based on requirements of the fiber processor. A commercial processor would expect debris to be removed, but washing animals would not be necessary. Note that it may take a day for a washed animal to dry, and the animal must be dry for shearing.
2. Clipping is easier than shearing, although hand shears may be used. Alpacas may be shorn with sheep shearing scissors or with electric clippers. Electric clippers are recommended if you have many animals requiring shearing. Scissors are more forgiving of mistakes. Dehairing is necessary if the fiber is to be commercially processed. The itchy coarser guard hairs are processed separately from the finer underdown.
3. Making second cuts on an already-sheared part of the animal will result in shorter fibers for further processing. This is something to be avoided as longer fibers result in higher quality yarn. Try to cut the desired length the first time.

The University of Massachusetts hosts a shearing school in the spring.

Resources:

University of Massachusetts has a Camelid Studies Program http://www.camelidstudies.org/ which includes a shearing school http://www.camelidstudies.org/ShearingClinic.html

The Massachusetts Sheep and Woolcraft Fair at www.masheepwool.org The fair includes shearing demonstrations and is held at the Cummington Fairgrounds in Cummington, MA. Alpacas, llamas, and goats, as well as sheep, are represented at the fair.

Massachusetts 4-H at www.mass4h.org does not have a program aimed specifically at alpacas, but does have a sheep and goat program which may be of interest to alpaca owners.

www.sheepusa.org has listings of alpaca as well as sheep shearers. Listings are by state, so check surrounding states if you don't come up with someone local.

http://www.all-animals.com/shearing.html is a commercial site

http://www.gatewayalpacas.com/alpaca-farming/alpaca-shearing.htm is also a commercial site

http://www.alpacanation.com/alpaca-services/alpaca-services-2.asp?servicetype=3 has a list of alpaca shearers, including some in New England.

For more information visit www.umass.edu/cdl

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Predation Control of Livestock

Introduction:

Predators such as coyotes, bears, and foxes play a crucial role in dynamic ecosystems. As keystone species they help maintain healthy populations of herbivores such as deer. This relationship enables a balance among all trophic levels within an ecosystem by suppressing overpopulated herbivores that would otherwise overgraze and lead to habitat damage. Predators, however, pose a great threat to livestock. Control efforts are made on national, state, and local levels to assist in the development and implementation of predation control methods. Predation accounts for the majority of livestock losses in agriculture, thus the importance of practicing preventative methods. According to the U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) in 2006, predators accounted for a loss of 190,000 head of cattle (a monetary loss of 92.7 million dollars). The most important aspect of predation control is to incorporate an integrated approach and initiate these methods as soon as a problem is noticed. There are many regulations, both federal and state, to consider prior to implementing an approach for problem wildlife. Prior to taking any direct action against predators contact your local Wildlife Services (WS), a program within the USDA's Animal and Plant Health Inspection Services (APHIS).

Check with your state's Wildlife Services (WS), a program within the USDA's Animal and Plant Health Inspection Service (APHIS) regarding questions of predation prior to taking any immediate action against predators.

Best Management Practices:

Evaluate specific needs and concerns and develop a damage management plan based on your needs. Remember that the most important aspect of an effective predation control plan is to integrate various techniques. The following control methods should be considered:

Exclusion:

Fencing- the following should be considered when installing a fence: height, length, terrain, and materials such as wood, wire-woven, barbed, cable, or tensile that is either electrified or not. Fencing can become expensive depending on material used, therefore, it is most cost effective when predation identified is high, and can be incorporated with other means of predation control. Get into the habit of checking all your locks throughout all facilities to ensure their security.

Employ a checklist of all facilities to ensure they are secure/locked.
- **Buildings/barns**
- **Grain/feed room**
- **Pens, holding facilities**

Guard Animals- usually consist of dogs, donkeys, llamas, or mules, and sometimes geese. This method may constitute an investment of both time and money, and sometimes does not guarantee effectiveness. In order to increase effectiveness of guard animals other predation control methods must be integrated. When deciding to employ a guard animal in your management plan, consider the size and species of the livestock, the environment they are housed in, and other control methods you will integrate. Always post signs to alert neighbors of guard dog.

Cultural Methods:

Animal Husbandry- a careful assessment of husbandry practices such as confining when birthing, corralling livestock at night, and removing carcasses immediately will lessen the threat of predation. Be aware of life cycles, such as birthing; the time your livestock is birthing coincides with higher rates of predation.

Waste - properly store waste in tightly sealed containers and reduce access.

Habitat Control/Modification:

Remove- potential habitat for undesired wildlife such as brush piles, weed patches, tall vegetation, dumps, and other debris that might offer advantageous cover.

Location- allow for pasture near buildings and human activity to contain highly susceptible animals such as, pregnant livestock and young. This will allow for quick response time to predators, and may deter predators due to human activity.

Frightening Devices and Repellents:

Frightening Devices- Employing scare tactics with sound, odor, and sight can be effective. Examples are propane cannons, sirens, radios, lasers and bright lights. It is important to note that when utilizing such methods, the target predator usually adapts to the tactics quickly and therefore these methods must be integrated with others to be effective.

Repellents- are used to deter predators from entering an area of concern. Some repellents used include urine from predators of the problem animal or chemically formulated substances such as mothballs.

Identifying Predation:

There are many causes of livestock death ranging from disease, to old age, or predation; most often predation is the cause. Assessing the carcass and surrounding area can help to differentiate between causes of death and identify the species of predator; however, it does not guarantee an exact identification. An excellent publication called, "Procedures for Evaluating Predation on Livestock and Wildlife" clarifies exact details involved in the examining process. The web site can be accessed at

http://texnat.tamu.edu/ranchref/predator/pred.htm

There are several factors to consider when distinguishing between likely predators. Species vary in food preference, method of attack, and feeding behavior. Therefore, the entire scene of attack must be carefully examined. Always wear proper protective clothing when examining. The following are general guidelines to consider when identifying a predator:

1. Examine the wound and feeding activity- where on the carcass are the wounds located, how many are there, how deep they are, and do teeth, claws, or talons make them. Is the body dismantled or intact?
2. If possible, locate the exact site of attack. Proceed cautiously throughout the site, so as not to destroy any evidence such as scat, prints, hair or any other data that would help to identify the predator.
3. Examine the carcass or wounded animal again for bruises, broken bones, hemorrhages, and feeding. Predators exhibit certain attack and feeding behaviors based upon their species. For example, a coyote will most likely attack at the throat of an animal, while a bear will usually attack from the front using its claws. During this stage of evaluating the carcass it is very important not to move it extensively. The body may be altered making it difficult for a professional to positively identify the predator.

Resources:

Browns, James E. and Wade, Dale A. Jan. 1997. "Procedures for Evaluating Predation on Livestock and Wildlife". Texas A&M University.
<http://texnat.tamu.edu/ranchref/predator/pred.htm>

General Laws of Massachusetts related to relocating and shooting predators can be found at the following two sites respectively:
<www.mass.gov/dfwele/dfw/wildlife/living/moving_wildlife.htm

<http://www.mass.gov/legis/laws/mgl/131-37.htm>

Gegner, Lance E. April 2002. "Predation Control for Sustainable and Organic Livestock Production". Appropriate Technology Transfer for Rural Areas (ATTRA): National Sustainable Agriculture Information Service.

Harwell, Lynne and Pinkerton, Frank.
"Housing, Fencing, Working Facilities & Predators".
<http://www.goatworld.com/articles/fencing/fencing1.shtml>

<http://www.attra.ncat.org/attra-pub/predator.html>
The ATTRA organization can also be contacted at
1-800-346-9140

The University of Maryland has an excellent web site containing numerous links to many resources. The site can be accessed at
http://www.sheepandgoat.com

The Wildlife Service program helps to ensure protection of agricultural resources through environmentally sound, humane, and effective solutions. They can be contacted

at (301) 734-7921 or at
http://www.aphis.usda.gov/wildlife_damage/

The web site, "Internet Center for Wildlife Damage Management", contains a compilation of extensive information regarding specific predator identification, control, and management. The site can be accessed at www.icwdm.org/handbook/index.asp.

Two other local resources to contact are animal control and the environmental police. Contact information for these sources would be listed in the local phonebook.

For more information visit www.umass.edu/cdl

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Biosecurity Guidelines for Animal Industries

Introduction:

Biosecurity is defined as a system of management practices that prevent or greatly reduces the risk of introducing new diseases to a farm or stable**.** A good biosecurity program should address the prevention of disease entry and spread on a farm, stable or home.

As with any biosecurity plan, livestock and horse owners should contact their regular veterinarian to discuss what appropriate measures should be implemented on their specific operation**.**

Best Management Practices:

Since some animals may not exhibit obvious signs of disease it is important to understand how diseases are transmitted.

- Spread of disease agents
  - Animal to animal
  - Animal to human
- Different routes of transmission
  - **Aerosol –** Disease agents are contained in droplets which can pass through the air
  - **Direct contact** - Disease agent in animals or the environment are transferred from one to the other

    Examples: Open wounds, mucous membranes, skin, blood, saliva, nose to nose, rubbing, biting

    Reproductive transmission - breeding or dam to offspring
  - **Fomite -** Contaminated inanimate object carries agents to other animals

    Examples: Brushes, needles, shovels, trailer, humans
  - **Oral -** Consumption of contaminated feed or water, licking or chewing environments containing feces, urine, or saliva
  - **Vector-borne** - Insect acquires pathogen from one animal and transmits to other animal(s)

    - Living organisms that carry disease agents from one host to another are called vectors

    Mechanical vectors: A vector that simply carries a microorganism with no replication from host to host Some examples: flies and cockroaches

    Biological vectors: In contrast, microbes must propagate within a biological vector before the biological vector can transmit the microbes. Some examples: fleas, ticks, and mosquitoes

Prevent the entry and spread of diseases by implementing and maintaining a good biosecurity plan.

- **Zoonotic** – Infectious agents that can be transmitted between (or are shared by) animals and humans
  Examples: Brucellosis, Tuberculosis, West Nile Virus, and the Plague

General Prevention Tips:

Purchasing and Introduction of New Animals to Herd

- Buy from a reliable source.
- Make sure health records on the new animals are up-to-date.
- Have a reliable veterinarian in the area inspect the animal(s) prior to purchase.
- Isolate animals once on your property (30 days is the recommended for cattle, sheep, goats, horses, poultry and 60 days for swine).
- Provide a pen or stall that has adequate ventilation and is not located near other livestock or horses.
- Do not cross use shovels, feed buckets, brushes or other equipment between the isolated animal and other livestock.
- Ensure workers clean their hands and boots and change clothes prior to entering other areas.

Returning From Shows or Exhibits

- Isolate animals once on your property (see above recommendations).
- Use your own trailer to transport your animals. If you do not have your own transportation, it is crucial to disinfect all returning animal's hooves prior to entering your barn or stable.

Limit Contact with Animals

- Neighbor's livestock
- Wildlife and birds
- Roaming cats and dogs

Maintain Secure Fences and Locked Gates

- Establish biosecurity protocols for delivery vehicles and personnel

Keep Up-To-Date Health Records on Every Animal

- Review vaccination and treatment programs
  - Annually, bi-annually
  - Protocol versus actual
- Investigate unusual signs and unresponsive cases
  - Neurologic, downers, or sudden death
  - Train farm or stable personnel to report sick animals
  - Inspect animals daily
  - Clean equipment, boots, and clothing
- Euthanize terminally ill animals promptly and appropriately
  - Removed and rendered
  - Necropsy animals that died from unknown causes

Key Points:

- Biological risk management is important
- All diseases are transmitted by a few common transmission routes (described above).
- Disease risk can be managed efficiently and effectively.
- Awareness education is essential.
- Work with your regular veterinarian.
- You play a critical role!

