Manure and Pasture Management for Recreational Horse Owners

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Acknowledgements

Thank you to the following reviewers:
Marleane Callaghan
Carolyn Dindorf
Dennis Johnson
Robert Jordan
Edward Musielewicz
Ken Olson
Robert Olson
Michael Schmitt
Wes Schroeder
EQIP Educational Team

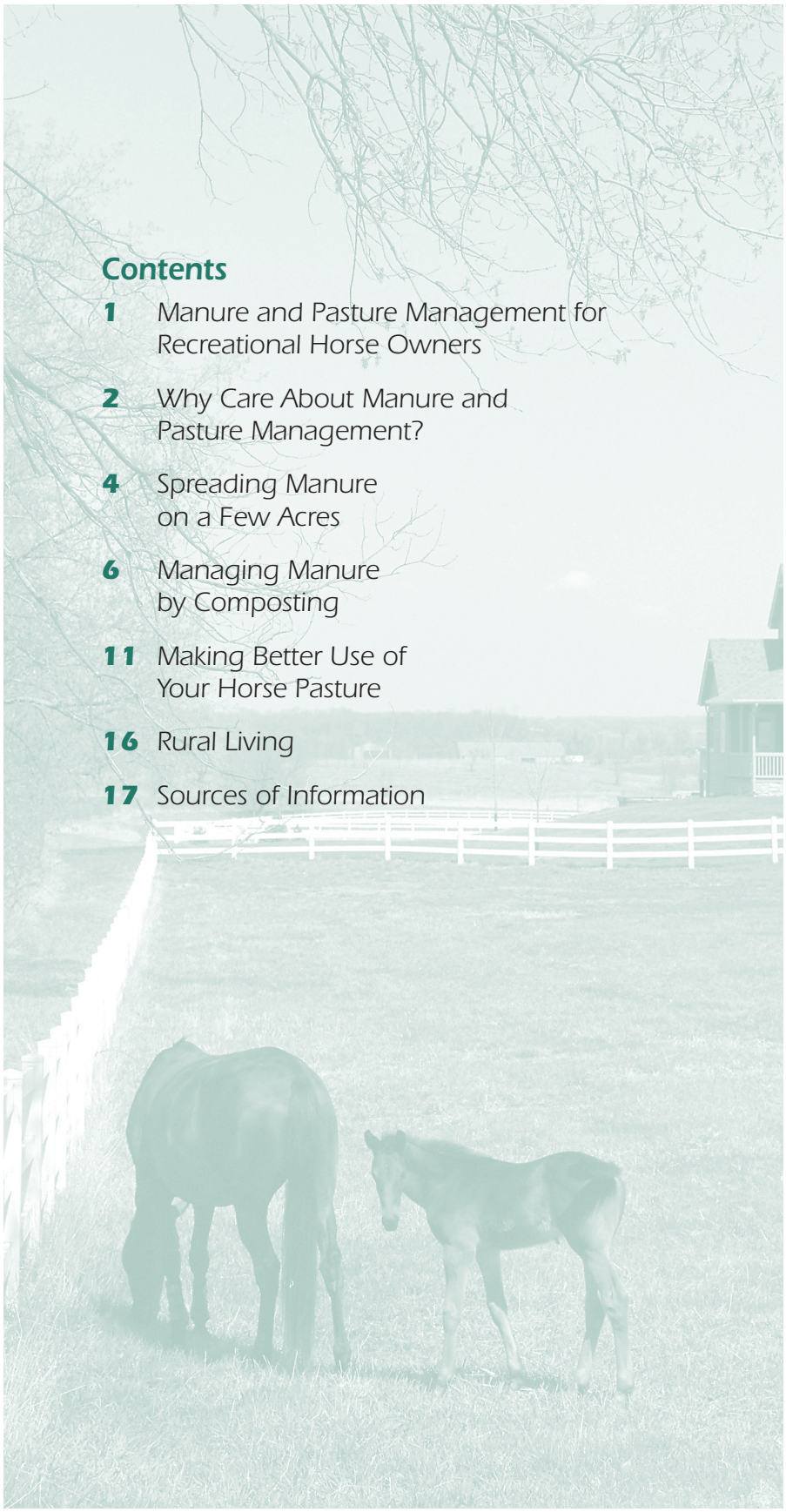
Product Manager: Gail M. Tischler
Editor: Mary K. Hoff
Graphic Designer: Jim Kiehne

Photo credits: Don Breneman (cover, contents page, and pages 1, 3, 6, 8, 10, 11, and 16); Maria Fernandez (page 15); University of Minnesota Extension Service photo archives (all others)

Funding

Funding for this publication was provided by an educational grant from the Environmental Quality Incentives Program (EQIP) of the 1996 Farm Bill.

Contents



Manure and Pasture Management for Recreational Horse Owners

Horses are a common sight along Minnesota's roads. No one knows how many horses there are in the state, but most enthusiasts would agree that the popularity of horses continues to rise. At the same time, new residents keep arriving, especially in the Twin Cities metro area, where forecasters estimate 600,000 more people will live by 2020.

As a result of these trends, Twin Cities recreational horse owners increasingly find themselves in the middle of urban or rapidly growing suburban areas, where they often receive more scrutiny from their local government and neighbors than do their counterparts in rural areas. To maintain good relationships and minimize the need for regulation, it is critical they know and practice proper manure and pasture management.

This publication is intended to help recreational horse owners better manage manure and pastures. It describes two options for manure management: land spreading and composting. It also offers guidelines for improving pasture productivity, and it provides practical management suggestions for owners in urban or rapidly growing suburban areas.

Hennepin County is home to more than 500 recreational horse owners and 2,800 horses, as well as more than 1 million people in 46 cities. Most horse owners in Hennepin County live in the western half of the county and care for 5 to 10 horses. Many own fewer than 20 acres of land, including buildings, exercise areas, pastures, and other crop fields. As a result, some lack the pasture, cropland, and/or equipment needed to benefit from the plant nutrients contained in their horses' manure. They also may lack the knowledge needed to prevent soil erosion from overgrazed pastures or denuded exercise lots and to prevent nutrient runoff as a result of overapplication, improper incorporation, or application of manure at the wrong time or in the wrong place.

TIP: A typical horse, which weighs about 1,000 pounds, produces between 45 and 55 pounds of manure per day, or around nine tons per year. Hennepin County's 2,800 horses have the potential to produce 50 million pounds of manure annually.

