MANAGEMENT

Composting Horse Manure in Dynamic Windrows

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Quick Facts...

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Horses provide utility and pleasure to many Coloradoans and visitors to the state. However, the buildup of horse manure for operations with horses on drylots or in stalls creates a management issue that cannot be ignored. Too often manure or manure mixed with bedding is piled on site for years without a plan for disposal or adding value to this raw product. This stockpiling can become a pest breeding ground and a water quality and nuisance issue. Some horse owners end up paying someone to haul the material away or hoping that gardeners and landscapers will remove it at no cost. In any case, horse manure is a resource to reuse. It serves no purpose sitting in a pile indefinitely.

With minimal amount of equipment, time, and money, horse handlers can implement an appropriate plan for composting this resource on site. Effectively composting horse manure will increase its value for application to pastures and for sale to farmers, gardeners, and landscapers.

What is a Windrow?

The term windrow was originally used to describe cut hay left in long rows to dry in fields. Windrows of compost resemble these long rows of hay but are mounds of material instead of a flat layer of hay. Windrows typically begin as 4 to 8 feet tall, 10 to 20 feet wide, and 10 to 200 feet long. They typically decrease in volume as they mature. The shape of the windrows allow for easy access to turn the material and provides the best configuration for the air, moisture, and volume requirements of the organisms that decompose the manure and bedding. The finished product is brownish-black in color with most particles less than one half inch in diameter. It has an earthy smell similar to healthy, fertile soil.

Is Windrow Composting Right for My Operation?

One horse generates, on average, over 5 cubic feet (about 350 pounds) of manure per week! Add to that 3 to 6 cubic feet of bedding per week from stalled horses and suddenly the volume and weight of this material becomes too much to move by hand. While it is possible to do windrow composting with a fork and a wheelbarrow, windrow composting is recommended for those operations that own or have access to a bucket loader.

Advantages

- Compost can be added to sand in arenas to improve footing.
- Compost is an excellent soil conditioner. It improves the drainage, structure, and nutrient holding capacity of all types of soils found in Colorado.

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• Composting improves manure handling by reducing the volume of manure/bedding by 40 to 60 percent and enhancing uniformity.
• Compost is more valuable than raw manure/bedding for land application because the process: a) creates a more stable form of nitrogen for sustained release in the soil; b) lowers the ratio of carbon to nitrogen, preventing nitrogen deficiencies in crops; and c) has the potential to kill parasites and weed seeds.
• Compost is valued by organic gardeners and farmers and by landscape professionals as a high quality soil amendment.

Disadvantages

• Requires time and money – must be turned and watered appropriately.
• Requires space suitable for forming and maintaining windrows.
• Suburban and urban areas may be subject to nuisance odors from the process (although odors are minimal if done properly).
• Colorado climate requires the addition of ample moisture to windrows and a buffer (i.e., space, trees, etc.) against blowing particles in some areas.
• Marketing of composting requires time and effort.
• Use of bedding in windrows requires the addition of a nitrogen source to speed up decomposition of the carbon source (i.e., bedding) if the carbon to nitrogen ratio (C:N) exceeds 30:1.

The Biology of Compost

Healthy compost is alive with organisms. An ecosystem of macro- and microorganisms feed on the carbon sources that are put into the pile (manure, bedding, etc.). There is a food chain that occurs in healthy compost piles from decomposers to predators. Bacteria, fungi, actinomycetes, and basidiomycetes do the bulk of the decomposition that creates the finished compost. Helping them are nematodes, red worms, millipedes, sowbugs, and some types of mites. Beyond these decomposers, a host of predators feed on them and each other. These include springtails, protozoa, rotifers, soil flatworms, centipedes, rove beetles, predatory mites, fomicid ants, and carabid beetles. But don't worry; none of these organisms are horse pests.

To make a good finished product, you must create the ideal environment for the primary decomposers (bacteria, fungi, actinomycetes and basidiomycetes). Dynamic windrow composting is one way to create and maintain these conditions.

Table 1: Maximum length of piles for manure vs. manure with bedding.

Number of Horses	Length – Manure Only	Length – Manure with Bedding[a]
10	94 feet	195 feet
20	195 feet	389 feet
30	292 feet	584 feet
40	389 feet	779 feet
50	487 feet	973 feet
60	584 feet	1168 feet
70	681 feet	1363 feet

[a]50 percent manure and 50 percent bedding.
+Based on a windrow formed to 6 feet high and 10 feet wide (capacity of most small tractors with bucket loaders) and will decrease as height and width increase (12 feet tall and 20 feet wide maximum).
++Length is maximum needed (based on 1 horse producing 0.8 cubic foot of manure per day) and does not need to be one continuous windrow.

How Do I Make Compost Using This Method?

It is important to distinguish between dynamic and static windrow methods. Dynamic methods rely on mechanical turning of the windrow for aeration. Static methods utilize perforated pipes to bring the air into the windrow. These pipes are either open ended, allowing air to diffuse into the windrow; or capped with blowers that force air into (and in some cases out of) the windrow. Both processes are similar in their management goals, differing only in how they bring oxygen to the organisms in the windrow. For more information on static methods of composting see fact sheet 1.226, *Composting Horse Manure in Static Windrows.*

Where to Put the Windrow

The ideal location for a windrow takes into account the following:

- Proximity to drylots and stalls to minimize transport;
- Access to a pressurized water source to add supplemental water;
- High, level ground away from surface and ground water sources (i.e., flowing and dry creeks, rivers, irrigation ditches, springs, ponds, lakes, and areas with a high water table) to minimize potential surface and ground water contamination; and
- Sufficient area to maneuver equipment and accommodate the volume of manure to be windrowed – at least 10 feet on all sides of the windrow (see Table 1).