Resources:

- American Veterinary Medical Association resources (geared toward veterinarians) include biosecurity resources, updates, information on disaster preparedness, and resources on select public health topics: http://www.avma.org/pubhlth/biosecurity/
- Biowarfare and Bioterrorism: http://64.177.207.201/cbw/
- Dairy Facility Biosecurity: http://www.state.ma.us/dfa/animalhealth/dairy_facility_biosecurity.htm
- Farm and Ranch Biosecurity: http://www.farmandranchbiosecurity.com
- Homeland Security: http://www.usda.gov/homelandsecurity/homeland.html
  Meat and Poultry Hotline: 1-888-MPHotline (1-888-674-6854); Hearing Impaired (TTY) 1-800-256-7072
- Livestock Biosecurity (Penn State website): http://www.vetsci.psu.edu/Ext/Biosecurity/BioMain.htm
- National Biosecurity Resource Center for Animal Health Emergencies (primarily focuses on pigs): http://www.biosecuritycenter.org/

For more information visit www.umass.edu/cdl

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UMassAmherst Outreach UMass Extension

Disposal of Dead Livestock & Equine

Introduction:

Methods and processes of dealing with dead animals have always been and continue to be a concern in all animal production operations both large and small, slaughter plants, and other facilities that have animals. Proper disposal methods/systems are especially important due to the potential for disease transfer to humans and other animals, and the pollution of soil, air and ground water. Properly composting animal carcasses may be less of a threat to groundwater than burial or unattended surface dumping. Composting has been shown has a viable means of disposing of dead livestock, horses and birds. (This method is not recommended for whole herd or flock disposal cases).

On-farm composting of dead animals generated on the same farm as the composting facility is exempt from having a permit if operated in compliance with the Massachusetts Department of Agriculture regulations. (Refer to MDAR 330 CMR 25:00).

Best Management Practices:

Burial

Burial must be no less than 6 feet deep with a minimum of 30 inches of soil cover. Burial must be in well drained soils and be at least 2 feet above the highest groundwater elevation. Burial must be at least 100 feet from a private well, 200 feet from a public well, 50 feet from an adjacent property line, 500 feet from a residence and more than 100 feet from a stream, lake or pond. Burial cannot be in a wetland, floodplain or shoreline area.

Check with your state's environmental agency or state veterinarian before you begin composting dead animals.

Composting

1. Check with your state's environmental agency or state veterinarian before you begin composting dead animals. The Massachusetts Department of Environmental Protection, for instance, does not require a permit.

2. As an underlying layer, or substrate, use a mixture of hay, manure and bedding with moisture content between 40 to 50 %. Odor can be kept to a minimum as long as the pile is turned to aerate it and the covering material has enough carbon sources, such as straw, sawdust or hay, to provide a 25:1 ratio of carbon to nitrogen.

3. Construct a windrow 10 feet wide by 4 feet deep of the dry manure and bedding mixture. Locate it on a solid spot where the ground slopes 1 to 2%. Site it lengthwise with the slope of the land so runoff and snow can't puddle against the windrow. If possible, orient the windrow north to south so that only one end faces a cold exposure. Choose an area where tractors can maneuver in all weather.

4. Once you've placed a carcass (might want to puncture the rumen on cattle to avoid a gas buildup and possible explosion), cover it with at least 2 feet of the same manure and bedding mixture that is underneath the carcass. Maintain a stockpile of the material for covering. Carcasses can be added anytime but should be spaced about 4 feet apart.

5. The pile must heat up for proper composting. Use a compost-style dial thermometer, ideally with a 30-inch long probe, to monitor the temperature. Temperatures around the carcass will rise to 150 to 160 degrees. Monitor temperatures every two to three weeks. When temperatures fall to 110 to 125 degrees, stir the material with a bucket loader, allowing oxygen to re-activate the composting.

6. Left untouched, an adult carcass will compost in five to six months. Stirring the mix and covering the carcass again can accelerate the time. Colder temperatures slow the compost process. When the air temperature is above 50 degrees and the pile is turned when its temperature drops below 120 degrees, the soft tissue in a 1,500-pound cow will finish composting as quickly as two to three months.

There will be less bony residue with younger carcasses. Calves, for instance, may compost in three to four weeks under summer conditions. In areas with heavy rainfall, the process can be slowed if there's too much moisture, preventing aeration.. Anchor a tarp over the windrow or mix some very dry sawdust or shavings into the substrate.

7. When you see no more soft animal parts, you can spread the compost or leave it in place. Bones, which degrade very little, can be pulverized to spread on fields, creating good fertilizer. Or they can be left in the pile.

Resources:

Glanville. Thomas. Dr. 1999. Iowa State University – Iowa Extension. Composting Dead Livestock – A new solution to an old problem. Department of Agricultural & Biosystems Engineering, ISU. Ames. IA. 50011.

Livestock and Poultry Environment Stewardship (LPES) Curriculum. Mortality Management. www.lpes.org/Lessons/Lesson51/51_Mortality_Management.html

Massachusetts Department of Agriculture Resources. 251 Causeway Street. Suite 500. Boston. MA 02114. Phone (617) 626-1700. Website: www.mass.gov/agr

Rynk, Robert, et.al 1992. On-Farm Composting Handbook. Northeast Regional Agricultural Engineering Service. 152 Riley-Robb Hall. Cooperative Extension. Ithaca, N.Y. 14853-5701.

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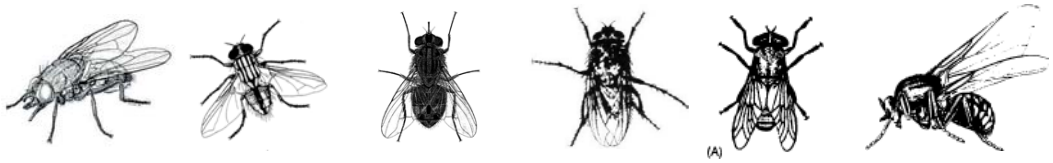
Fly Control Measures

Implement a fly control program before flies become a problem.

Introduction:

You should not wait until a problem exists to begin a fly control program. Flies are among the most difficult pests to control. A good program needs to be in place before fly numbers increase. Often flies are hidden during a portion of their lifecycle making them undetectable. Knowing when and where they may be found increases the ability to limit potential losses in your animal's performance. Proper identification of the fly and knowledge of the life cycles is important to help to target control measures. The following four flies are the more common ones found around livestock and horse areas.



Horn Fly **House Fly** **Stable Fly** **Face Fly** **Horse Fly** **Black Fly**

(These six flies are the most common types found on the farm)

The Horn Fly and Face Fly cause problems in pasture situations, while the House Fly and Stable Fly are a problem around barns and stable areas.

Horn Flies-They are dark gray in color with two transparent wings folded flat over the back, often in a delta wing position. Their life cycle is completed in 8 to 45 days depending on temperature and humidity. The horn fly rests on different parts of the host's body – on light or dark-colored patches of hair (dark when cool and light when hot) and underside during rain or heat. Horn flies will only leave their host when they lay eggs, move to other cattle in the herd, or when the cattle enter buildings. Most of the feeding occurs along the underline of the animal and often bloody, scabby sores can be seen. The horn fly can feed from 10 to 38 times per day and this results in irritation to the host and decreased grazing time and thus reduced weight gains and milk production.

Identifying species of flies and their life cycles will help to generate better solutions to problems.

House Flies- The adult house fly is very similar in appearance to stable flies and develop in fresh manure. The life cycle is about two weeks. House flies can not pierce the skin of an animal; instead they feed on animal wastes, decomposing feeds, and other liquefied organic matter. Numerous animal and human diseases can be traced back to the house fly.

Stable Flies- They resemble the common house fly except that they have "checkerboard" markings on the underside of their abdomen. Life cycle is 3 weeks in the summer and longer in cooler weather. They feed on most species of livestock, but are most prevalent on cattle and horses. The primary area that they feed (suck blood) is on the front legs causing the animal to bunch in a circle to protect their front legs.

Face Flies- The adult face fly is similar to the house fly except that it is larger and darker in color. They are more prevalent on cattle and horses and are considered a serious pest. Face flies are non-biters that feed on secretions, nectar and cluster around the animal's eyes, mouth, and muzzle. These flies serve as vectors of eye diseases such as pinkeye and eyeworms. They have a high longevity, over wintering in homes and barns.

Horse Flies- Are large biting flies which can inflict painful bites on horses and humans. Horse flies have been incriminated in the transmission of equine infectious anemia. Further, because the bite is painful, horses may become restless and unmanageable when they attempt to ward off attacks by these flies. Life cycles are long. Only female flies feed on blood.

Black Flies- Black flies are small, 1/12 to 1/15 inch long, hump backed; biting flies which may have high populations in the spring and early summer, particularly in pasture areas along streams. The immature stages are found in flowing water. Pupation occurs underwater and the adults float to the surface, ready for flight, feeding, and mating. Adult feeding on horses and other animals can pose serious animal health problems, and the irritation caused by black fly bites can make horses unmanageable. A large numbers of bites may cause weakness from blood loss, anaphylactic shock, or death.

Best Management Practices:

Sanitation is the most important factor in any fly control plan. Manure and other organic fly breeding material should be regularly removed from barn and stable areas. Composting manure can also aid in fly control. The heat generated by proper composting will kill fly eggs, therefore reducing fly populations. Clean up spilled feed and other organic materials to prevent additional fly breeding grounds. Automatic waterers should also be properly cleaned and maintained

Treatments:

Horn Flies- Sprays can be used but need frequent reapplication. Dust bags and back rubbers work well, but animals must be forced to use them. For a non-insecticide option, a walk through fly trap can be positioned by gates where livestock pass through. Feed additives can also be used for controlling fly larvae developing in manure.

House and Stable Flies- Sanitation is the key in controlling house flies. Sprays do not work well on animals since the flies are only on them for a short period of time. Feed additives are available but not effective for adult flies or larvae that develop in organic material other than manure. Residual sprays can be effective as a surface treatment where flies lay.

Face Flies- Control of face flies is difficult. Much effort has been made using various insecticides and application techniques, such as dust bags, mist sprays, and wipe-on formulations. Also, insecticides and insect growth regulators are used as feed additives. However, results are usually less than satisfactory. The introduction of insecticide-impregnated ear tags has provided somewhat better control. Fly repellent can be wiped around the horse's face and when turning out a horse, use a properly-fitted fly mask to keep flies away from the face while grazing. You can buy masks that include ear and nosepieces as well as eye protection to cover as much of the face as possible. Be sure to wash the mask when it becomes dirty to ensure visibility.

Horse Flies- Control is difficult; individual animal treatment using repellents or insecticidal sprays may reduce fly bites.

Black Flies- Control is difficult; species which feed in the ears of horses can be controlled using insecticidal applications or by using petroleum jelly in the interior of the horses' ears. Fly masks have also been known to help. When possible, horses can be stabled during the day and pastured at night. Black flies only feed during daylight hours and usually do not enter stable areas. Area sprays or general topical applications of insecticides are not very effective

Resources:

Ohio Pesticide Applicator Livestock Training – Student Workbook - http://www.ohioagriculture.gov/plnt/STUDY_MATERIAL/9%20Livestock%20Workbook.pdf

University of Kentucky Department of Entomology **http://www.ca.uky.edu/entomology/entfacts/ef511.asp**

For more information visit www.umass.edu/cdl

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Odor Control

Introduction:

Odor issues are one of the most frequent complaints received by local boards of health. Zoning enforcement officers and local health officials, often get into debates with farmers over odor issues. These disputes are very common throughout the Commonwealth, particularly when farmers are spreading manure near homes. Massachusetts law allows local boards of health to investigate when a nuisance smell appears to go beyond "normal maintenance" on a farm. Often the Department of Agricultural Resources will be called to send a representative to inspect the farm.

Controlling farm odors is not as difficult as you might think. The first step is to follow the four basic control strategies:

Prevent the creation of odors.
Alter strong odors to less intense odor.
Capture odors so they do not escape to surrounding areas.
Disperse odorants once they leave the farm.

For further information, please refer to the Massachusetts Department of Agricultural Resources – Right to Farm Law (Article 97) of the Articles of Amendment

Prevention:

Manure is the major source of farmstead odors. Manure is food to bacteria, and bacteria give off odors as they digest manure. You can reduce odors by preventing bacteria from growing in manure. Methods to reduce bacterial growth include killing bacteria with disinfectants, adding lime to raise manure pH, and keeping manure dry. It is difficult to completely stop bacteria from growing. Manure is just too good a meal for them to pass up. A second prevention strategy is to move waste away from trouble spots before bacteria can begin to grow. For example, flushing raw manure from buildings means fewer odors are released into the building by rotting manure. Changing your animal's diet can also reduce odors. Odors released by manure containing large doses of nitrogen and sulfur are particularly strong smells. If you reduce nitrogen and sulfur content of feed, you might prevent creation of nitrogen and sulfur odors in manure.