Why Care About Manure and Pasture Management?

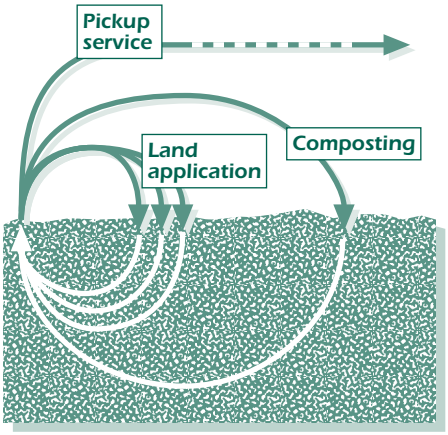


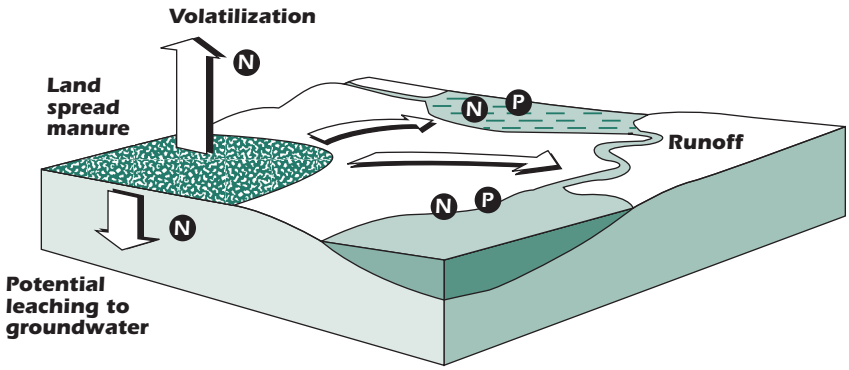
Figure 1.
Manure management options

Proper manure management is important for the health of horses and the environment. Ideally, manure should be removed from stalls daily. If allowed to accumulate in stalls, it can attract flies, harbor parasites and pathogens, increase the risk of thrush and other hoof-related problems, and generate offensive odors. Exercise paddocks may need weekly cleaning.

Manure should be spread evenly on cropland and incorporated into the soil to maximize its nutritional benefits to crops and minimize odor pollution. However, some horse owners may not have enough land to spread manure without overapplying, which creates a pollution hazard. If this is the case, rotationally grazing horses in pastures can help minimize manure buildup and manure-handling costs. If you have very little land, you might need to compost manure to reduce its nitrogen content and volume. Or you may wish to hire a pickup service or find a nearby landowner or farmer who can make productive use of your horse's manure (Figure 1).

Figure 2.
How nitrogen (N) & phosphorus (P) enter water supplies

Adapted from Category Solid: Commercial Animal Waste Technician Training Manual, University of Minnesota Extension Service, 1999.



Horse manure is an excellent nutrient source for pastures and other field crops when properly applied at the optimum time and in the correct amounts. It contains nitrogen, phosphorus, potassium, sulfur, and micronutrients, and is high in organic matter. Proper application of manure's nutrients can help reduce the need for costly supplemental fertilizers. Organic matter provided by manure enhances soil structure and water- and nutrient-holding capacity, reducing the soil's susceptibility to erosion. Overall soil quality is enhanced with manure applications.

Environmental Concerns

The nutrients in manure that boost plant growth can be a pollution hazard if the manure is improperly handled (Figure 2). For example, if manure is overapplied to fields, nitrogen in the form of nitrates can move into the soil and eventually into groundwater, a major source of drinking water for many rural homes and communities. Consumption of water with high nitrate levels can reduce the oxygen-carrying capacity of blood (methemoglobinemia). Nitrate consumption has also been linked to cancer. In light of this health risk, the Minnesota Pollution Control Agency (MPCA) explicitly prohibits the overapplication of nitrogen on pastures and other field crops.

Horse manure also contains phosphorus. When phosphorus enters lakes, rivers, and other surface waters, it stimulates the growth of algae, aquatic plants, and other vegetation. One

pound of phosphorus can produce up to 500 pounds of aquatic plants. When these plants decay, they reduce oxygen to levels where many fish species cannot survive. Generally, phosphorus moves into surface waters when manure applied or stored on the soil surface is moved laterally, usually by rainstorms, into a drainage flow system toward the water. Even manure that has been worked into the soil can be a concern if the soil erodes into the water body throughout the year. Currently, no Minnesota law limits the amount of phosphorus that can be applied to cropland or pastures.

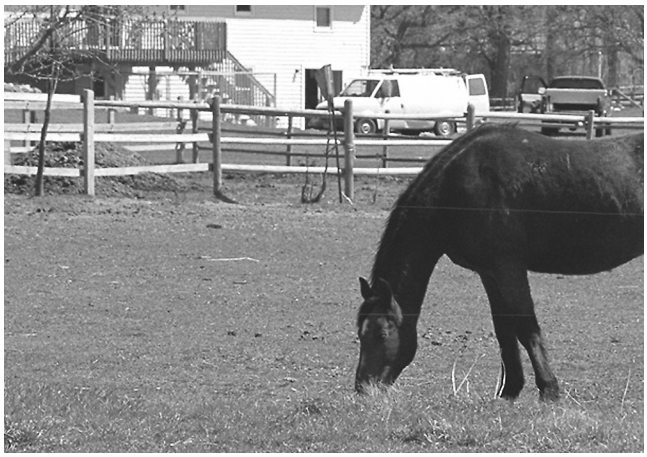
Feedlot Permits

Minnesota's feedlot program, created in 1971, helps protect the state's waters from improperly managed manure. The MPCA, which administers the program, defines a feedlot as "any animal confinement area where a vegetative cover cannot be maintained, including poultry ranges, zoos, and race tracks and fur farms." Many recreational horse owners do not need to apply for a feedlot permit. You will need to apply for a feedlot permit if you operate a feedlot, manage 50 or more horses (in shoreland areas, 10 or more horses), and any of the following conditions exist:

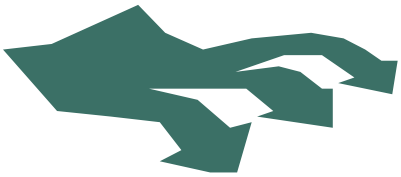
- A new feedlot is proposed.
- A site that has been abandoned for five years or more is restocked.
- An existing feedlot is expanded or modified.
- The ownership of an existing feedlot changes.
- A National Pollution Discharge Elimination System (NPDES) permit is required under state or federal rules.
- Investigation of a complaint on a feedlot reveals a pollution problem.

