Managing Horse Manure by Composting

Why Compost?

Many horse owners and urban horse facilities do not have access to enough land to make good use of raw manure by spreading. If you are one of these individuals, composting provides another option for managing horse manure.

Manure starts to decompose as soon as it hits the ground. Microorganisms in the soil, including bacteria, fungi, insects, worms and other creatures, break down the organic components of manure and bedding into smaller particles (Figure 10). In doing so, they recycle nutrients back into the soil, while releasing carbon dioxide, water and heat.

Although manure can decompose on its own, composting is a method of speeding up this natural process. The breakdown of manure and bedding occurs much more rapidly in the compost pile because the environment can be made ideal for the microbes to do their work. The end result of composting is a dark, crumbly, earthy-smelling product similar to potting soil.

Composting is of particular interest to horse owners because, if it is done properly, composting kills parasites eggs and larvae and destroys weed seeds in horse waste. Therefore, if the compost is later spread on pastures, the possibility of re-infection is reduced. Composting also reduces the odor of the manure and can decrease the size or volume of the pile by 50 per cent. Finished compost can be used to improve soil quality or serve as a mulch or growing media for plant nurseries, gardeners, mushroom growers and worm farms.

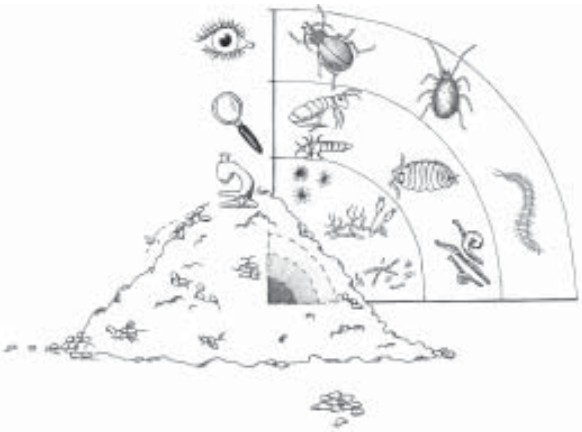

Figure 10. Soil microorganisms break down manure and bedding to form compost.

Recipe for Successful Composting

Like animals, the microorganisms responsible for composting need food, water and air to survive. The goal of composting is to provide the ideal environment and the proper balance of nutrients needed by the microorganisms to encourage their growth. Components of this "recipe" for successful composting include a number of key ingredients:

1) **Availability of air**
   Microorganisms need air (oxygen) to be able to decompose manure properly. To provide space for air to move in and out of the pile, manure should be combined with bulkier materials, such as wood shavings or straw bedding mucked from a stall, or even lawn clippings, leaves or hay. Infusing air into the pile is also accomplished by mixing and turning the pile frequently or by inserting perforated PVC pipes into the pile.

Benefits of composting

- Kills intestinal parasite eggs and larvae
- Destroys weed seeds
- Reduces flies by eliminating their breeding ground
- Reduces odor
- Reduces volume of manure
- Serves as an excellent soil amendment
- Produces an attractive product to use, give away, or sell to others

2) **Moisture level**
Microorganisms grow best with the moisture level at around 50 per cent. The average moisture content of horse manure is 70 per cent, but the manure may be closer to the ideal moisture content when it is combined with soiled bedding.

3) **Particle size**
Small particles decompose faster because they have more surface area for microbial activity. If you own a shredder or tub grinder, consider processing straw bedding, hay and other coarse materials before adding them to the compost pile.

4) **Temperature**
As microorganisms decompose manure and bedding, their body heat causes the temperature in the pile to rise. A hot pile decays much faster than a cold pile. Greater heat is necessary to kill weed seeds and parasites. Effective composting takes place around temperatures of 55 to 65°C (Figure 11).

Figure 11. Effective composting takes place at temperatures of 55 to 65°C (130 to 150°F).

5) **Pile Size**
The size of the pile influences whether the pile will hold heat. Small piles are usually colder and dry out faster. A pile of at least one cubic meter (3.5 x 3.5 x 3.5 feet) is big enough for year-round composting, even in the winter cold.