Alteration:

The second strategy for controlling odors is to change strong odors given off by decaying manure into weaker odors. For example, raw manure settles to the bottom of a lagoon. Bacteria in the lagoon digest the raw manure and release strong-smelling liquids. The smell will improve if another group of bacteria, living above the sludge, convert the odorous liquids into odorless gas. Masking agents are not usually effective on the farm. Masking agents do not alter odors; they merely try to hide them. The smell of manure is a strong odor, and trying to cover up the smell of manure with a stronger scent just adds to its power.

Capture:

The third strategy is to keep odors from escaping. In other words, trap and hold odors before they can leave the place they are created. Hydrogen sulfide is a strong smelling gas associated with manure. Hydrogen sulfide also sticks to iron. If you pass manure odors through a filter made of iron filings, hydrogen sulfide will stay with the iron and not escape to the surroundings. Some of the most effective filters not only capture but alter odors as well. Living filters, sometimes called biofilters, trap odors then use bacteria to eat the trapped odors. Biofilters can operate for a long time without having to be replaced.

Dispersion:

The final strategy uses the environment (wind) to disperse odors once they leave the farm. Plans that include separation distances between farms and residences rely on dispersion to dilute farmstead odors before they reach the neighbors' nose. Trees strategically placed on the farm help the wind mix and dilute odors. You cannot always count on the wind to disperse odors, though. On calm nights, heavy farmstead odors are carried to low spots in the landscape by gravity. You must fall back on other strategies (prevention, alteration, and capture) to reduce odors during windless periods.

Resources:

Hamilton, Douglas. W. Oklahoma State University Extension Service. Strategies to Control Farmstead Odors. Oklahoma State University. Stillwater, OK

Massachusetts Department of Agriculture Resources. 251 Causeway Street. Suite 500. Boston. MA 02114. Phone (617) 626-1700. Website: www.mass.gov/agr

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Nutrient Management

Introduction:

Nutrients, whether in fertilizer or organic amendments such as manure and compost, are an essential crop input and a major cost for crop production. On a typical livestock farm nutrients are recycled from soil, to crops, to animals, and finally, to the soil as manure (Figure 1).

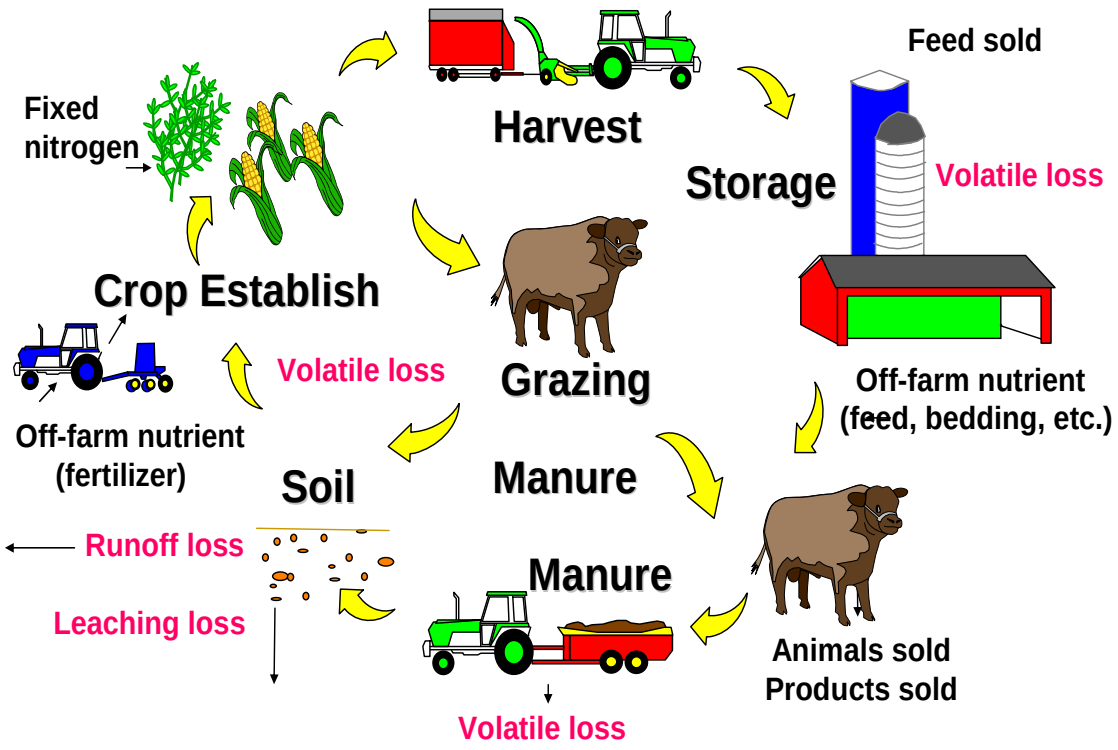
Nutrient recycling on most farms does not form a closed loop and farmers usually purchase off-farm nutrients to compensate for those lost in various ways to the environment. Farmers may also unknowingly apply nutrients in excess of recommended rates. For example, some farmers may apply commercial fertilizers without proper regard to the nutritive value of their manure. This can harm crop production, incur additional costs, and jeopardize soil and water quality. Similarly, the application of too little nutrients can sacrifice yield, quality, and profits.

A nutrient management plan helps ensure that nutrients are used efficiently for economic production of feed and animal products.

A nutrient management plan helps ensure that nutrients are used efficiently for economic production of feed and animal products, as well as for the protection of air and water quality. Development of a nutrient management plan requires integrated knowledge about soils, cropping systems, crop nutrient needs, nutrient sources, nutrient application timing, and method of application.

Best Management Practices:

Figure 1: Flow of nutrients on a typical crop/livestock farm where nutrient import exceeds nutrients lost from the farm through crops, animals and animal products in the form of sales.



Developing a nutrient management plan is a complex task and requires collecting information about farm resources and current as well as past farm management practices. This information includes but is not limited to:

a) Nutrient inventory; including nutrient status of the soil, nutrient content in manure, nitrogen fixation by legumes, and nutrient availability from cover crops and previous crop.
b) Crop nutrient requirements based on; type of plant, yield expectation, and nutrient removal by crop.
c) History of cropping management; including crop rotation, manure application in the past, and cover crop.
d) Information about type and number of animals, manure storage capacity, and spreader capacity.
e) Environmental risk assessment for individual fields which requires information about soil, topography, flooding frequency, as well as current cropping management.

Due to the complexity of the calculations and vast knowledge that a nutrient management planner requires, computer software is often used to aid in decision making. University of Massachusetts Extension has developed and uses FarmSoft for generating a nutrient management plan. The program calculates manure and /or fertilizer rates to meet nutrient needs and helps identify fields receiving excess nutrients. The program also calculates a site vulnerability index, highlights any major environmental concerns associated with individual fields, and prioritizes fields for receiving manure.

For more information visit www.umass.edu/cdl

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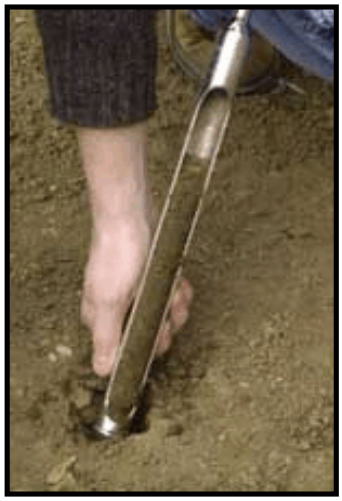
Sampling Soils for Meaningful Results

Introduction:

The objectives of soil testing are to accurately determine the status and availability of nutrients, and to clearly indicate any deficiency or excess that may exist. Soil test results can be used to determine specific crop nutrient needs for profitable and environmentally sound application of fertilizer, lime, and organic soil amendments including manure or compost. Applying fertilizer or manure without the benefit of a good soil test is like throwing money away. Without the proper guidance of a soil test, the farmer could lose profit due to lower yields or from unnecessary expenditures.

Accurate soil tests are important for a successful nutrient management plan.



Four Steps of Soil Testing

- Collect the soil samples
- Analyze the sample
- Interpret the results
- Make fertilizer and lime recommendations

The first step is the responsibility of the farmer while the next three are performed by a soil testing lab. Each step is important for meaningful results.

Collection of soil samples from a field:

Taking a soil sample truly representative of a field's characteristics is very important. Poor sampling gives misleading test results. Large differences are often found the same field. These differences usually are not sampling or testing errors but are actual variations in fertility patterns. To minimize the effect of these inherent fertility differences, this established sampling procedure should be followed:

- The closer the samples are taken to planting time, the less chance there is for changes to occur. Nitrogen levels tend to vary a lot so sampling near the time of planting is best. However, soil samples may be taken either in the fall or spring. Fall sampling ensures that test results are ready in plenty of time for spring or for fall fertilization when weather conditions are good and time is not so critical.

Soil tests are required every three years.

- Take soil samples every 2-3 years. Keep a record of soil test results on each field to evaluate long term trends in nutrient levels.
- Each soil sample should be a composite of soil cores taken from a similar area. When sampling, avoid unusual areas such as eroded sections, dead furrows, flooded areas, fertilizer bands, and fence lines. Divide each field into uniform soil and past cropping areas (see figure1).
- Assign a permanent identification name/number for long-term record keeping. Fertility trends over a period of years provide important information, indicating the adequacy of a fertilizer program (too much, too little, or the correct amount).
- To sample an area of one soil type, take at least 15-20 small samples or cores at random from each area to give a composite sample at tillage depth (upper 6-8 inches for most crops). For perennial pastures or hay crops (cases where the soil is not annually mixed), sample only to 4 inches deep.
- Use a soil probe or soil auger to collect the samples (See the Figure 2). You can also use a shovel or spade for shallow samples.

- The subsamples should be collected into a clean plastic container and mixed together well.
- From this composite sample remove about a cup of soil and allow it to air drywithin12 hours of sampling. Place the sample into a Zip-Lock bag for shipping. Label the outside of the bag with your name, address, field, and intended crop.

Resources:

Soil samples can be sent through standard mail services to UMass Soil Testing Lab, West Experiment Station, UMass, Amherst, MA 01003. For further information contact the Soil Test Lab (413-545-2311).

For testing services and price list log on to:
http://www.umass.edu/plsoils/soiltest/services1.htm

For results and interpretation of soil test log on to:
http://www.umass.edu/plsoils/soiltest/interp1.htm

For more information visit www.umass.edu/cdl

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Sampling Livestock Manure

Introduction:

Animal manure has long been used as a nutrient source for crop growth. Using manure on the farm can greatly reduce the need to purchase fertilizers. Estimates of manure nutrient content are available from a number of published sources, but nutrient composition varies widely between farms due to differences in animal species, age of animal, feed ration, type and amount of bedding, storage structures, and manure handling. For example the nitrogen content of dairy cow solid manure may vary from 3 to 33 lb N/ton, and for phosphorous from 0.2 to 35 lb P/ton. In order to maximize the economic value of manure, a nutrient analysis should be conducted. Knowing the nutritive value of one's manure is as important as knowing the nutrient content of purchased fertilizer or animal feed. Remember that stockpiled manure and poultry litter should be stored under cover on an impervious surface. It is essential that the sample obtained for analysis represent the manure that is applied to the fields. Unfortunately, manure nutrient content is not uniform within storage structures and obtaining an accurate manure sample can be challenging.

When is the best time to sample manure?

It is essential that the sample obtained for analysis represent the manure that is applied to the fields.

Manure nutrient content may vary with time and method of storage. Test results may not be accurate when manure is not thoroughly mixed. Therefore, for more meaningful results samples should be taken near or at the time of application. This is when slurry pit manure is likely being agitated in order to load the tank, and semi-solid manure is moderately mixed after being loaded into a box spreader. But remember when samples are taken during hauling, the results can only be used for a subsequent manure spreading plan and to adjust commercial fertilizer application in the future.

Take manure samples annually for three years, followed by samples every 4-5 years. If storages are emptied twice a year, it is recommended to sample in both spring and fall since the different storage temperatures in summer compared to winter will affect manure nutrient levels.

How to sample:

a) Sampling Solid Manure (greater than 20% solids by weight):

It is recommended to collect solid manure samples directly from the spreader using a pitchfork, shovel, or plastic gloves. Collect 5-10 sub-samples from different loads. Avoid large pieces or chunks of bedding. Mix all sub-samples thoroughly and remove a cup, placing it in a heavy weight plastic freezer bag. Squeeze the bag to remove air. Use a second freezer bag to prevent possible leakage.