More than half of Minnesota counties have accepted delegated authority under the MPCA's feedlot program. In these counties, the county feedlot officer (CFO) is responsible for enforcing regulations and issuing permits for most feedlots. Hennepin County has not requested this administrative authority, so it is under the direct jurisdiction of the MPCA. Check with your county environmental officer or the MPCA regarding how state feedlot rules apply to your operation.

The Minnesota feedlot rule is currently under public review. Under the proposed rule, horse owners may need to register with the MPCA and abide by new land-spreading rules. In addition, the minimum number of horses for a feedlot designation may change. Check with the MPCA feedlot program hotline, (651) 296-7327 or (877) 333-3508, if you have questions about whether you need to register or apply for a permit.



Recreational horse owners need to know how to properly manage manure and bedding.



Spreading Manure on a Few Acres

TIP: Many horse owners lack the equipment to load, handle, haul, and spread manure. Purchasing a tractor and manure spreader may be too expensive for your individual needs. If this is your situation, consider hiring neighbors who own the proper equipment or jointly purchasing equipment.

TIP: To temporarily store manure, surround the pile with a narrow ledge or berm to guard against nutrient or pathogen runoff and prevent nutrient leaching. Avoid stockpiling in or near wetlands or surface waters. Keep the stockpile 300 feet from surface drainage inlets. Do not store manure for more than one year.

Even if you don't need a feedlot permit, you still need to understand and employ proper practices when spreading manure. Limit manure application to agronomic rates (rates that are equal to or less than what the existing plants can use in a year), and ensure that the manure does not pollute water. Do not apply manure on shoreline property.

The MPCA prohibits manure spreading

- on soils with a high water table;
- on floodplains;
- on lakes, intermittent streams (streams flowing after certain rainfall events), seasonal streams (streams flowing only during snowmelt), and ditches;
- on grassed waterways;
- on frozen soils with slopes greater than 15 percent; and
- near direct groundwater conduits (e.g., wellheads and quarries).

Check with your local soil and water conservation district or Natural Resources Conservation Service office to help identify these special protection areas on your land and on bordering properties.

Land Application Guidelines

Proper manure application generally requires a series of decisions and some additional information gathering.

If all of the manure will be applied to existing pasture, the horses can do a fairly good job of distributing it themselves. Unfortunately, the droppings from the horses are often quite concentrated and can suffocate or stunt plants underneath them. To maximize pasture production, drag or harrow the pasture to break up the droppings and more evenly spread the manure.

If stockpiled manure is to be spread onto a field, you need to know the nutrient content so the application matches the nutrient needs of the crop. Although each source of horse manure will vary, a standard "N-P-K" value (Table 1) can be used to determine the number of acres needed to properly spread the horse manure.

When using stored manure in place of purchased fertilizer, you may wish to have a more accurate estimate of its nutrient content. Manure can be sampled, packaged, and sent to a soil-testing laboratory for nutrient analysis. Check with the University of Minnesota

Table 1. Nutrient content of horse manure

Manure (tons/year)	Percent Solids	Nutrient Content (lb./year)		
		Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)
9.3	21.0	110	59	110

Livestock Waste Facilities Handbook, MidWest Plan Service 1993, Table 2-2, p. 2.2.

Extension Service (Extension) office in your county for bulletins with sampling procedures for manure and interpretation guidelines.

Not all of the nutrients in manure are available for plant use. For example, the percentage of the total nitrogen available is a function of the method of manure application and management as well as the chemical composition of the manure. For horse manure, typical nitrogen availabilities range from 35 percent of the total nitrogen if the manure is spread and left on the soil surface, to 60 percent if the manure is spread and worked into the soil within a day. Availabilities of phosphorus from phosphate (P_2O_5) and potassium from potash (K_2O) are commonly set at 80 percent and 90 percent of totals, respectively.

After estimating the manure's nutrient content, select the field/crop targeted for application. Certain fields and portions of fields must be excluded from manure application based on environmental precautions. Some guidelines are listed in Tables 2 and 3.

The amount of nutrients to be applied to a field depends on the crop to be grown, its expected yield, soil test levels, and other credits. For more information contact your University of Minnesota Extension Service county office.

Calculating manure application rates is a mathematical exercise that aligns the nutrients supplied in the manure and the nutrient demands of the crops. Although it sounds quite simple to take a manure analysis, account for availability, and then match this to crop needs, several decision aids are available upon request.

After you determine application rates, you need to make some decisions about method of application. The primary goal is to uniformly apply manure throughout the field. This takes time and effort on the part of the person driving the applicator. It is also important to know the actual rate of manure application and how to modify the tractor speed to achieve the desired rate. Several bulletins are available for making this calculation.

The timing of the manure application is also important. The ideal scenario is to spread manure in the spring. This supplies nutrients for the upcoming growing season and minimizes the amount of time for potential losses before crop uptake. An alternative is to spread manure in the fall. Avoid applying manure in winter. Manure applied in this fashion is highly susceptible to movement if it rains.

Table 2. Recommended separation distance (feet)

	Surface spreading (no incorporation)	Incorporation
Streams or rivers	*	*
Lakes	*	*
Water wells	200	200
Sinkholes	100	50
Individual dwelling**	100	50
Residential development	300	300
Public roadways	25	10

* See Table 3

** Distance may be reduced with permission of owner

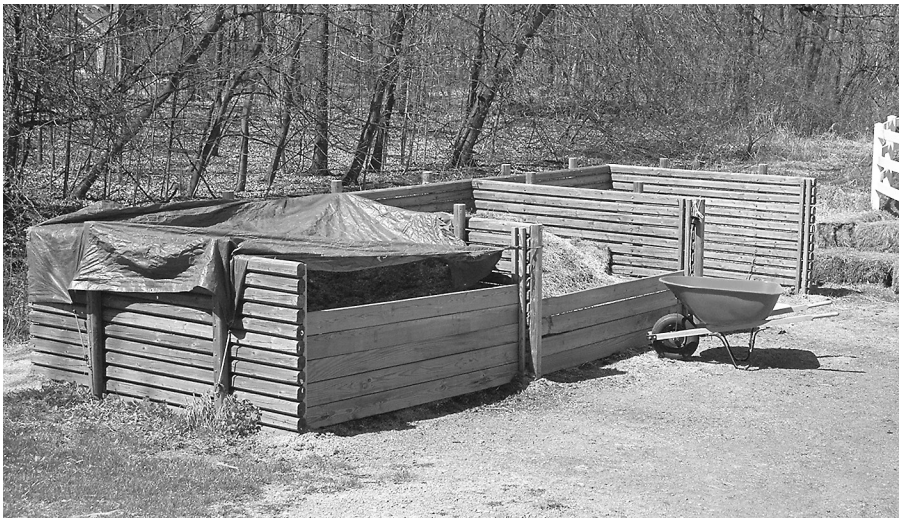
Adapted from Running Your Feedlot for Farm Economy and Water Resource Protection, MPCA, 1993.