6) **Nutrients**
Microbes use carbon, nitrogen and other nutrients from materials added to the pile to support their own growth. Nitrogen is the main nutrient found in manure; carbon is the main element found in bedding material. The challenge is to ensure the proper proportions of carbon and nitrogen needed for successful composting.

The carbon-to-nitrogen ratio (C:N) of a material is an estimate of the relative amounts of these two elements. A ratio of about 30:1 is ideal for composting. Table 2 shows the approximate ratios for some materials commonly added to compost piles.

A mixture of one part manure with two parts bedding (by volume) usually gives a reasonable mix for rapid composting. However, the amount and type of bedding can alter the C:N ratio and influence the management needed for successful composting (refer to the sidebar "Bedding Tips.")

Table 2. Carbon to nitrogen ratios for manure and bedding materials.*

Material	C:N Ratio
Horse manure	20-40:1
Grass clippings	25:1
Horse manure with bedding	30-60:1
Grass hay	30-40:1
Straw	40-100:1
Paper	150-200:1
Wood chips, sawdust	200-500:1

* C:N ratios represent comparative weights. For example, 20 pounds of horse manure would contain 1 pound of nitrogen, while 500 pounds of sawdust would contain 1 pound of nitrogen. To estimate the C:N of a mixture, average the ratios of the individual materials. For example, a mixture of equal parts horse manure and straw might have a C:N of 30:1 ((20 + 40)/2 = 30).

Bedding Tips

- **Use less bedding…**
  Large quantities of bedding mixed with manure can slow the composting process by contributing excess carbon and upsetting the ideal C:N ratio. Be conservative with the amount of bedding in your stalls and remove only soiled material when cleaning. Installing rubber stall mats or rubber pavers can reduce the amount of bedding needed while maintaining the comfort of stalled horses.
- **If you use straw bedding…**
  The porous, spongy consistency of straw usually provides close to the right amount of free air space within the pile. However, the large particle size might delay the breakdown of straw. If a shredder or chipper is available, consider processing straw bedding before adding it to the compost pile. The addition of nitrogen to the compost pile may be necessary if large amounts of bedding are used.
- **If you use wood chips or sawdust bedding…**
  Wood bedding products contain very little nitrogen and a lot of carbon. Therefore, it may be necessary to add supplemental nitrogen to facilitate proper composting, particularly when large amounts of bedding are used. Wood chips are less likely to compact the pile, compared to finer sawdust. If you bed on sawdust, you may need to add other bulking materials to improve aeration. The advantage sawdust has over straw and wood chips is a smaller particle size. In fact, if managed properly, sawdust will compost faster than coarser bedding materials.

Locating Your Compost Pile

The first step in setting up a composting system is choosing a location. When choosing a location, consider the following:

1. **Select a fairly flat site**
2. **Avoid low lying areas**
   Pooled water, especially around manure and compost, will cause odour and fly problems and will increase the risk for runoff to contaminate water sources.
3. **Locate the compost pile away from groundwater and natural open bodies of water**
   In Alberta, compost sites cannot reside within 100 meters (330 feet) of any spring or well and must be located at least 30 meters (100 feet) from any open body of water, such as a stream, lake, river or slough. For more information on guidelines and regulations, refer to the chapter on “Manure Storage and Handling” in this manual.
4. **Locate the pile where water can be accessed if necessary**
   Water may be needed to maintain the appropriate moisture content of the compost pile and will need to be located conveniently in the unlikely event of a combustion fire.
5. **Be considerate of your neighbors**
   A well-managed pile will not have a foul odor or attract flies. Nonetheless, try to locate your bins out of view and downwind from neighbors.
6. **Allow room to maneuver equipment to build and turn the pile**

Choosing a Composting System

There are several ways to design an on-farm composting system, and no single one is appropriate for all sizes and types of equine facilities. You can tailor your composting system to meet your needs depending on how many horses you have, the space and equipment available and how intensively you plan to manage the pile.

Free-standing Compost Piles

Making compost does not necessarily require a special structure to house the materials. A simple, free-standing pile can be turned into an effective composting system and works well for one- or two-horse operations (Figure 12). The pile grows as manure and bedding are continually added to the top or sides of the mass. When the pile gets too big, additional piles can easily be created.