How to Get Started

Uniformity is important to ensure an even, predictable composting process. If you are using varied sources for your windrow (i.e., manure only; manure and several types of beddings [pine sawdust, woodchips, shavings, straw, etc.]) try to mix them together until you see no pockets of the various sources. If you can regulate bedding types, try to use only one.

Once your windrow is uniform, determine if supplemental nitrogen is necessary. Take a sample to a laboratory for analysis of carbon and nitrogen levels. An acceptable carbon to nitrogen ratio (C:N) for composting is 30:1. Horse manure sampled in Colorado has a C:N of 21:1, on average, making it an ideal compost material. If you have wood chips or sawdust in your windrow mix you will create a C:N that can approach 400:1. This C:N can double the time necessary to decompose the material thus increasing your labor and machinery costs for turning it. For more efficient composting, use Table 2 to determine how much N to add per cubic yard of material.

As you build the pile with your bucket loader, add the N source evenly over 1 foot thick layers of material. You may have better results if you dissolve the N fertilizer in water before applying it. This is an ideal time to add moisture to the new portion of the windrow. Moisten the manure/bedding so that it feels moist to the touch but no water comes out when you squeeze it (like a damp

Table 2: Pounds of pure N and N sources needed per cubic yard of material to lower C:N to 30:1.

Manure and Bedding Mix	Nitrogen	Ammonium Nitrate	Urea	Bloodmeal	Alfalfa Hay
75% Manure/ 25% straw	None Required	None Required	None Required	None Required	None Required
50% Manure/ 50% straw	2 lbs.	6 lbs.	4 lbs.	17 lbs.	67 lbs.
75% Manure/ 25% sawdust	None Required	None Required	None Required	None Required	None Required
50% Manure/ 50% sawdust	6 lbs.	18 lbs.	13 lbs.	50 lbs.	200 lbs.
75% Manure/ 25% chips/ shavings	None Required	None Required	None Required	None Required	None Required
50% Manure/ 50% chips/ shavings	6 lbs.	18 lbs.	13 lbs.	50 lbs.	200 lbs.

+For horse manure calculations only – C:N for straw 80:1, all others 400:1
++33 percent N in ammonium nitrate, 46 percent N in urea, 12 percent N in bloodmeal, and 3 percent N in alfalfa hay.

Warning! Manure and bedding are difficult to wet once they completely dry out!

sponge, about 40 percent moisture). Moisture is essential for the health of the compost organisms and to prevent spontaneous combustion of the windrow.

Each time you gather manure and bedding, go through the above process, adding to **one end** of the windrow only. In this way you can build a windrow that can operate continuously and mature in one direction along its length.

As the microbes begin to digest the material, heat is released from the decomposition process. Temperature and moisture must be monitored at least weekly for optimal composting conditions.

Turning and Monitoring the Windrow

Turning. During the initial stages of decomposition, bacteria dominate the process and require a lot of oxygen. These same bacteria are responsible for the heat that the windrow produces. Turning the pile with a bucket loader does several things:

- Releases heat and gases (some gases are toxic to the compost organisms);
- Fluffs the pile to increase passive air exchange and add fresh air (oxygen); and
- Mixes the materials and brings the outer layers of the windrow to the center where they can be exposed to temperatures that kill parasites and weed seeds (145 F).

Temperature. Heat is necessary for fast decomposition, but it evaporates the moisture in the pile and reduces microbial activity above 140 F. Heat in a dry pile can result in spontaneous combustion (fire). Therefore, turning the pile as soon as internal temperatures (monitor with a 3 foot long compost thermometer) reach 145 F is critical.

Monitor the temperature every 20 feet or less along the length of the pile (determined by the age of sections of the windrow). As oxygen levels drop below 5 percent, decomposition slows, and temperatures decrease. When temperatures drop to 120 F, turn the pile and check for moisture. The frequency of turning decreases as the compost matures.

Moisture. Microbial activity diminishes as moisture drops below "moist sponge" levels. Sufficient moisture levels may be reached by applying water to the top of the windrow. However, it may be necessary to open a section of the windrow with a fork or bucket loader and spray it with water. Another way is to use a watering probe. This is a thin perforated pipe that attaches to a garden hose and is pushed into the pile. Water is injected into the pile, minimizing losses to evaporation and runoff. Check for moisture from a few inches beneath the surface to the center of the windrow when turning.

Curing

When temperatures fall below 120 F after turning (assuming proper moisture levels exist) the windrow has moved into its curing stage. Curing is critical to finish the life cycle of oxygen consuming microbes, shift the pH toward neutral, increase levels of nitrate-nitrogen, and allow for the recolonization of soil microorganisms. The enhancement of these qualities ensures a market-ready product. When windrow temperatures reach air temperatures, the curing is complete (about one month). Now the compost is ready for use.

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