Table 3. Separation distance from streams, rivers, and lakes for land spreading of manure (feet)

Slope (%)	Soil texture	Time of year	Minimum separation (feet)
0–6	Coarse	May to October	100
0–6	Coarse	November to April	200
0–6	Medium to fine	May to October	200
0–6	Medium to fine	November to April	300
Over 6	Coarse	May to October	200
Over 6	Medium to fine	May to October	300
Over 6	All soils	November to April	Not recommended

Adapted from Running Your Feedlot for Farm Economy and Water Resource Protection, MPCA, 1993.

Managing Manure by Composting



Composting requires several bins.

Another way to manage horse manure is to compost it. Composting is managed, accelerated decomposition. In decomposition, microorganisms—including bacteria, actinomycetes, and fungi—break organic materials into smaller particles and build new molecules. In doing so they give off carbon dioxide, water vapor, and heat. Composting accelerates decomposition by promoting the growth of microorganisms. It kills weed seeds and reduces pathogens, odors, and volume. The finished compost is a valuable soil amendment.

Composting is often slightly more expensive than land spreading manure. However, many people who have become avid composters believe that the added benefits of composting far outweigh the costs.

Most people have at least some familiarity with composting through campaigns that encourage backyard composting of grass clippings or leaves. Composting of horse manure differs only in the type and volume of materials composted.

Horse manure and bedding contain the carbon and nitrogen necessary for successful composting. The challenge is to ensure the proper proportions of the materials. The type and typical daily volume of bedding will substantially affect the ease and rate of composting. Different types of organic materials compost differently. You'll need to customize the process to fit your specific combination of manure, bedding, and other organic materials. You can find the best mixture by developing a clear understanding of the process, accurately measuring materials, and going through some trial and error.

Composting is a balancing act. Providing ideal environmental conditions for microbial growth accelerates the process. Just enough water, air, carbon, and nitrogen getting piled, turned, and aged without contaminants makes for good compost. Some things to consider for successful composting:

Air. Approximately two-thirds of the pile's initial volume must be interconnected free air space. Air space allows oxygen to move into and carbon dioxide and water vapor to leave the pile. Too little air space reduces the oxygen available to the microorganisms; too much air space dries the pile out and prevents it from reaching temperatures high enough to compost.

Manure without bedding, or manure with sawdust or wood shavings, may create a pile with too little air space. Measure air space using

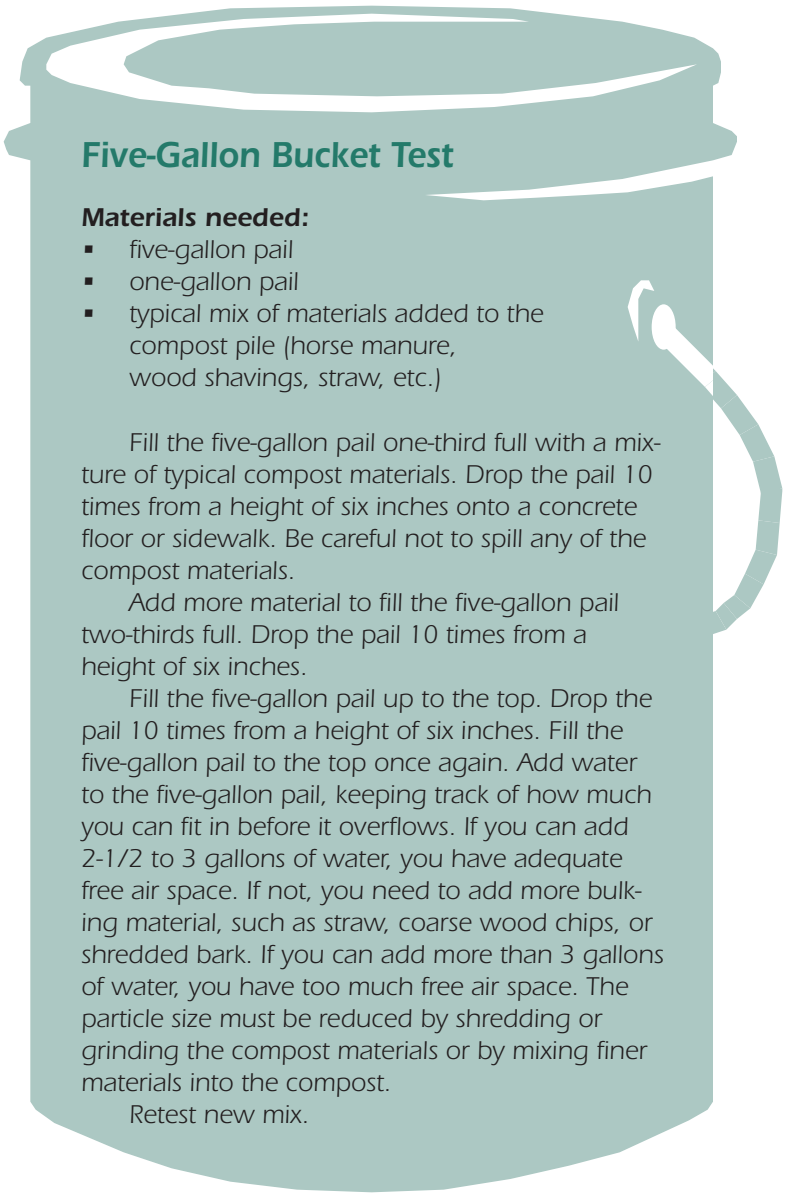
the "five-gallon bucket test" (see right). Add bulking materials, such as shredded wood, bark, or dry straw, to increase air space.