Frequent turning of the pile will hasten the composting process and help reduce parasites and weed seeds. However, many people prefer a less labor-intensive approach of building a new pile once or twice a year, turning the pile two or three times, then letting it take a year or so to mature. In this case, parasites and weed seeds may not be adequately destroyed.

Free-standing piles are usually the least costly option for composting because they do not require special structures or equipment. However, free-standing piles will require more space and careful consideration of location to prevent leaching and water contamination.

Windrow Composting

Manure and bedding can also be formed into long, horizontal piles, or windrows, for composting (Figure 13). The windrow pile is typically about 1.5 to 2 meters tall (5 to 6 feet) and 2 to 3 meters wide (6 to 10 feet). Materials are added at the end of the pile, allowing the pile to grow to any length.

These piles are generally turned with front-end loaders or specially equipped tractors, although they can also be turned by hand. Windrow composting works well for people with large herds and lots of space.

Figure 13. Composting manure in windrows.

Figure 12. Free-standing compost pile.

Figure 14. Multiple bin composting system.

Multiple Bin Composting System

Compared to stacking manure in a pile or windrow, decomposition is best and space is used more efficiently if the materials are placed in bins or some type of enclosure (Figure 14).

At least two bins are recommended for small operations that support just a few horses, or for those with no mechanical equipment. In this scenario, the first bin is filled to capacity and periodically turned and mixed with a shovel or pitchfork to promote composting. When the first bin is full, materials can be added to the second bin.

Larger facilities or those equipped with a small tractor or front-end loader, should consider building three or more bins. A series of bins allows the containment of waste at different stages of the composting process.

In a three-bin system, manure and bedding are piled into bin one until it is full. The material is then shifted into bin two for holding and composting. Meanwhile, bin one can be refilled. When bin one is full again, materials in bin two are shifted into bin three, and materials in bin one are shifted into bin two. Shifting material from one bin to the next serves as part of the turning and mixing process. Ideally, by the time bin one is full again, materials in bin three will be completely composted.

The size of the bins will be dictated by several factors:

- the amount of manure and bedding produced
- how long the materials will remain in the bin
- the equipment, if any, the bins will have to accommodate

Ideally, your bins should be large enough to accommodate all the waste materials accumulated for several months of composting. Refer to the sidebar “Determining Bin Size.”

The materials needed for the construction of suitable bins will depend on the size of bins desired and whether they need to accommodate mechanical equipment. 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. A concrete floor and strong walls are handy for larger bins that will accommodate mechanical equipment. A gravel access is convenient for loading or using a wheelbarrow to bring the manure to the heap.

Covering the compost bins with a permanent roof, plastic sheet or tarp is recommended. Protecting the pile from rainwater and snow will help you regulate the proper moisture level by preventing piles from becoming too wet in the winter or too dry in the summer. Covering will also prevent rain and snow melt from leaching contaminants from the pile and creating a pollution hazard.

Basic components of all composting systems:

1. **Adequate space for storage and composting.**
2. **A set of two or more bins or free-standing piles large enough to maintain elevated internal temperatures.**
3. **A mechanism for turning the piles or moving the compost from bin to bin, such as a pitchfork or a small front-end loader.**
4. **A water faucet or pump/water tank combo and a spray nozzle.**

What can you compost?

- Manure mixed with bedding from stalls
- Manure picked up from pastures, corrals, arenas and trails
- Old, moldy or unwanted hay
- Grass clippings
- Leaves
- Household vegetable wastes

Things to keep out of the compost pile:

- Weeds
- Baling wire or twine
- Syringes and needles
- Soda cans and other trash
- Shoes, nails and other metals
- Plastic
- Cedar wood (resistant to decay)