When sampling manure from piles, follow these steps:

1. Identify 10-12 widely dispersed points on the stack that represent the average moisture content of the manure. Samples should be taken from a depth of at least 18 inches at various locations of the pile.
2. From each point, remove the top crust layer which is lower in nutrient and collect 3 to 5 sub-samples using a small shovel or plastic gloves.
3. Place all sub-samples in a wheelbarrow or plastic bucket. Thoroughly mix and crumble the collected sub-samples.
4. Remove one cup and place it in a heavy weight plastic freezer bag.

5. Samples must be kept cool to prevent any ammonia nitrogen loss.
6. Freeze the sample before sending it to the lab for analysis. Use a rapid transit courier.

b) Sampling Slurry Manure (10-20% solids):
Dairy manure (about 12% solid as excreted) and hog manure (about 10% solid as excreted) is often collected and stored as a slurry in earthen, concrete, or steel storage structures.

For taking a good representative sample:

1) Agitate the manure mixture for 2 to 4 hours before sampling.
2) Sub-samples can be dipped from the agitated storage using a bucket on a rope, thrown into the manure storage, or taken from spreader tank loads, or taken from transfer pipe.
3) Samples also may be taken at the time of application. Place 3-6 small buckets (plastic coffee cans) at several locations in the field(s).
4) Place all sub-samples in a larger clean plastic pail and stir the contents thoroughly.
5) Use a long handled dipper to take several cups of mixture into a clean one quart plastic bottle until the liquid is about 2-3 inches from the top of the bottle.
6) Freeze the sample before sending it to the lab for analysis. Use a rapid transit courier.

c) Sampling Liquid Manure (less than 10% solids):
Liquids, such as effluent from a solid separator or runoff from an outdoor open feedlot, are often stored in earthen structures. They can be sampled following the procedure for sampling slurry, although most of the solids in liquid manure are suspended, and therefore, agitation for mixing may not be necessary.

Resources:

Currently, the University of Vermont accepts manure samples for nutrient analysis. Address samples to: Agricultural and Environmental Testing Lab, 219 Hills Building, Univ. of Vermont, Burlington, VT 05405-0082 or call 1-800-244-6402 for more information.
For more information about manure testing log on to:
http://www.uvm.edu/pss/ag_testing/

For more information visit www.umass.edu/cdl

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This publication has been funded in part by Mass. Dept. of Agricultural Resources in a grant to the Massachusetts Farm Bureau Federation, Inc. and by Mass. Dept. of Environmental Protection, s319 Program.

UMassAmherst Outreach UMass Extension

Manure Inventory

Introduction:

Manure management should be a top priority on any dairy and livestock farm. Mismanagement of manure can have a substantially negative impact on our air, water, and soil. When used appropriately, manure has significant agronomic and economic value. When used correctly, manure improves soil biological activity, tilth, and chemical properties. The purpose of a manure inventory is to estimate the amount of manure produced on a farm and therefore, to calculate the amount of nutrients excrete by livestock and poultry. A manure inventory also will assist a farmer in determining if sufficient land is available for agronomic utilization of manure nutrients.

Currently, manure production or nutrient excretion by various animals are based on body weight of the animal and often does not account for large variations in feeding types and amounts. Also, nutrient content of manure varies widely between farms due to differences in animal species, age, feed ration, bedding characteristics, storage structures, and manure handling.

The purpose of a manure inventory is to estimate the amount of manure produced on a farm and therefore, to calculate the amount of nutrients excrete by livestock and poultry.

Calculations:

Each ton of manure produced by dairy cows contains approximately 10 lbs. of nitrogen (N), 4 lbs. of phosphorus (P_2O_5), and 8 lbs. of potassium (K_2O) (Table 1). The actual concentration of these nutrients in stored manure will be influenced by storage losses and dilution from water (rainfall and milk wash waste water) as well as bedding.

Table 1: Average daily manure production and nutrient content of manure. Values are based on animal unit (1000 lb) and do not include bedding*.

Animal Type	Daily Production	Analysis Units	N	P_2O_5	K_2O
Dairy Cow Lactating (liquid)	13 gal	lb/1000gal	28	13	25
Lactating (solid)	106 lb	lb/ton	10	4	8
Dry	82 lb	lb/ton	9	3	7
Calf and heifer	87 lb	lb/ton	7	2	7
Beef cattle Cow and calf	60 lb	lb/ton	11	7	10
Steer	75 lb	lb/ton	14	5	8
Veal	5 gal	lb/1000 gal	36	27	55
Swine Gestation	4 gal	lb/1000 gal	30	35	15
Lactation	10 gal	lb/1000 gal	25	20	15
Nursery	14 gal	lb/1000 gal	40	40	25
Grow-finish	11 gal	lb/1000 gal	50	55	25
Farrow to feeder	7 gal	lb/1000 gal	40	35	15
Sheep	40 lb	lb/ton	23	8	20
Horse	45 lb	lb/ton	12	5	9

*Adapted from: The agronomic guide 2002. College of Agricultural Sciences, Penn State University.

Manure production on a farm can be estimated by using the following formula:

Manure production =
Number of Animals x Average Weight of Animal (lb) ÷ 1000 (animal unit) x Daily Manure Prod. x Manure Collection Period (days) + Estimated Percent of Bedding in Manure.

Example: You have 10 lactating cows, each with an average weight of 1250 lbs. The animals are on pasture for 5.5 months (mid April through early October). You usually add about 5% bedding to the manure.

Total annual collectable manure =
10 (animals) x 1250 (avg. wt.) ÷ 1000 (animal unit) x 106 (daily manure prod. from Table 1)
= 1325 (lbs/day).
1325 x 195 (days kept in barn) = 258375 (lbs manure/year).

Total waste production (bedding included) =
258375 x 0.05 = 12919 (lbs bedding added to the manure).
258375 + 12919 = 271294 (lbs/year) or: 271294 ÷ 2000 = 136 (ton/year).
Each ton of manure produced by dairy cows contains approximately 10 lbs. of nitrogen (N), 4 lbs. of phosphorus (P_2O_5), and 8 lbs. of potassium (K_2O) (Table 1). The actual concentration of these nutrients in stored manure will be influenced by storage losses and dilution from water (rainfall and milk wash waste water) as well as bedding.

In the above example, nutrient inventory for the farm can be calculated as:
136 x 10 = 1360 lb N, 136 x 5 = 544 lb P_2O_5, and 136 x 8 = 1088 lb K_2O

Manure nutrient inventory for a farm is only practical if used in conjunction with proper on-farm management practices including manure storage and handling, application method, correct timing for crop uptake, and nutrient availability of applied manure.

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Nitrogen Management: Pre-Sidedress Nitrate-N Test (PSNT)

Introduction:

The pre-sidedress nitrate-N soil test (PSNT) is a late spring nitrogen management tool that can be used to aid in more accurate nitrogen management decisions for corn production. It is an especially appropriate test for fields with relatively high in organic matter. The PSNT therefore, is almost exclusively promoted for fields that have received manure or other organic amendments or where corn is following a forage legume crop. This is because the availability of nitrogen from organic matter decomposition can often be uncertain. The PSNT conducted on soils that do not have a manure history or previous forage legume crop rarely show nitrogen levels high enough to prompt a decision.

The amount of nitrate present at sampling is directly related to the N supplying capability of the soil during the entire growing season.

Over-application of N from fertilizer and manure can result in N loss throughout the growing season, and especially after crop harvest in the fall, which increases production costs.

The PSNT should be conducted when corn measures 10–12 inches tall from the ground surface to the center of the whorl (about 5-6 weeks after planting). The amount of nitrate present at sampling is directly related to the N supplying capability of the soil during the entire growing season. At this stage of corn growth, mineralized N and fertilizer N will move rapidly to the active root zone even if the fertilizer is not incorporated into the soil.

Nitrogen transformations occurring in soil are dynamic and strongly influenced by environmental conditions because they are a direct result of soil biological activity. When weather conditions in spring are cold, the rate of mineralization is low and result of a PSNT may not be accurate. Also, in dry seasons, PSNT may not be accurate since movement of N to the active root zone is limited.

How to Collect Samples:

PSNT is especially appropriate for farms that are utilizing manure.

The PSNT soil sample should be collected from 0 – 12 inches deep and represent areas of the field that have similar soil properties and past management histories.

- Make a composite of 25-30 soil cores from each sample area by thoroughly mixing all the soil in a bucket before the subsample for analysis is removed. The large number of cores is important due to non-uniformity of manure application.
- Take the soil cores from the center of planting rows.
- Immediately after samples are taken, air dry the samples by spreading them out in a thin layer of non-absorbent paper.
- Include with soil sample field identification, your name, address, phone number, together with testing fee. Send up to one cup of dried soil placed in a zip lock bag to:
  Soil Testing Lab
  West Experiment Station
  University of Massachusetts
  Amherst, MA 01003
  (ph. 413-545-2311).

Interpreting your PSNT Results:

Depending upon the PSNT level, a farmer receives an estimate of the likelihood of seeing a response to additional nitrogen fertilizer, but will not receive an actual nitrogen recommendation from soil lab. Results of the lab analysis are usually reported in parts per million (ppm) nitrate-N. However, pounds of actual nitrogen per acre can be estimated by multiplying ppm nitrate-N in the top 12 inches of soil by 4. PSNT values of 25 ppm or higher are unlikely to benefit from additional nitrogen fertilizer and the higher the value the less likely the need for supplemental nitrogen. The problem arises when PSNT values are less than 25 ppm. PSNT values below this level may or may not respond to additional nitrogen fertilizer, but the stock recommendation would be that they do require more nitrogen. The following table can be used to determine N fertilizer requirement for various PSNT values in Massachusetts:

Sidedress N fertilizer recommendations for silage corn based on PSNT and the field yield potential*

Soil NO_3-N test level	Corn silage yield goal in tons/acre			
ppm	17	21	25	28
Sidedress N recommendation (lbs N/acre)				
0 - 10	100	130	160	180
11 - 15	75	100	125	145
16 - 20	50	75	100	120
21 - 25	25	50	75	90
25+	0	0	0	0

* Based on field data from Massachusetts, Connecticut, Pennsylvania, and Vermont

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Nitrogen Management:
End-of-Season Cornstalk Nitrate Test

Introduction:

Many corn producers fertilize corn plants to maintain dark green color even late in the growing season. Producers therefore, may apply much more N than is really needed to obtain an economically optimum yield. Reliable tissue tests for detecting N status of corn plant can improve profitability and reduce the potential for nitrate contamination of water supplies.

During the grain-filling period, if nitrogen levels are not adequate, corn plants remove nitrogen from the lower portion of their stalks. When corn plants are over fertilized, nitrate will accumulate in the lower portion of stalks without contributing to a greater yield. Measurement of nitrate concentration in the lower portion of corn stalks at the end of the growing season can be used to determine nitrogen deficiency, sufficiency, or excess in corn silage, grain corn, and sweet corn. The Cornstalk Nitrate Test (CSNT) can be used to gain confidence in the nutrient management planning process. It can be used to check availability of N from manure and from the pre-sidedress N test (PSNT). In years with a cool and/or wet spring, microbial activity responsible for mineralization is low. In this condition PSNT may indicate the need for N fertilizer when sufficient N may still be released from the manure and soil organic reserve when soil temperature gets warmer later. The end-of-season cornstalk nitrate test can confirm if fertilizer was needed and help farmer decide N application adjustment in future years.

Measurement of nitrate concentration in the lower portion of corn stalks at the end of the growing season can be used to determine nitrogen deficiency, sufficiency, or excess in corn silage.

Sampling Procedure:

The test requires collection of corn stalks at end of season just before harvest. For grain corn, stalk samples should be taken between one and three weeks after black layer formation on 80% of kernels.

- Collect samples from 15 random plants for every 10 acres of field.
- Cut an 8 inch segment of stalk starting 6 inches above ground level.
- Remove leaf sheaths from the segments.
- Stalks severely damaged by disease or insects should not be used.
- Areas with differing soil types, or management history should be sampled separately.
- Place segments in a paper bag (not plastic, this promotes fungal growth) and dry or freeze.
- Send samples to:
  CSNT Lab
  Dept. of Plant, Soil, and Insect Sciences
  Bowditch Hall
  University of Massachusetts
  Amherst, MA 01003-9294

Interpretation of Stalk Nitrate Concentration:

Stalk nitrate concentrations for silage corn can be divided into three categories;
Low; less than 500 ppm N
Optimum; 500 to 1700 ppm N
Excessive; greater than 1700 ppm N

If test shows nitrate concentration is low, it means corn plants could have benefited from higher N fertilizer application. When N concentration is more than 1700 ppm N, it indicates that corn plant had access to more N than it needed to produce maximum yield. In this situation it is recommended that the farmer lowers fertilizer and /or manure application rates by 5-10% and repeat the test in the next 2-3 seasons to reach the optimum level.