Water. Water is required for good composting. Microorganisms grow best with moisture around 50 percent. If the compost feels like a freshly wrung out sponge, the pile most likely contains the proper amount of moisture. If water runs out of the pile or if you can squeeze water from a handful of compost, it is too wet. In this case you will need to add straw, fall tree leaves, corncobs, shredded bark, or chipped brush to dry the pile.

Closely monitor the moisture level, especially during hot, windy summer days when as much as 5 percent (water equivalent) of the pile's total dry weight can be lost. Adding a little water each day is much better than letting the pile get dusty and dry, then trying to rewet it back to the 50 percent range.

Size and construction. Size of the pile does matter. Bins 4′ x 4′ x 5′ tall seem to work best for horse manure. Bins constructed from 2″ x 6″ (untreated) boards and heavy-duty posts will hold up the best. Bins with a wooden floor with small spaces between boards that allow air to move from underneath the pile perform better than bins built directly on the ground. Laying flat drain tile on the wooden floor will further enhance airflow. Each of these bins should easily hold 1.5 tons of horse manure. If your horse manure fills up more than six bins of this size, you may want to consider a windrow composting system.

Temperature. Temperatures of 131° F to 150° F are ideal. Hotter or cooler temperatures will slow down the process. Maintain these temperatures for at least 21 days



Five-Gallon Bucket Test

Materials needed:

- five-gallon pail
- one-gallon pail
- typical mix of materials added to the compost pile (horse manure, wood shavings, straw, etc.)

Fill the five-gallon pail one-third full with a mixture of typical compost materials. Drop the pail 10 times from a height of six inches onto a concrete floor or sidewalk. Be careful not to spill any of the compost materials.

Add more material to fill the five-gallon pail two-thirds full. Drop the pail 10 times from a height of six inches.

Fill the five-gallon pail up to the top. Drop the pail 10 times from a height of six inches. Fill the five-gallon pail to the top once again. Add water to the five-gallon pail, keeping track of how much you can fit in before it overflows. If you can add 2-1/2 to 3 gallons of water, you have adequate free air space. If not, you need to add more bulking material, such as straw, coarse wood chips, or shredded bark. If you can add more than 3 gallons of water, you have too much free air space. The particle size must be reduced by shredding or grinding the compost materials or by mixing finer materials into the compost.

Retest new mix.

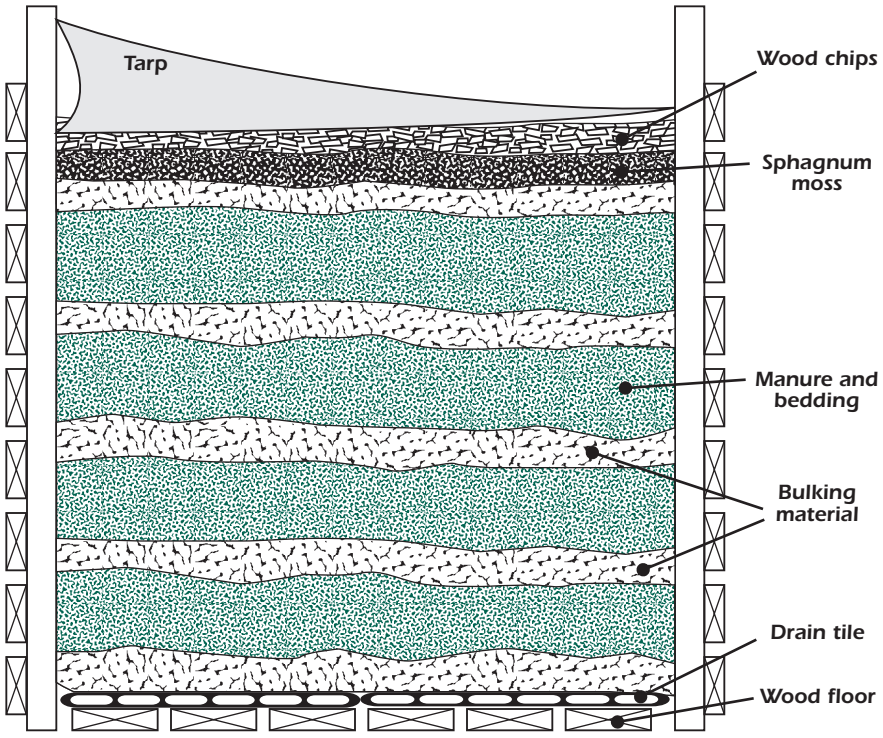
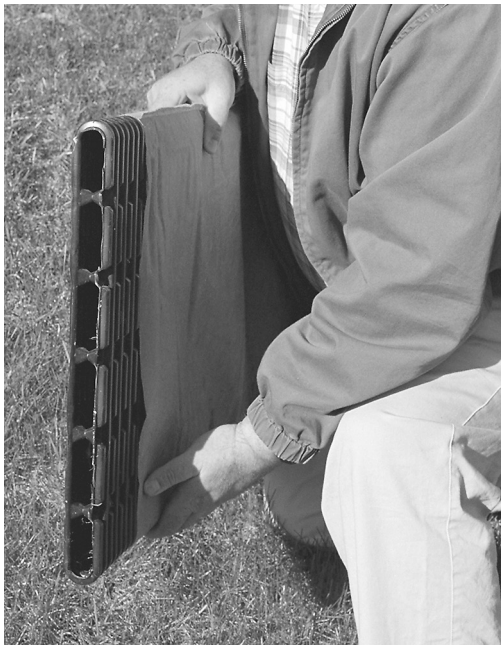


Figure 3.
Layering the compost pile

Adapted from Composting Fish Waste: An Alternative for Minnesota Resorts, Minnesota Sea Grant College Program and Minnesota Extension Service, 1991.



Line the bottom of each compost bin with flat drain tile.

to reduce pathogens and kill weed seeds.

A three-foot-long, nonmercury compost thermometer, available at some hardware stores, is useful for taking pile temperatures. Recording daily temperatures will help you become a better composter. If pile temperatures far exceed 150° F, reduce the size of the pile and check to make sure it has adequate free air space.