Determining Bin Size

- **Calculate the amount of manure and bedding produced** (see Tables 3 and 4 for Example Calculations) An average 500 kg (1100 lb) horse produces 22 kg (0.81 ft^3) of manure plus bedding each day. If soiled bedding is combined with manure, the total volume generated each day can easily double (44 L or 1.6 ft^3) or triple (66 L or 2.4 ft^3). Alternatively, you can count the number of wheelbarrow loads generated from your operation each day and estimate the capacity of each load. Keep in mind these are just estimates and may increase or decrease depending on the volume of stall waste produced.
- **Determine how long the materials will remain in the bin** The use of only one or two bins usually means the materials will remain in the bins for longer periods (three to six months). When using three or more bins, each bin should provide enough space to house material generated for a two-month period. The volume of material in each bin will decrease over time as materials degrade, so subsequent bins may be slightly smaller if necessary.
- **Plan for extra bin space** if your operation will house more horses in the future.

Table 3.

Example Calculation: Two-Bin System for a Small Operation	
Number of horses	2
Volume of manure and bedding generated each day	2.4 ft^3/horse x 2 horses = 4.8 ft^3 (66 L/horse x 2 horses = 132 L or .13 m^3)
Amount of time materials will remain in each bin	4 months (120 days)
Size of each bin (2 bins)	4.8 ft^3/day x 120 days = 576 ft^3 576 ft^3 = 10 ft x 10 ft x 6 ft (.13 m^3/day x 120 days = 15.8 m^3) (15.8 m^3 = 3.5 x 3.5 x 1.3 m)

Table 4.

Example Calculation: Three-Bin System for a Large Operation	
Number of horses	12
Volume of manure and bedding generated each day	2.4 ft^3/horse x 12 horses = 28.8 ft^3 (66 L/horse x 12 horses = 792 L = .79 m^3)
Amount of time materials will remain in each bin	2 months (60 days)
Size of each bin (3 bins)	28.8 ft^3/day x 60 days = 1728 ft^3 1728 ft^3 = 17 ft x 17 ft x 6 ft (0.79 m^3/day x 60 days = 47.4 m^3) (47.4 m^3 = 5.6 x 5.6 .1.5 m)

Managing Your Compost Pile

Composting does demand some time and attention. Management of the compost pile can be kept simple or be quite sophisticated and should be customized to fit your specific situation and goals. Remember that some trial and error is an essential part of developing a successful composting system.

Building the Pile

A minimum pile size of one cubic meter (3.5 x 3.5 x 3.5 ft) is needed to achieve composting temperature. The pile can be bigger and will obviously be dictated by the type of composting system you choose and the space available. The minimum pile size may be created all at once or amassed over several days, and the pile allowed to grow from there.

Add manure and bedding directly to the compost pile as you clean your horse stalls. This is also the best time to add water if needed. Manure picked up from riding rings, arenas, trails and corrals can also be added directly to the pile. Avoid picking up too much dirt along with the manure, and keep all trash out of the pile.

Monitoring the Temperature of the Pile

You should monitor the temperature of the pile weekly to ensure active composting is taking place. Effective composting temperatures range from 55 to 65°C. The center of a properly made heap should reach such temperatures within a week during the summer. In cooler seasons, it may take up to a month to reach effective composting temperatures.

To destroy parasites and weed seeds, temperatures of 55 to 65°C should be maintained for at least 21 days. Piles that are too cool (below 55°C) break down more slowly and do not kill parasites or weed seeds. Piles that are too hot (above 71°C) kill the composting microorganisms and result in an extremely foul-smelling pile.

A temperature probe can be used to eliminate the guesswork. Long-stemmed compost thermometers are available at most hardware and garden supply stores (Figure 11).

Turning and Mixing the Pile

The most active site of composting takes place in the hotter center of the pile. Therefore, the pile needs to be turned and mixed to expose the material from the cooler, outer edges to the hot center. Turning not only helps aerate the pile, but it also ensures that weed seeds and parasites in the cooler sections are destroyed by bringing them into the center to "cook."

Depending on your composting system and the amount of manure generated, the pile can be mixed and turned by hand with a pitchfork or mechanically with a small front-end loader.

Frequent turning accelerates the composting process; the more it is turned, the faster the pile breaks down. Turning may be done on a weekly or monthly basis, or turning may be based on the measured temperature of the pile. If using temperature as a guide, you should turn piles when temperatures fall to 43°C or when they rise above 65°C.