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Nitrogen Management: Soil Amino Sugar Test

Introduction:

In humid areas including Massachusetts, the result of soil N measurements prior to planting is not accurate and most often cannot predict N needs for the coming growing season. In these regions, using Pre-Sidedress Nitrate Test (PSNT) which predicts N supplying capacity of the soil during the entire growing season is recommended. This soil testing method is especially appropriate for those cropping system where producers are utilizing animal manure. However, using PSNT is not always accurate and convenient since: a) soil samples should be collected during busy growing season; b) it cannot be used in fields where nitrogen fertilizer or manure has been applied in a band application; c) may be much less accurate when used on sandy soils or soils with poor drainage; d) results may not be accurate if the weather condition is wet and cold and therefore, N release processes through bacterial activities is slow. That is why in some growing seasons under or over N fertilization occurs; even when management practices on a farm remain unchanged. While excessive N application increases the risk of environmental pollution as well as production costs, insufficient application of N may cause significant yield reduction.

Soil amino sugar is highly correlated with responsiveness of soils to fertilizer-N. More amino sugar in soil decreases the response of corn to N fertilization.

Attempts have been made to introduce an alternative technique for determination of N sufficiency in soil for corn production. Ideally, a soil test for N would estimate the supply of organic N that gradually but continuously releases NO_3^-. This approach however, would be effective only if the organic N compounds are readily mineralized and highly correlated to fertilizer-N responsiveness.

Soil Amino Sugar Test (Illinois Soil N Test):

Most often, the total N content of soils is much higher than N available to the crop. The total soil N of an acre of soil is usually greater than 2,000 pounds per acre, while a high yielding corn hybrid in Massachusetts requires about 180 pounds per acre. Therefore, there must be some component of total soil nitrogen that acts as a reservoir for the growing crop.

Researches in Illinois reported that among various organic fractions in the soil, concentrations of amino sugar N is highly correlated with responsiveness of soils to fertilizer- N. In other words, accumulation of amino sugar N in soil reduces the yield response of corn to N fertilization. In these studies, soil concentrations of amino sugar N have shown a high correlation with both yield and fertilizer-N response.

For Soil Amino Sugar Test

- Soil samples should be collected from a depth of 8 inches.
- Sampling should be done 6-8 weeks after manure spreading or cover crop plow down to avoid any ammonium –N released in the soil by newly added organic materials.
- Results indicate organic N mineralization potential of the soil which is valid for 2-3 years. Therefore, when using this method, annual soil sampling is not needed.

How to Interpret the Results

When amino sugar N concentration of the soil is greater than 250 mg kg^{-1}, the corn plants most likely will not respond to additional N because there is enough readily mineralizable organic N in the soil. In this situation about 20-30 pounds of N in the starter fertilizer can be used. However, when amino sugar N concentration in the soil is less than 200 mg kg^{-1}

corn plants will most likely respond to N fertilizer application. The rate of N fertilizer can be determined as follows:

- 180 lbs N/acre for yield goal of 24 tons per acre, 160 lbs N/acre for yield goal of 20-24 tons per acre, and 140 lbs N/acre for yield goal of less than 24 tons per acre.
- Recommended N rates should be reduced if manure is applied in spring.
- Nitrogen credit from spring applied manure depends on rate of manure application, nutrient content of manure, and how fast manure was incorporated into the soil.
- Inorganic N in manure which accounts for almost half of the N is readily available after application. However, the rate of N release from organic N in manure is about 35, 12, and 5% in years 1, 2, and 3, respectively.
- As an example, if 6000 gallons of manure that contains 25 pound N per 1000 gallons was spread in spring and incorporated immediately into soil the total N credit for this season will be:

Inorganic N = 6000/1000 × 25 × 50% = 75 pounds
Organic N = 6000/1000 × 25 × 50% × 35% = 26 pounds
Total N credit = 101 pounds

The soil amino sugar test has potential economic implications for production agriculture, and also should be of value for controlling NO_3^- pollution of ground and surface water.

Resources:

Khan, S. A., R. L. Mulvaney, and R. G. Hoeft. 2001. A simple soil test for detecting sites that are nonresponsive to nitrogen fertilization. Soil Sci. Soc. Am. J. 65: 1751-1760.

Nutrient Management Spear Program Agronomy Fact Sheet Series: http//nmsp.css.cornell.edu

For more information visit www.umass.edu/cdl

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UMass Soil Test Levels for Corn and Forage Crops

A critical aspect of nutrient management is balancing supply and need of nutrients for each field.

Phosphorus:

Silage corn and Alfalfa		Grasses	
Soil Test level (P mg/kg)	Rating	Soil Test level (P mg/kg)	Rating
0-5	very low	0-4	very low
5-10	low	4-8	low
10-15	medium	8-13	medium
15-30	high	13-27	high
> 30	very high	>27	very high

Potassium:

Silage corn and Grasses		Alfalfa	
Soil Test level (K mg/kg)	Rating	Soil Test level (K mg/kg)	Rating
0-35	very low	0-40	very low
35-70	low	40-80	low
70-120	medium	80-140	medium
120-240	high	140-260	high
> 240	very high	>260	very high

Alfalfa: alfalfa and clover/grass hay crops.

Grasses: predominantly grass hay and pastures.

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Guidelines to Nitrogen Application on Agronomic Crops in Massachusetts

Introduction:

Adequate nitrogen is essential for optimum crop production. However, applying excess nitrogen can have serious environmental consequences. Nitrogen, in the form of nitrate, is extremely soluble in water and will be carried down below the root zone as the water drains. Over-application of nitrogen can mean a decrease in profits and an increased potential for ground water contamination.

Nitrogen dynamics in the soil are very complex with over 98% of the nitrogen in the top 6" of soil is 'tied-up' in soil organic matter and not readily available for plants. Nitrogen is released slowly as microorganisms decompose the soil organic matter. The rate of release increases as soils warm. This makes it very difficult to estimate nitrogen needs for the season based on a soil test taken before planting.

The largest demand for nitrogen by corn, for example, begins 30-40 days after emergence. If soluble nitrogen fertilizer is applied at planting, much of it may have been lost from the soil root zone through leaching by the time the corn has its greatest nitrogen requirement. In determining nitrogen fertilizer rates it is important to be aware of all nitrogen sources on the farm and to give them adequate nitrogen fertilizer credits.

Over-application of nitrogen can mean a decrease in profits and an increased potential for ground water contamination.

Nitrogen Sources on Farms:

Soil Organic Matter - Organic matter is approximately 5% nitrogen by weight. As it decays, nitrogen will be released in a form suitable for plant use. About 10-40 lbs/acre of fertilizer equivalent-N will be available in a growing season for every 1% of organic matter in the soil. Rate of N release is dependent on soil temperature, pH, moisture, oxygen and type of organic material. For example, a soil with an organic matter content of 4% in average will supply about approximately 80 lbs N/acre.

Manure - Animal manures supply nitrogen to crops, but the fertilizer equivalent from manures will vary greatly depending on such factors as animal species, moisture content, handling and storage, and the elapsed time between spreading and incorporation. If manure is applied, it is important to know the analysis and the amount that you are spreading. If for example 20 tons/acre of dairy manure (10 lb N per ton in average) is applied and incorporated into soil the same day, then approximately 120 lbs/acre of nitrogen is available that year. Even though 200 lbs of nitrogen would be added to the soil, only 50 to 60% of that nitrogen is available the first year with the remainder becoming available in subsequent years. However, if the manure is incorporated after 48 hours or later only 40 lbs/acre of nitrogen will be available. More than 60 lbs will have been lost to the atmosphere and through runoff. Liquid portion of manure contains almost 50% of the total N and nearly 90% of the potassium. Therefore, it is very important to conserve the liquid portion of the manure.

Legumes - Legumes can supply substantial amounts of nitrogen when incorporated. The amount of nitrogen will vary widely depending on the legume species, the amount of time that it has been allowed to grow before incorporation, in addition to other climatic factors. The fertilizer equivalent can be as high as 100 lbs/acre from a reasonable stand of

alfalfa, or a good stand of hairy vetch planted in early to mid-September and incorporated in late May.

Non-legume cover crops - Non-legumes such as winter rye and oat are not as rich in nitrogen as legumes; however they will conserve nitrogen in the field and eventually release it when incorporated.
Many non-legumes are very efficient in 'mopping-up' nitrogen that is still available in the soil after crops are harvested. This emphasizes the importance of seeding cover crops soon after harvest since most of the leaching of nitrates in the Northeast occurs in the fall and spring. We are recommending that legumes be seeded in combination with grasses like rye and oat so that less nitrate will move below the root zone. Although legumes can fix nitrogen from the atmosphere, most are not as efficient as grasses in taking up nitrogen from the soil.

Composts - Composts can also be used to add nutrients and organic matter to the soil. Composting dairy manure can be used to help stabilize nitrogen in excess to crop requirement. Composts vary in their nitrogen supplying capacity and even though nitrogen is stabilized, some can supply substantial amounts of nitrogen.

Chemical Fertilizer - Most formulations of chemical fertilizer are readily available to crops soon after soil application. This however, is accompanied by a high leaching potential. Spring applications of chemical fertilizers coupled with the usual wet conditions at this time of the year increase the danger of leaching. As mentioned above, the greatest amount of nitrogen uptake by corn begins several weeks after plant emergence. Timing fertilizer applications to coincide with this time of greatest demand by the crop will make for more efficient fertilizer utilization.

Recommended Nitrogen Rates for Agronomic Crops:

Corn Silage-Recommended nitrogen rates are based on yield goals and should be reduced by the N credits from previous crops, previous manure application and current manure application. In Massachusetts the following rates are recommended:

- 140 lb N/ac for less than 20 ton corn silage per acre (or <100 bu/ac)
- 160 lb N/ac for 20 to 24 ton corn silage per acre (or 100 - 130 bu/ac)
- 180 lb N/ac for greater than 24 ton corn silage per acre (or >130 bu/ac)

Legume Based Hay-Nitrogen fertilizer application is not generally recommended for forage legume hay crops including alfalfa, clovers and birdsfoot trefoil. These legumes can fix sufficient atmospheric N to supply the needs of both the legume, and the grass in legume-grass mixtures. Adding nitrogen may encourage competition from the grass and from weeds as stands thin or are damage by harvest equipment or by winter conditions.

Use of a starter fertilizer during establishment of up to 20-60-20 lb (N-P_2O_5-K_2O) per acre may be beneficial especially in cool soils without a history of manure application. Band placement if possible to maximize the benefit of the phosphorus is highly recommended. Do not use any nitrogen in no-till seeding as this will encourage weed competition.

Application of manure when surplus to needs of the corn crop is possible to vigorous alfalfa stands and to stands that are running out. It is not recommended to stands in early stages of decline or to legume-grass hays where there is a desire to retain the legume.

For legume grass mixtures use the grass hay maintenance recommendation for hay crops that have little or no legume component. For example if the amount of birds foot trefoil has declined to 30% or less use the grass hay recommendation.

Grass Hay-For all perennial grasses seeded alone apply 40-40-40 lb per acre, banding if possible. Do not apply any nitrogen as plow down. Applying 30 lb N per acre in late summer of the establishment year can be beneficial.

For established grass apply up to 150 lb N per acre per year in split applications. Apply 50 to 60 lb/acre when the grass first greens up and 50 lb/acre after each cutting. The amount applied after each cutting should be based on the expected yield for the next cutting.

Pasture-Fertilizing pastures with nitrogen is not recommended if the legume content is greater than 30% because the legumes (usually clovers or trefoil) provide adequate nitrogen through N fixation. If there is less than 30% legume, fertilize similar to grass hay with 100 to 150 lb N per acre per year depending on the productivity and growth cycle of the species. Split applications applying at least three times, early spring, early summer, and late summer, with no more than 50 lb N per acre at any one time.