Location. Locate your bins at least 100 to 150 feet away from wells, ditches, streams, and lakes. Leave a buffer strip of taller grasses, wildflowers, and shrubs between the compost bins and any drainage way or water feature to keep manure from washing down a slope and into a water body during a heavy rainstorm. Place your bins in a dry area near the point of manure collection. Try to locate them out of view and downwind from neighbors. Bridal wreath spirea works well as a visual screening plant in most soils in this climate. Check with your local municipality for any additional regulations.

Building a Compost Pile

Start by creating a base layer that will allow air to flow into the bottom of the pile. Lay down 6 to 8 inches of wood chips or flat drain tile directly on the wooden floor of the bin. (If you use drain tile, cover it with a thin layer of a synthetic polyester material to prevent the holes from plugging up.) The bin is now ready for the manure and bedding mixture, along with any bulking materials, such as wood chips or shredded bark, needed to provide free air space.

Build the pile by alternating layers of manure and bulking materials (Figure 3). Separate manure layers with 6 inches of bulking material. The finer the bedding material, the more likely the manure layer will benefit from additional bulking

material, and the thinner the manure layer should be. The manure layer should be from 6 to 24 inches thick. To ensure good composting, add a bucket of mature compost or soil little by little as you build the pile.

Build the pile to a height of 5 feet and cover with a 4-inch layer of sphagnum peat moss to control odors and top it off with a 4-inch layer of wood chips. A tarp placed 2 to 10 inches above and covering only the top of the pile will prevent it from quickly drying out or receiving too much moisture from rain and snow. You can easily attach a tarp by extending the corner posts of the bin with short lengths of two-by-four.

The higher the bedding-to-manure ratio, the more likely it is that you will need supplemental nitrogen. If you have the proper amount of water and free air space and the pile still doesn't heat up, add one-third cup of a commercial nitrogen fertilizer such as ammonium nitrate or ammonium sulfate or another high-nitrogen fertilizer
(33-4-2) to the pile each day.

Turning mixes the pile's cooler, outside layer with the hotter center and enhances the composting. Once you have your pile built, wait 7 to 28 days before turning so it can "cook." Try turning again at 24, 72, and 120 days. Three to seven turns during the life of the pile are common. Base the turning schedule on the pile's materials, weather, and the anticipated use of the compost. When piles have the right amount of moisture and air space, a temperature of
120° F or lower usually indicates the need to turn the pile so it can reheat.

Frequently Asked Questions About Composting

Does the compost pile need a starter or activator to get the composting process going?
No. Just add a five-gallon pail of fertile soil or mature compost to the pile as you build it. That should provide enough microorganisms to ensure composting.

Can backyard materials go into the pile?
Yes, but limit grass clippings to layers of one or two inches. Dry fall leaves work well as bulking materials.

How long does it take to make good, mature compost?
It depends. With average management and most conditions achieved most of the time, good, mature compost will take about six months. Measure six months from the day you completely fill a bin.

How will I know that the composting is done?
The compost is done when the pile no longer reheats after turning and the volume has decreased to half its original size. Mature compost should look more like soil than bedding material and manure.

How do I prepare the pile for winter?
If you have an entire bin available, build a six-to eight-inch layer of wood chips. Next, put down three feet of leaves and then alternate layers of manure and bulking materials. By spring the leaves will have decomposed and the pile will need some turning, but it should be nearly finished.

Composting Hints

When cleaning the horse stalls, put the manure and bedding directly onto the compost pile. This is also the best time to add water if needed.

Sawdust contains very little nitrogen and a lot of carbon. In small quantities (less than 10 to 15 percent) it can help prevent compaction in compost piles. However, this is only true of coarse sawdust from sawmills or chain saws. The very fine sawdust from carpentry and cabinetwork—often preferred by horse owners—may actually compact so tightly so as to make a compost pile almost airless. If you use fine sawdust for bedding, you will most likely need to also add bulking material to prevent compaction and provide free air space so oxygen can get to the microorganisms.

Wood shavings provide more air space than sawdust but still require the addition of more bulking material to achieve the proper amount of free air space. Straw bedding can sometimes meet the requirement for air space. Use the bucket test to find out if you have adequate free air space. Remember to add the bulking material as you build the compost pile.

If you can't build enough bins to hold all of your manure for the roughly six months it takes to create mature compost, you may instead choose to produce immature compost. If you set up and properly manage your bins, you can expect to reduce the volume of manure up to 50 percent and produce immature compost in six to eight weeks when outside air temperatures are above 50° F.

Immature compost provides organic matter, retains moisture, and can work quite well as mulch in home gardens. Do not apply in excess of ½ to 1 inch thick because it will likely create a nitrogen deficiency in plants for 4 to 10 weeks after application.

Using Compost

Making compost is really only a start. You need to think about how you will use the finished compost. Will you use it yourself? Sell it to your neighbors? Market it to a wider geographical area? By using compost to grow plants we complete the organic matter cycle.

Good quality compost should be applied only at recommended rates and to plants and soils that can use the nutrients. As a rule of thumb, good quality horse manure compost can be applied ½ to 1 inch thick (approximately 24 to 57 tons per acre) and then mixed well into the soil.

Making Better Use of Your Horse Pasture

Improving the productivity of your pasture offers several benefits. Pasturing can:

- ***Reduce the amount of purchased hay.*** If you have only a few acres to dedicate solely to pasture, the total substitution of pasture for purchased hay may be an unattainable goal. However, you can reduce the amount of purchased hay by improving the productivity of your pasture. An ideally managed, highly productive pasture can potentially provide a large portion of a horse's forage requirements from May through September.

- ***Distribute manure in the field and reduce time spent cleaning stalls.*** Horses grazing managed paddocks will drop their manure in different parts of the pasture instead of concentrating it in stalls, feedlots, exercise lots, and loafing areas. This reduces the volume of manure in stalls and lots as well as the time needed to clean these areas.

- ***Reduce the labor and equipment used to harvest forage.*** Think about your pasture as a crop that horses harvest by grazing. When grazing, horses eliminate the time needed to cut, rake, bale, store, and feed the forage and the cost of buying, operating, and maintaining machinery.