Alternatively, your composting system might dictate your turning schedule. For example, if you have a multiple bin system, turning might occur as you shift the heap from one bin to the next.

Weather conditions might affect your turning schedule. The pile will take longer to reheat in the winter, so you may not want to turn the compost as often. Monitoring the temperature of the pile will be helpful in deciding when to turn the pile during the cold winter months in Alberta.

Winter composting tips:

- **Composting can still take place in the center of large piles in the winter.**
- **Composting will occur at a slower rate in the winter (four to five months, compared to two to three months in the summer). Make sure you have adequate storage space for stall waste.**
- **Keep piles large (at least one cubic meter) to maintain adequate heat for composting.**
- **Turn piles less frequently in the cold winter months. Turning piles during extremely cold weather may result in a slower rebound back to composting temperatures or a total shutdown of the whole composting process.**
- **If you are not already composting, winter is not the best time to begin. Instead, establish your composting system when the weather warms up in the spring.**

How long will it take to compost?

Depending on the amount of materials and how diligent the horse owner is in turning the compost pile, composting can take several months. A well-managed pile will break down the fastest—as quickly as 60 days—although the average time is 120 days. Piles that do not have the correct mix or are not maintained break down much more slowly, taking 6 to 12 months or more. In the winter, properly managed piles may require 4 to 5 months to compost.

As an alternative to frequent turning, PVC pipes can be inserted into the center of the compost pile like chimneys. Drilling several holes (1 cm or ½-inch in diameter) along each pipe (at approximately 15 cm or 6-inch intervals) will allow air to enter the pile passively.

Occasional turning of the pile may still be needed to get manure from the outside into the center, so the heat from the composting process can destroy parasites and weed seeds. It may take longer to compost a pile aerated by PVC pipes compared to a pile that is actively mixed on a regular basis.

Adding Water to the Pile

All materials in the pile must be moist, but not soaking wet. The moisture level can be gauged by squeezing a handful of compost. Compost that contains an adequate amount of moisture will feel like a freshly wrung out sponge. 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, tree leaves, shredded bark or old hay to dry the pile. If the compost does not feel moist, you need to add water.

One of the biggest mistakes people make is putting a lot of water on the pile all at once, then ignoring the pile. Adding a little water each day is much better than letting the pile get dusty and dry, then trying to re-wet it back to the 50 per cent range. Consider watering your compost with a garden hose when you turn the pile. Or, an easy way to add water is just to hose down the manure in your wheelbarrow before you dump it into the pile.

The actual amount of water needed will vary substantially depending on the kind and amount of bedding used, the weather and if the compost is protected from rainfall. The more dry bedding included in the mixture or the warmer and dryer the weather, the more likely it is that you will have to add water. Make it a habit to check the moisture content when you turn the pile, or check more frequently during hot, windy summer days.

Can the Compost Pile Catch Fire?

Despite the high temperatures that develop in a compost pile, the pile will only ignite if the hot zone is next to a dry zone. So, it is important to keep the pile mixed and at the proper moisture level (50 per cent).

Adding Extra Nitrogen to the Pile

The more bedding you use, the more likely it is that you will need to add supplemental nitrogen. Bedding contributes primarily carbon to the compost pile. The use of too much bedding offsets the ideal C:N ratio and slows the composting process.

Because of the high C:N ratio of wood products, supplemental nitrogen may also need to be added to the pile if you use shavings or sawdust bedding.

Commercial fertilizers, such as urea, ammonium nitrate or another high-nitrogen fertilizer, can be added to the pile to provide supplemental nitrogen. Ideally, nitrogen should be sprinkled on each wheelbarrow load of manure dumped on the pile each day. Alternatively, nitrogen can be mixed into the pile when it is turned.

Table 5. Sources of supplemental nitrogen and amounts needed to provide 1.5 kg/tonne (or 3 lbs per ton).