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Manure Spreader Capacity

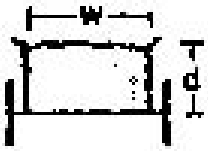
Introduction:

Determining manure spreader capacity is one of the important aspects of manure management. Use the following datasheet to determine your spreader's capacity:

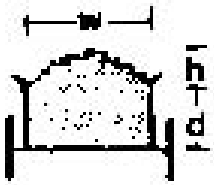
For weight basis:

- Tons/load = volume × density ÷ 2000.
- Density = [wt. of 5-gal bucket full of manure – wt. of empty bucket] × 1.5
- Density varies between 55 (dry) to 62 (liquid) lb/cu ft.
- The more bedding in manure, the less dense the manure will be and the more water, the denser the manure.

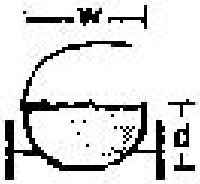
To determine the volume, select one of the following spreader and then follow the calculations:



Box spreader (level load)
Volume = length (l) × width (w) × depth (d)



Box spreader (piled load)
Volume = length (l) × width (w) × depth (d) ÷ staking height × 0.8



Flail-type barrel
Volume = length (l) × width (w) × depth (d) × 1.6

Determining manure spreader capacity is one of the important aspects of manure management.

Example: You have measured your box spreader (level load) and found its inside dimensions to be 12 feet long and 5 feet wide. An average depth of load is 4 feet high:

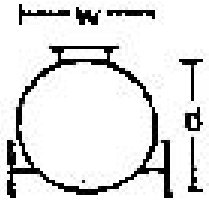
Volume = 12 ft × 5 ft × 4 ft = 240 cu ft

Your 5-gallon bucket weighed 3 pounds when empty and 42 pounds when filled with manure:

Density = (42 lb - 3 lb) x 1.5 = 58.5 lb/ft^3

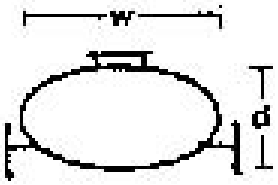
Tons/load = 240 (lb) × 58.5 (lb/ft^3) ÷ 2000 (lb/ton) = 7.02 ton

For tank spreaders, you assume that the tank is not completely filled because of foaming. Therefore, you measure the volume and then multiply it by 80%:



Round tank spreader

Volume = length (l) × tank diameter (d) × tank diameter (d) × 0.8



Noncircular tank spreader

Volume = length (l) × width (w) × depth (d) × 0.8

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Manure Spreader Calibration

Introduction:

To be able to manage manure on farms it is essential to know the quantity being spread. Knowing the amount of manure spread at the planned rate and plant nutrients available from the manure enables an adjustment to be made to the amount of fertilizer needed. It is important to spread the manure evenly possible to avoid part of the field getting excessive nutrients and another part not getting enough. Equally important is to spread the manure over the whole farm since the nutrients in the manure in part come from crops harvested from the whole farm. This will avoid potential accumulation of excess nutrients in fields close to the barn.

How to Calibrate Manure Spreader:

Method 1 (solid or semi solid manure)

Equipment required: plastic sheet 6 x 6ft or 10 x 10ft, scale, and a bucket.

1. Weigh sheet with bucket on the scale.
2. Lay sheet in the field in the path of manure spreader, positioning it so the tractor will be at spreading speed before it reaches the sheet.
3. After spreading, weigh sheet and manure in the bucket. Repeat this step to get an average weight. Subtract weight of sheet plus bucket.
4. Tons manure/acre = wt. of collected manure (lb) x 21.8 ÷ size of plastic sheet (sq ft)

Proper and timely adjustment of manure spreaders can minimize the chance of over-application of manure.

Method 2 (liquid manure)

Equipment required: yard stick, rope.

1. Determine manure spreader capacity (see factsheet number 26).
2. Tie rope around the tractor tire to determine distance traveled in one revolution.
3. Spread manure load, counting wheel revolutions to determine the distance traveled.
4. Measure width that spreader is covering with manure, multiply by distance traveled.
5. Divide by 43,560 to determine area (in acres) covered by one load.
6. Divide spreader capacity (step 1) by acres covered (step 5) to determine tons or gallons applied per acre.

For more information visit www.umass.edu/cdl

Factsheets in this series were prepared by Stephen Herbert, Masoud Hashemi, Carrie Chickering-Sears, and Sarah Weis in collaboration with Ken Miller, Jacqui Carlevale, Katie Campbell-Nelson, and Zack Zenk.

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Field Assessment for Determining Priority of Manure Application

Introduction:

Spreading livestock and poultry manure on crop and pastureland is an increasingly popular and recommended way to provide plant nutrients or to fertilize fields. This reduces the need to purchase feed and inorganic fertilizer. Managing manure to optimize its economic returns and at the same time minimize its potential environmental impact is critical.

In the past, manure spreading strategies have often been based on convenience. Usually those fields that are closest to the barn receive most manure. This strategy does not account for the economic value of nutrients in the manure and fails to protect the environment, especially air and water quality.

Based on soil test and state specifications, fields are required to be ranked for receiving manure.

Every farm is unique with respect to site conditions, cropping patterns, and number and type of livestock. However, there are basic criteria that can be used for developing a manure application strategy. Based on soil and manure analysis, cropping system, and site limitations, fields can be ranked from highest to lowest priority for receiving manure.

What follows is a simple and flexible ranking method which farmers can use to quickly determine which fields should have priority for receiving manure. Fields with the highest accumulated points should be considered priority fields for manure application.

Category	Points*	Field # 1	2	3
1. Planned Crop (select one only)				
a. Continuous corn or corn not following legume:				
yield goal > 25 ton/acre	10			
yield goal 20-24 ton/acre	9			
yield goal <20 ton/acre	8			
b. Second-year corn following legume	8			
c. First-year corn following legume	1			
d. First-year corn following non legume	10			
e. Non-forage legume	2			
f. Small grains	6			
g. Prior to direct seeding legume forage	7			
h. Top dress (good legume stand)	1			
i. Top dress (fair legume stand)	2			
j. Top dress (poor legume stand)	3			
k. Hay grass	6			
2. Phosphorous and Potassium soil test level (select one for each category)				
A: Phosphorous (ppm)				
a. < 5 (Very low)	15			
b. 6-10 (Low)	12			
c.11-15 (Medium)	10			
d. 16-20 (Optimum)	6			

Prioritization of fields for manure application saves money and protects the environment.

e. 21-25	(High)	4
f. 26-30	(Very high)	1
g. >30	(Excessive)	0

B: Potassium (ppm)

a. <70	(Low)	10
b. 71-120	(Medium)	8
c. 121-240	(High)	4
d. >240	(Very high)	0

3. Site / Soil conditions
(select one for each category)

A: Proximity to surface water or ground water

a. Manure applied and incorporated within frequently flooded plain or within <150 ft of surface water or ground water access	1
b. Manure applied and incorporated within frequently flooded plain or within 150-300 ft of surface water or ground water access	3
c. Application outside these restrictions	5

B: Slope (%)
(Do not apply in winter (Dec–Feb) if slope > 2 %)

a. <2	10
b. <6 (incorporated, contoured, or terraced)	8
c. <6 (no runoff reduction practices)	6
d. <12 (with runoff reduction practices)	4
e. <12 (no runoff reduction practices)	2
f. >12	1

C: Soil texture

a. Sands, sandy loams, loamy sands (fall app.)	1
b. Sands, sandy loams, loamy sands (spr. app.)	3
c. Other soils	5

D: Depth to bedrock (inches)

a. 0-10	0
b. 10-20	1
c. > 20	5

E: Years since manure applied

a. > 5 years	10
b. 2-5 years	5
c. applied manure last year	0

F: Distance to storage

a. <2 miles	10
b. 2-6 miles	5
c. 6-10 miles	0
d. >10 miles	-10

G: Odor and neighbor concerns -20

4. TOTAL POINTS

_____

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Soil Organic Matter

Introduction:

Soil organic matter (SOM) is the fraction of the soil consisting of plant and animal residues in various stages of decomposition. Organic matter contains organic carbon and nitrogen. Carbon is a source of energy and nitrogen is a source of protein for microorganisms in the soil. Some of the microorganisms are pathogens which cause plant disease but in a healthy soil the vast majorities of these organisms are beneficial and help prevent any one type of organism such as a plant pathogen from being dominant.

Organic matter is the key to soil health and contributes to soil productivity in many ways.

SOM consists of three distinct parts.

Living organic matter (about 15%) consists mainly of decomposers:

Microbial Group	Population per gram of soil
Bacteria	300,000 – 200,000,000
Actinomycetes	100,000 – 100,000,000
Fungi	20,000 - 1,000,000
Protozoa	10,000 - 100,000
Algae	100 - 50,000

Other living SOM include nematodes, insects, earthworms, plant roots and small animals.

Dead organic matter (about 15%) serve as food for living organisms and include dead microbes, old plant roots, crop residues and bodies of larger insects and animals.

Very dead organic matter (about 70%) are well decomposed, dark colored organic substances also called humus. Humus continues to decompose, but at a very slow rate.

Why is SOM important?

Organic matter in soil is the key to soil health. SOM improves many physical, chemical, and biological characteristics of the soil, including water holding capacity, cation exchange capacity, pH buffering capacity, and chelating of micronutrients. Furthermore, well decomposed SOM improves soil structure by increasing aggregation, enhances biological activities in the soil, slowly releases nutrients, and suppresses some diseases. A loss of SOM can lead to soil erosion, loss of fertility, compaction, and general land degradation.

A single manure application of cover crop will not increase the percent organic matter significantly. It takes time and patience to improve the soil organic matter level.

What factors influence the amount of SOM?

The average SOM in most Massachusetts soils ranges between 1-5 % where a minimum of 4% SOM is desirable. The maintenance and enhancement of soil organic matter is crucial to the soil health and sustainability of farming systems. The accumulation of SOM within soil is a balance between the return or addition of plant and animal residues and their subsequent loss due to the decay of these residues by microorganisms and mismanagement of soil. In general, any factor that affects soil microbial activity also affects SOM breakdown.

Temperature-Soil temperature has a marked influence on microbial activity. The optimum soil temperatures for bacterial activity are in the 70 to 100^{o} F range, but some activity may occur in as low as 40^{o} F, although at greatly reduced rates.

Oxygen-Soil microbes require oxygen and water for their respiration and when soil is compacted or saturated with water, respiration slows down which in turn reduces decomposition of SOM.

Soil pH-Under acid conditions, bacterial activity which is responsible for most of the decomposition of organic matter is greatly reduced. Soil fungi responsible for breakdown of SOM are generally less affected by low pH.

Best Management Practices to increase SOM:

Soil organic matter level depends on both uncontrollable factors i.e. weather conditions, and controllable factors i.e. soil management. Managing SOM is a balancing act of additions; crop residues, manure, and compost and losses; decomposition plus erosion.

Addition of organic materials including animal manure, compost, cover crops (green manure), and some off-farm materials such as municipal leaves and food residuals will increase SOM. Agricultural practices also have a significant effect on improving SOM level:

- Cover crops: Increase SOM directly when residues are returned to the soil, protects soil against erosion, helps to retain and cycles nutrients.
- Crop rotations: Perennial forages (hay-type crops) develop extensive root system which when die add new organic matter to the soil. They also reduce the rate of decomposition of SOM because soil is not continually being disturbed.
- Tillage practices: Conventional plowing and disking breaks down natural soil aggregates that allow wind and water erosion. They also expose the soil to direct sunlight which increases the SOM decomposition.
- Increasing the percent organic matter in the soil takes time and patience. It is unlikely that a single incorporation of manure or cover crop will noticeably increase the percentage of organic matter. Repeated application of an organic amendment in combination with reduced tillage will improve the organic matter level.

Resources:

Soil Organic Matter. Maryland Cooperative Extension, Fact sheet # 783.

Cornell Soil Health Assessment Training Manual. Cornell University, College of Agricultural and Life Sciences.

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Basics of Pasture Management

Introduction:

Pasture management must emphasize utilization of all feed grown.

Productivity of livestock as individuals and productivity on a per unit area basis both originate from the combined effects of (i) efficient capture of solar energy (sunlight), (ii) efficiency in forage harvested by the animal(s), and (iii) efficiency in conversion of the forage into animal growth or production. The first two of these will be discussed in more detail below. Feed grown does not benefit the animal or become profit until it is utilized by grazing animals.

Sufficiently high stocking rates are necessary to graze the whole area of a paddock.

Poor utilization results in selective overgrazing of the most palatable species, wasted feed, poor regrowth, and opening up of the sward with establishment of weeds. Continuous heavy grazing may cause a reduction in legumes because of reduced energy reserves for regrowth. High producing pasture species, on productive soils, have highest production with rotational grazing that allows a resting period for forage growth, and full recovery of reserves for regrowth. When growth is slower, the recovery period between grazings is lengthened.