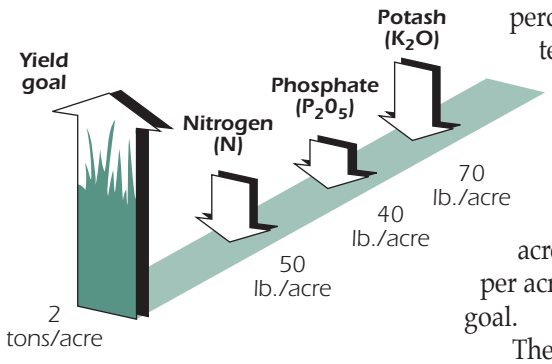
- ***Reduce the amount of purchased fertilizers.*** Manure recycles nutrients beneficial to pasture plants. The more nutrients manure provides, the fewer pounds of supplemental fertilizer are required. To ensure that pasture plants can more easily use the manure's nutrients, frequently drag or rake the manure deposited in the pasture. This will more evenly distribute the manure and promote its breakdown while also reducing the potential exposure of horses to internal parasites.

- ***Enhance community viewsheds.*** The term "viewsheds" refers to fields alongside roads in primarily residential areas that allow drivers and residents to enjoy open views of bordering landscapes. Providing a bucolic scene like horses grazing on pasture can build goodwill with neighbors.

Pasturing horses offers numerous benefits to recreational owners.

TIP: *To protect water quality and shorelines, horses should not have free access to waterways, ponds, lakes, or wetlands. Do not allow animals to graze in public waters. Check with your local government about regulations governing acceptable sites for pastures.*

Figure 4.
Recommended fertilizer application for a grass pasture



Pasturing horses also has some disadvantages. It can increase time and expense of fencing, monitoring pasture growth, and moving horses; potential for neglecting horses; risk of danger to horses from toxic weeds, escape, or injury on fencing; potential for horse damage to trees; and potential exposure to internal parasites, disease-carrying insects, ticks, and mosquitoes.

Pasture Improvement

Horse pastures must be carefully managed in order to maximize their productivity. Some things to consider:

Soil fertility. Fertility refers to the level of essential nutrients present and available for pasture plants (forages). You can test your pasture's soil to determine if additional nutrients must be applied to yield the volume of grasses and legumes desired. If a soil test reveals a deficiency, you will need to apply additional nutrients using horse manure and/or commercial fertilizers.

You can get a soil test kit from any University of Minnesota Extension office or private soil testing laboratory. Follow the instructions for collecting a sample to send in for analysis. Request tests that measure the levels of phosphorus (P) and potassium (K), soil pH, percent organic matter, and soil texture. Note on the test form whether the pasture consists of grasses or a mixture of grasses and legumes. Additionally, provide a desired yield goal (tons of forage per acre) for the pasture. Two tons per acre is an easily attainable yield goal.

The test results will include fertilizer recommendations in the form of nitrogen (N), phosphate (P_2O_5), and potash (K_2O). Pastures may need additional nutrients that are best applied in early spring (mid April to early May). You may need to add lime to acid soils to adjust the pH.

Although fertilizer application should be based on a soil test, Figure 4 offers some general guidelines for the amount of fertilizer to apply to a primarily grass pasture.

Most of the phosphorus and potassium consumed by horses will be returned to the pasture through their manure. Periodic soil tests on the pastures will confirm this nutrient recycling. Nitrogen will likely need to be annually applied to pastures consisting of primarily grass with few legumes.

Weeds. Weeds compete with legumes and grasses for soil moisture, sunlight, and nutrients. Grazing will keep some weeds out of pastures, but cannot eliminate all weed problems. Positive identification of weed species is the first step in determining the appropriate control strategy. Horse owners should be most concerned about toxic weeds (e.g., hoary alyssum) but should strive to control other weeds in order to further improve their pasture's productivity. You can control weeds by rotational grazing, mowing, hand pulling, or chemically treating weeds when the horses are elsewhere.

Species mix. Pastures can provide feed for horses from May through September. Generally speaking, grasses prosper during the cooler days at the beginning and end of the growing season, while legumes such as alfalfa and other clovers are most productive in the warmer, midsummer months. Additionally, legumes add protein to the pasture's feed value and provide nitrogen for the grasses through nitro-

gen fixation.

If you do not choose to devote a high level of management to your pastures, it may not be worth the extra expense of including legumes. Additionally, the durability of grasses helps the pasture resist extensive trampling by the horses. When starting a new pasture, research from the University of Minnesota suggests the following mix for horses (per-acre basis):

- 8 pounds alfalfa
- 6 pounds smooth bromegrass
- 2 pounds orchard grass
- ½ pound white clover (if desired)

Close and continuous grazing of pastures with this mix will likely result in the survival of only bluegrass and thistles. If you choose to allow your horses to continuously graze the pastures, substitute bluegrass and white clover for alfalfa. Bluegrass can withstand close grazing and forms a sod that can better tolerate horses' hooves.

Overgrazing. Continuous grazing, or allowing horses access to the entire pasture from spring through fall, will make existing weed problems even worse. If allowed to continuously graze a pasture, horses can seriously reduce the forages' productivity. Under continuous grazing, forages never get a chance to recover and outgrow the weeds. Legumes such as alfalfa and other clovers will not survive if continuously grazed. Grasses such as Kentucky bluegrass can tolerate continuous grazing but will be less productive than if managed under a rotational grazing plan.

Carefully monitor your horses' grazing to maximize feed value. Continuous, close grazing, when horses eat the plants down to very short levels, will seriously stunt the regrowth of the plants and allow weeds such as

Rotational Grazing

Healthy forage plants are more productive if given an opportunity to regrow between grazings. You can enhance forage growth by dividing a pasture into at least four separately fenced paddocks and rotating your horses among them (Figure 5).

Since grass pasture plants grow most rapidly in spring and slow down in the fall, you will need to experiment to come up with an optimum rotation length. Start with three to four weeks of rest per paddock during summer, maybe fewer in spring and more in fall.

The stocking rate per acre does not change under a rotational grazing plan. The general rule of thumb is to start your horses grazing in a paddock when the forages are at least 6 to 10 inches long; move your horses after they have grazed the forage to an average height of 3 to 4 inches. (If bluegrass is the dominant forage, horses can graze it down to 2 inches and then get turned back into the pasture when it has reached a height of 6 to 8 inches.)