Nitrogen source	% Nitrogen	Amount added per tonne (ton) of manure	Amount added per horse per day*
Urea	46%	3.25 kg (6.5 lbs)	75 g (2.5 oz)
Ammonium Nitrate	33%	4.5 kg (9.0 lbs)	100 g (3.25 oz)
Calcium Nitrate	15%	10 kg (20.0 lbs)	200 g (7 oz)

* Assumes 20 kg (45 lbs) of manure are produced per horse per day.

When adding supplemental nitrogen, a good rule of thumb is 1.5 kg of nitrogen per tonne of stall waste (3 lbs per ton). A ton of stall waste is equivalent to a pile approximately the size of an average washing machine. Table 5 lists several different sources of supplemental nitrogen and the amounts to add per tonne (or ton) of stall waste or the amount per horse per day.

Putting Compost to Use

After you have successfully produced compost, you need to think about what you will do with it. In many cases, compost is a more attractive product than raw manure, making it easier to give away or sell to others if you cannot use it yourself.

Figure 15. Harrowing horse manure compost distributes the nutrients more evenly across the field.

Properly prepared compost has many uses:

- **Soil Amendment**. Although compost contains nutrients, its greatest benefit is in improving soil characteristics. Composted horse manure can be used to increase the organic matter content and the water and nutrient-holding capacity of sandy and heavy clay soils.
- **Growth Media**. Finished compost can be used by plant nurseries as potting soil and is an excellent media for the production of mushrooms and fish worms.
- **Mulch**. Compost can be a valuable mulching material for garden and landscape plants. And if used as mulch, the compost need not be completely finished.
- **Slow-release Fertilizer**. When applied to lawns, cropland or pastures, finished compost can supply a modest amount of nutrients that will be released slowly over time. Since compost is already broken down, it does not deplete the soil of nitrogen needed by plants to grow. Nitrogen depletion can occur when uncomposted horse waste (or unfinished compost) are spread on fields. And because composting kills parasites and weed seeds, the risk of re-infection is reduced. Additional fertilization may be necessary to obtain acceptable growth yields when compost is applied as fertilizer.

If applying finished compost to cropland (Figure 15) or pastures, it should be applied only at recommended rates and to plants and soils that can use the nutrients. For more information on testing your soil and compost, as well as guidelines for spreading compost on pastures and cropland, refer to the chapter "Managing Manure by Spreading on Cropland or Pasture" in this manual.

Is it Ready?

- **Finished Compost**
  When manure and bedding are completely degraded, they are termed "finished" compost. Finished compost will not heat up anymore and has an earthy smell and a crumbly soil-like texture. Properly produced compost will also be less likely to contain parasites and weed seeds. Because of this characteristic, finished compost can be safely used in gardens or applied to cropland or pastures.
- **Unfinished Compost**
  Decomposition will take place even if a compost pile is ignored after it has been built, but at a slower rate. Decay will be slower, cooler and less effective at killing weed seeds and pathogens. Manure and bedding that are not allowed to decompose fully are termed "unfinished" compost.

The Bottom Line

- Composting provides a viable option for managing horse manure.
- Properly prepared compost has many uses as a soil amendment, growing media, mulch or slow-release fertilizer.
- Compost may be a more attractive end product, compared to uncomposted stall waste, making it easier to give away or sell.
- Composting kills intestinal parasite eggs and larvae and also destroys weed seeds, reducing the risk of re-infection if compost is spread on pastures.
- On average, a well-managed pile can be composted in two to three months in the summer or four to six months in the winter.

Table 6. Compost troubleshooting

Symptom	Cause	Solution
Compost pile will not get hot	Pile may be too dry	Add water
	Pile may contain too much bedding (carbon)	Add fertilizer or manure to supply more nitrogen
	Pile may be too wet	Add more bulking materials; cover from rain
	Pile may be too small	Build a bigger pile
	Cold weather	Build a bigger pile
Compost has foul smell	Pile may be too wet	Add more bulking materials and turn pile
	Pile may need more air	Turn the pile more often
	Pile may contain a dead animal	Remove the carcass
Compost pile does not seem to be breaking down	Pile may be too dry	Add water
	Pile may be too small, not holding heat	Build a bigger pile
	Pile might not contain enough nitrogen	Add fertilizer or manure to supply more nitrogen