The length of the rest period between grazings must be varied.

The rest period may be only 12-15 days after grazing in mid-April, but should be lengthened to 30-36 days after grazing in late August (Table 1). To be able to manage pastures and to provide animal-free rest periods there must a sufficient number of paddocks. This is illustrated in Table 2 with the number of paddocks required at the season's end. Earlier in the season when rest periods are shorter fewer paddocks would be needed to complete one rotation of grazing. Surplus forage from paddocks not included in this first grazing may be harvested as haylage or hay, thus conserving feed for winter. Too often dairy farmers in New England adopt a modified version of set stocking or lax form of rotational grazing. With set stocking there is difficulty in matching feed supply to animal requirements and as a result many farmers under-stock continuously grazed areas. Figure 1 shows the effect of grazing pressure on animal productivity.

Pasture Tip:
Dairy, beef and sheep farmers in New Zealand and the UK use a simple 'workboot' measure to evaluate pasture mass available pre- and post-grazing. With practice they become proficient at estimating pasture mass from the pasture height on their boot.

Table 1. Length of Rest Period.

Mid-Apr to mid-May	12-15 days
June 1	24
July 1	24
August 1	30
September 1	30-36

Productivity of pastures is influenced by the availability of a soil nitrogen source.

This most economically can be provided by legumes fixing atmospheric nitrogen in root nodules. Fertility and grazing management must be designed to promote the growth and persistence of legumes in mixed grass and legume pastures. Other nutrients also must be in balance and are best checked by using a soil test.

Table 2. Number of paddocks needed for a 36 day rest period.

Days Grazing	Number of Paddocks
½	73
1	37
2	19
3	13

Correct height of grazing of varies with species.

Continually grazing tall growing species such as orchardgrass to one inch will depress yield and cause a decline in plant vigor because of low residual leaf area and because tillers that store energy for regrowth are also partially grazed. Such management of alfalfa, which depends on the root

reserves for regrowth, would soon lead to a stand decline, both in vigor and number of plants. Shorter growing species such as white clover, Kentucky bluegrass and perennial ryegrass can withstand grazing to one inch. For legume-grass mixtures, light grazing over a prolonged period may lead to a reduction in legumes because of competitive growth of the grass. Continuous heavy grazing may also cause a reduction in energy reserves in roots that are needed for regrowth. Rotational grazing, with a short grazing period followed by an adequate regrowth between grazings, will promote persistence of legumes, and increase growth and quality of grasses. It may also increase profitability of the farm enterprise.

Table 3. Guide for managing forage species and mixtures.

Species	Continuous grazing average height of pasture	Rotational grazing heights Before	After
	---------- inches or stage ----------		
Bluegrass-white clover	2 to 3	4 to 6	1 to 2
Perennial Ryegrass	2 to 3	4 to 6	1 to 2
Orchardgrass-ladino clover	3.5 to 5	7 to 10	2 to 4
Alfalfa	N/R[1]	bud[2]	2 to 3
Alfalfa-grass	N/R	bud	3 to 4
Red clover	N/R	bud	2 to 3
Red clover-grass	N/R	bud	2 to 4
Birdsfoot trefoil	3.5 to 5	bud[3]	3 to 4
Birdsfoot trefoil-grass	3.5 to 5	10 to 12	3 to 4

N/R - not recommended to graze continuously
[2] Allow alfalfa to go to first flower at least once during the summer
[3] To replenish the stand, allow trefoil to go to seed once every two years

Maintaining an adequate quantity of available pasture will influence animal performance (Fig 1). If overgrazed animals cannot consume sufficient forage while undergrazing leads to much wasted feed through plant avoidance and trampling.

Other Considerations:

Adequate fencing is needed to control animals being managed particularly for rotational grazing. The animal type and temperament will dictate the style and needed strength of the fence. There are many fencing options including permanent multi-strand high-tensile boundary fences, with or without being electrified, where reliability in containing animals is essential. The other extreme is a temporary single electrified polywire fence which is movable depending on size of paddock needed for grazing. Electrified tape and rope are sometimes used for making fences more visible.

Animals also need access to water. On average a dairy cow requires 20 gallons of water daily, a horse 10 gallons and one sheep 2 gallons. Research has shown that as the distance to the water source increases above 900ft the amount of pasture forage decreases. Access to water is needed in each pasture. If animals have to travel back to a centralized water tank near the barn then they are less likely to return to the pasture to continue grazing. Nutrient transfer is also influenced by location or portability of water.

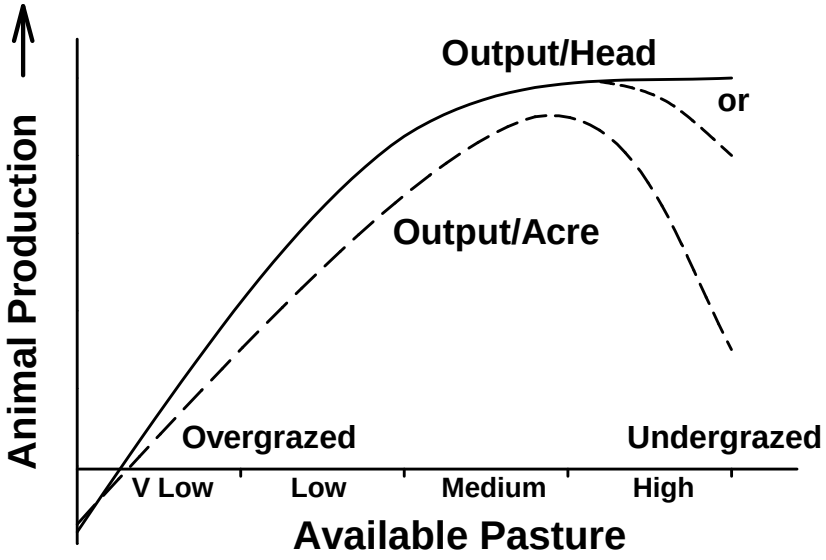

Figure 1. Influence of available pasture on animal production.

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Alfalfa *In-brief*

Description and Adaptation of Alfalfa (*Medicago sativa*)

Origin:

Comes from Asia minor, a semi-arid region where insufficient moisture is the chief limiting factor to plant growth. With little or no leaching, soils were neutral in reaction and generally well supplied with minerals. The name "alfalfa" comes from the Arabic language, meaning "best forage". Alfalfa was carried across North Africa and southern Europe to Spain, from Spain to the West Coast of South America, and from there to California about 1850.

Plant Characteristics:

Root system - Long, thick, sparsely branched tap root with few small roots. Where soil conditions favor deep rooting, tap root may penetrate 15 to 20 feet. Deep rooting habit (where possible) makes alfalfa a very drought resistant plant. Lack of abundance of small feeding roots may account for part of the difficulty in getting satisfactory inoculation.

Stems - Moderately strong, woody, upright stems high in fiber. For this reason and others, alfalfa is chiefly a hay and not a pasture plant. Stems arise from a "crown" or part of the plant close to the soil surface. The crown increases in size each year and may measure 12 inches or more in diameter. As a crop of stems begins to flower, new stems or "shoots" start to grow from the crown. This periodic development of new shoots (every four to six weeks during the growing season) explains why alfalfa is so productive. Two, three and even four crops can be harvested in one season. In the Imperial Valley in southern California, ten crops of alfalfa are harvested in one year.

Leaves - Palatable and nutritious but can be easily lost during drying especially if raked below 40% to 50% moisture.

Flowers - Typical small "bean" type flowers occurring individually. Medicago sativa (alfalfa) has purple flowers; *Medicago falcata* (a trailing, cold resistant species) has yellow flowers. Most cool region varieties have come from *sativa* x *falcata* crosses for winter hardiness. Flower color is "variegated" - from purple to almost white and light yellow.

Soil Adaptation:

The soil requirements of alfalfa are exacting. Drainage must be good and high fertility levels must be maintained. A constant supply of available calcium, magnesium, potassium and boron is essential. A pH of 6.5 or above should be maintained.

Diseases and Insects:

Alfalfa is plagued with many serious diseases and insect pests in humid regions. Leaf spot diseases are especially serious with first cutting. Several insects including alfalfa weevil, and leafhopper are potentially serious pests.

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Birdsfoot Trefoil *In-brief*

Description and Adaptation of Birdsfoot Trefoil (*Lotus corniculatus)*

Origin:

First cultivated in northern Europe.

Plant Characteristics:

Root system - Strong branched tap root with many smaller roots.

Stems - Relatively small stems arising from a crown semi-erect or upright in growth habit. There is less fiber than in alfalfa or red clover.

Leaves - Palatable and nutritious. Occur alternately either side of the stem. Each is composed of five leaflets, three apical and two basal resembling stipules.

Flower - Large "bean' type yellow to orange flowers. "Corniculatus" is from the Latin meaning 'yellow'.

Soil Adaptation:

Adapted to loam soils with good moisture holding capacity, and also to heavy clay soils. It is not adapted to sandy soils. High soil temperatures appear to favor root diseases. Legume of choice where drainage or acidity are a problem. It will tolerate low levels of fertility but is productive only on soils with good fertility.

Birdsfoot trefoil is a slow growing perennial legume adapted to cooler climates. It is slow to establish and being a light loving plant will not withstand much competition at the seedling stage. Successful inoculation is difficult. Birdsfoot trefoil is more tolerant of grazing than alfalfa and red clover, and will normally outlive red clover by several years. Bloat is not a problem with birdsfoot trefoil.

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Red Clover *In-brief*

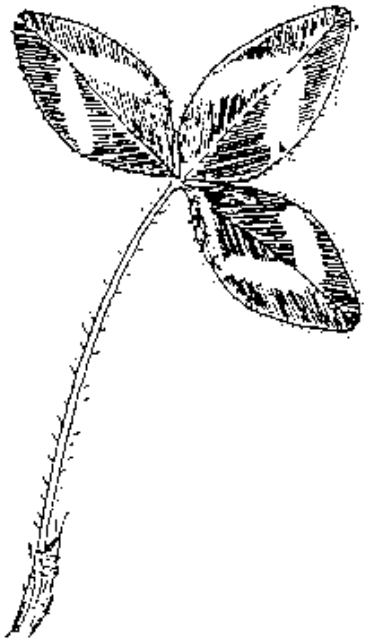
Description and Adaptation of White Clover (*Trifolium pratense*)

Origin:

First cultivated in northern Europe.

Plant Characteristics:

Root system - Well developed tap root with many small roots contributes to drought tolerance and ease of inoculation.



Stems - Strong, upright woody stems, high in fiber. A better hay than grazing plant.

Leaves - Palatable and nutritious.

Flower head - The pink to red flower head is made up of many (100 or more) small typical legume flowers.

Soil Adaptation:

Will grow on wide variety of soil types, from sandy loams to silty clay loams of from moderate to high levels of fertility. Red clover is relatively easy to establish and will grow on soils too acid or too wet for alfalfa. It is a short-lived perennial which persists for only one and a half to three years. It is susceptible to disease.

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White Clover *In-brief*

Description and Adaptation of White Clover (*Trifolium repens*)

Origin:

First cultivated in northern Europe. Ladino clover, is a large form of white clover, originated near Lodi in the Po River Valley in northern Italy.

Plant Characteristics:

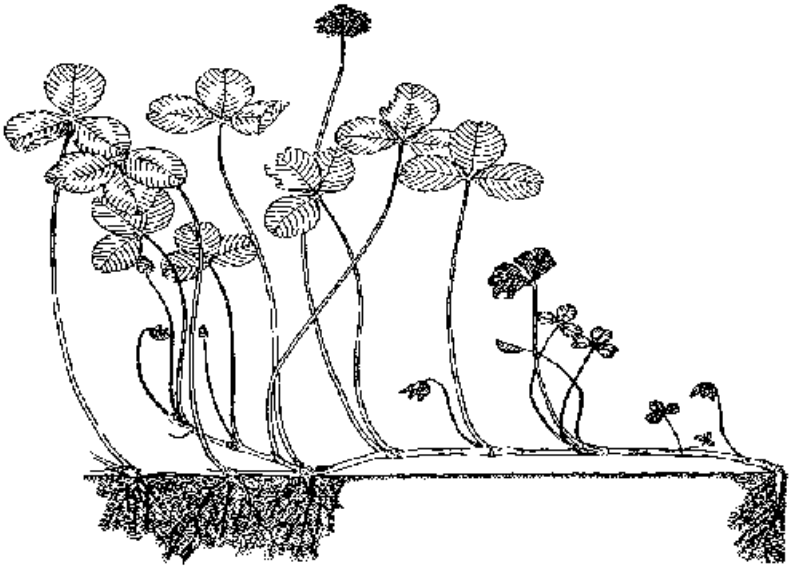
Root System - Seeding plant develops several small short tap roots. Additional short fine roots arise at the nodes of trailing stems which spread over the ground. Because of the relatively small shallow root system, white clover, including Ladino, is very sensitive to dry weather.