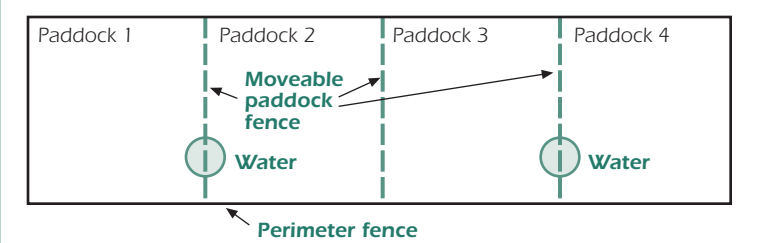


Figure 5. Rotational grazing paddock layout

For example, say you have two horses and four acres of pasture with uniform soil type, topography, plant species, and yield throughout the entire area. You could divide the pasture into four one-acre paddocks and graze the horses for one week per paddock. This will give each paddock three weeks to regrow. If regrowth is slower, you'll need to supplement the pasture with hay. If the growth is faster, you'll need to rotate more often or make hay from the paddock.

Undergrazing (grazing too few horses on too large of a paddock for too short of a grazing period) can encourage horses to selectively graze and result in a lot of underutilized forage requiring clipping or hay making.

Lightweight electric fencing consisting of polywire strung on lightweight plastic or fiberglass posts work well for dividing a pasture into paddocks. These materials are easily connected to perimeter fences and allow you to modify the paddock size or shape depending on forage growth.

thistles and other less desirable species such as bluegrass to get ahead of the desirable forages. Well-timed rotations through several, smaller-sized paddocks will help desirable plants reestablish themselves.

Water. Like urban lawns and other field crops, horse pastures benefit from adequate water throughout the growing season. However, purchasing and maintaining irrigation equipment can be much more costly than occasionally purchasing supplemental forage. Healthy plants that have not been overgrazed will be more productive during drought.

Pasture Management Summary

Table 4 summarizes management activities for grass pastures. Well-managed grass/legume pastures will not need supplemental nitrogen. After you have gotten to know how much your horses' grazing reduces the soil nutrients, you will not need to annually test your soil.

Table 4. Pasture management calendar

Dates (approximate)	Pasture Activity
March 1	Animals out of pasture
April	Soil test and fertilize (end of month)
mid-April	Apply supplemental nitrogen (grass pastures)
May 1–15	Begin grazing
June	Cut surplus forage for hay
mid-June	Apply supplemental nitrogen (grass pastures)
early July	Cut weeds and mature plants
mid-August	Apply supplemental nitrogen (grass pastures)
September	Cut or spray perennial weeds
September/October	Let plants recover
winter	Snow cover

Frequently Asked Questions About Pastures

How much pasture should I allow per horse?

Stocking rates depend on your horses' feed needs and the pasture's yield. As a general rule, horses eat about 1 to 2 percent of their body weight per day in the form of pasture forage. Assume that a 1,000 pound horse will eat about 15 to 20 pounds of pasture forage per day.

Stocking rates of one horse per two to four acres may be easily achieved with a little attention to fertility, weeds, and forage mix. Higher rates could result in the horses trampling much of the pasture and damaging forage. However, well-managed pastures (those with adequate fertility, few weeds, and the appropriate plant mix) can be rotationally grazed at higher stocking rates.

What should I do about uneven grazing?

Since horses selectively graze younger pasture plants, you may need to clip the mature grasses and legumes still standing after the horses have grazed the pasture to induce them to regrow. Allowing the ungrazed plants to remain standing without clipping could stunt the regrowth of the other forages by shading them out. If you need to clip your pastures, leave a four-inch stubble. Clipping the pasture too frequently will encourage short, less productive forages such as bluegrass.

How can I renovate existing pasture?

An overgrazed, underfertilized, weedy pasture will become more productive when managed effectively. One of the most common ways to renovate existing pastures is to directly seed legumes into the standing forages. You can do this by scattering the seeds on the soil surface, interseeding with a conventional grain drill, or interseeding with a heavy grain or no-till drill. Some county soil and water conservation districts rent seeders for a nominal fee.

To give the newly seeded forages the best chance of establishing themselves, University of Minnesota research recommends a spring seeding when the pasture grasses are five to six inches tall. Since new seedlings can't compete with established plants without help, consider applying a glyphosate herbicide like Roundup® at a reduced dosage (about two-thirds strength) before seeding to suppress the standing grasses just enough to allow new seeds to get started. Grass pastures may benefit from adding nitrogen over the course of the growing season. If soil tests indicate a nitrogen deficiency, consider applying urea in mid-April, June, and August.

Can grazing legumes lead to bloat?

Pastures with a large percentage of legumes can lead to bloat. To help prevent bloat, introduce horses to fresh, lush grass/legume pasture a little bit at a time. Do not turn hungry horses into a lush grass/legume pasture. Provide dry hay and plenty of salt and water to newly pastured horses.

What can I do about pocket gophers?

Pastures may suffer from an infestation of pocket gophers. Pocket gophers feed on forages and their hills can smother plants. Horses can trip on their mounds and mound entrances.

One way to eradicate pocket gophers is to rotate pastures to crops such as small grains that effectively eliminate their food source. If rotation is not an option, you can use repellants, toxicants, and traps to control

A no-till drill can be used to interseed directly into existing pasture.

Rural Living

Urban neighbors may know very little about managing horses.

Most state regulations regarding livestock and agriculture do not cover owners of small numbers of recreational horses. Some communities, especially those becoming more suburban, have adopted ordinances to fill this apparent regulatory void. Such ordinances may limit the number of horses allowed per grazable acre, require horse owners to draw up and abide by a manure management plan, or simply request the owner to ensure that the operation does not have a potential pollution problem.

If you live in an urban or rapidly growing suburban area, you will likely receive more scrutiny from your neighbors and municipality than recreational horse owners living in rural areas. By taking the initiative to be a good neighbor, you can demonstrate responsible management and share the joy of horses with your community.

Some suggestions:

- Acquire and display a working knowledge of the potential environmental and health impacts of your operation.
- Keep manure off roadways when transporting to distant fields.
- Consider wind direction when spreading manure. Incorporate manure as soon as possible to minimize odor pollution.
- If stockpiling manure, pay special attention to odors and flies.
- Keep current on proposed local ordinances and state regulations.
- Host an open house to inform your neighbors and demonstrate how to properly manage your land, pasture, and manure.
- Encourage and help other horse enthusiasts to learn and practice proper manure and pasture management.

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Produced by Communication and Educational Technology Services, University of Minnesota Extension Service.

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BU-7540-S
2000