Stems - Main stems trail on the ground surface, but many upright stems or petioles, some bearing leaves and some seed heads, arise at nodes. Stems and leaves are soft and succulent, making white clover and Ladino the most palatable and nutritious of the clovers.

Flower head - Flower heads and flowers are white and smaller than those of red clover.

Soil Adaptation:

Adapted only to soil with moderate to good moisture relationships. Ladino clover and New Zealand type white clovers are among the most productive, palatable, and nutritious legumes available, especially for pasture. The most serious problem is animal bloat, hence these clovers must be grazed with caution. Ladino clover is larger leafed and more suited to hay situations when combine with grass than Dutch or common white clover.



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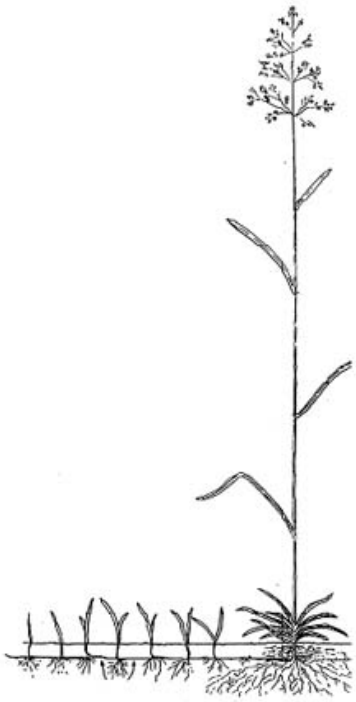
Kentucky Bluegrass *In-brief*

Description and Adaptation of Kentucky Bluegrass (*Poa pratensis*)

Plant Characteristics:

Kentucky bluegrass is a long lived sod-forming perennial grass. Stems grow 1 to 2 feet in height when allowed to grow uncut. Leaves are narrow and dark-green 2 to 7 inches in length. The inflorescence is a pyramid-shaped panicle about 2 to 8 inches long. Kentucky bluegrass reproduces by rhizomes as well as by seed. New tillers with their roots, grow from the nodes along the rhizomes, continually filling the spaces left by the death of the older tiller tufts. Each tiller tuft may only survive for two years.

Kentucky bluegrass is a palatable pasture plant making very early growth in the spring. It becomes the dominant grass species, in most of the older pastures. It withstands close and continuous grazing, but becomes nearly dormant in midsummer when daily maximum temperatures approach 90^0F. Growth resumes with the return of cool weather in the fall. Kentucky bluegrass is not a good hay crop.



Adaptation:

Kentucky bluegrass is adapted to the humid and subhumid sections of the northern half of the United States. It does best under cool, humid conditions on highly fertile soils not prone to drought. Kentucky Bluegrass grows best on heavier soils with a pH above 6.

In pasture mixtures, bluegrass is generally seeded with other grasses, and clovers. Usually two to three years are required to produce a good sod from seeding. Because of its dense turf, bluegrass is also the most popular lawn grass in America.

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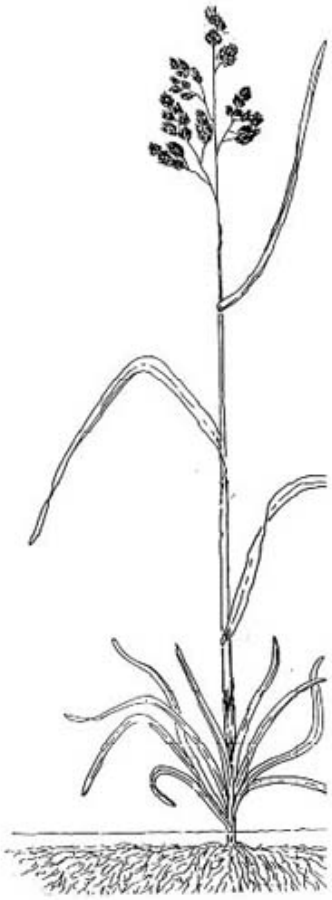
Orchardgrass *In-brief*

Description and Adaptation of Orchardgrass (*Dactylis glomerata)*

Plant Characteristics:

Orchardgrass is a long-lived perennial, a distinctly bunched type of grass with folded leaf blades and compressed sheaths. It is non-sod-forming without rhizomes. The flowering stems (culms) are smooth and from 2 to 4 feet high. The inflorescence is a thickly clustered panicle 3 to 6 inches long. Panicle branches have a few one sided dense clusters of green or purplish spikelets.



Adaptation:

Orchardgrass is shade tolerant is a vigorous, tall, rapid grower and is next to Kentucky bluegrass in being one of the earliest to start growth in the spring. It continues growth to quite severe frosts. It is more heat resistant and drought resistant than timothy or smooth bromegrass and makes excellent regrowth in the summer period. It tolerates the 3-cut system used with intensive alfalfa production better than other grasses. Orchardgrass must be well managed to limit its competition with legumes and for acceptable feed value. Orchardgrass will not stand close continuous grazing and is best adapted to medium-textured well-drained soils.

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Reed Canarygrass *In-brief*

Description and Adaptation of Reed Canarygrass *(Phalaris arundinace)*

Plant Characteristics:

Reed canary grass is an erect long-lived clumpy perennial with coarse rhizomes. It grows 2 to 7 feet tall with leafy stems. Under proper hay and pasture management it makes a dense, close sod. It spreads by rhizomes as well as by seeds. When it mature seeds shatter unevenly from an inflorescence which is a semi-dense panicle 2 to 8 inches long. Reed Canarygrass may become weedy or invasive and in Massachusetts because it may displace desirable vegetation in wetlands it has been placed on the invasive species list. Thus, it is prohibited to buy seed and plant new fields of Reed Canarygrass.

Adaptation:

Reed canary grass is a wetland grass that also does well on peat and well drained land. It can be used for pasture, silage or hay as well as for erosion control. It starts growing early in spring and is both summer and winter hardy. Having a long growing season, its forage is palatable and nutritious and will yield 3 to 5 tons per acre. To obtain best forage, the grass should be kept from becoming coarse and from reaching maturity. First grazing should be made before jointing or between early and full head. This latter management will probably require clipping. The cutting for hay should be between the early and full head stage. Second cutting should be based on the appearance of new basal sprouts near the soil surface.

For more information visit www.umass.edu/cdl

Factsheets in this series were prepared by Stephen Herbert, Masoud Hashemi, Carrie Chickering-Sears, and Sarah Weis in collaboration with Ken Miller, Jacqui Carlevale, Katie Campbell-Nelson, and Zack Zenk.

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Smooth Bromegrass *In-brief*

Description and Adaptation of Smooth Bromegrass (*Bromus inermis*)

Plant Characteristics:

Smooth bromegrass is an erect sod forming perennial ranging in height from 20 to 40 inches. Pure stands of bromegrass are likely to develop a sod-bound condition in three years, unless fertilized with nitrogen. Growth begins early in spring and continues into late fall. Bromegrass makes high quality hay or silage. Protein content is relatively high and crude-fiber content relatively low. It is a palatable pasture plant especially for spring grazing. Smooth bromegrass matures later in the spring and makes less summer growth than orchardgrass.

Adaptation:

Smooth bromegrass is a widely adapted cool season grass. It can be grown on a wide variety of soil types, but makes its best growth on moist, well-drained clay to silt loam soils. It produces satisfactorily on sandy soils when there is sufficient moisture, and will survive periods of drought and high temperatures.

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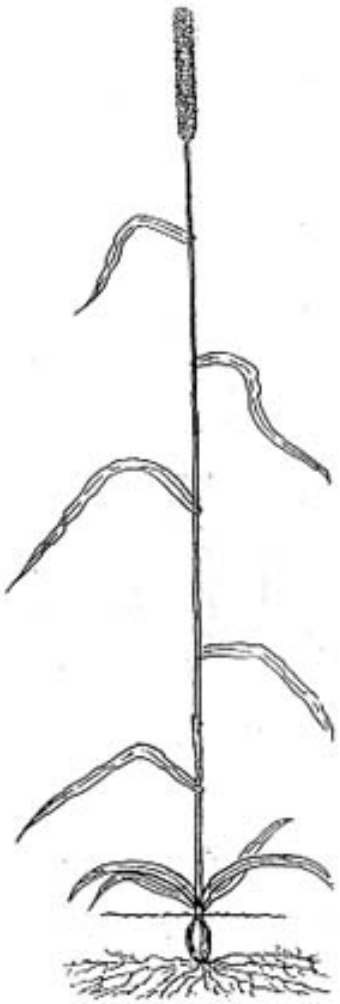
Timothy *In-brief*



Description and Adaptation of Timothy (*Phieum pratense*)

Plant Characteristics:

Timothy is a relatively short-lived perennial, a bunched grass with a shallow, compact and fibrous root system. It has erect flowering stems (culms) 20 to 40 inches high topped by a dense cylindrical spikelet inflorescence. Spikelets are one flowered but it is a prolific seed producer. Leaves vary in length from a few inches to about a foot. Timothy is different from most other grasses because of a basal internodal swelling of the stem and this can be used for identification.

Adaptation:

Timothy is adapted to cool and humid climate. It is more cold resistant than most cultivated grasses but is not drought resistant. It is better suited to finer textured soils and even tolerates poorly drained soils but not wet or droughty soils. It produces an excellent first cutting each year, but tends to be summer dormant if temperatures exceed a 77^0F mean temperature. It is a good companion grass for legumes but will not stand close grazing or trampling, and survives poorly in alfalfa mixtures harvested under 3-cut or 4-cut systems.

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Equipment Maintenance

Introduction:

Many farm tasks require the use of equipment. Proper maintenance of equipment is crucial in the smooth day to day operations of a farm. Periodic inspections are the best way to prevent potential breakdowns and setbacks. No matter what the equipment is, a few minutes to look things over before getting started could save thousands of dollars and countless hours spent on equipment repair. Several different manufacturers make equipment which performs the same job, but equipment parts and modes of functioning will be different from one manufacturer to the next. Reading the owner's manual is the easiest way to become familiar with and get a basic understanding of how the equipment functions. Operating the equipment is the best way to become familiar with how it handles and what its limitations are. Required maintenance may also vary between equipment manufacturers. Referring to the owner's manual is the best way to find out manufacturer recommendations for required maintenance. The more a piece of equipment is used, the more maintenance will be needed, even more than what the manufacturer recommends. Get to know each piece of equipment.

Get to know the equipment. Read the owner's manual.

Best Management Practices:

1. Become familiar with the equipment. **READ THE OWNER'S MANUAL**.
2. Inspect equipment periodically, particularly before and after jobs requiring extended and heavy use.
3. Check the fluids (engine oil, transmission fluid, coolant level, etc.)
4. Check for leaks around hydraulic lines, fuel lines, radiator hoses, oil lines, and cylinders.
5. Check for loose and broken bolts and pins.
6. Check bearings for any play or grinding.
7. Check tension on belts and chains.
8. Check belts for cracks.
9. Check the air filter and change as needed.
10. Check the tire pressure.
11. Listen for any unusual sounds.
12. Pay attention to any unusual odors.
13. Pay attention to any unusual responses from equipment.
14. Change oil and oil filter as needed. Oil and oil filter will need to be changed more frequently with heavy use of equipment.
15. Change hydraulic oil once every couple of years. Hydraulic oil will need to be changed more frequently with heavy use of hydraulically driven implements.
16. Change fuel filter at least once a year.
17. Grease equipment frequently. Lubricate cables and chains frequently.
18. Tools that are used frequently should be kept with the equipment.

Inspect equipment periodically and pay attention to anything out of the ordinary.

Much maintenance can be done during the off season, but if possible, make repairs immediately. Many unforeseen problems can occur when working with equipment and making repairs is very much learn-as-you-go. Read the owner's manual often, and if problems occur that can't be fixed with resources at hand, contact other farmers or local mechanics for assistance.

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