ONE HORSE OR A HUNDRED

Equine Program

WO 1018 (No. 1 in Series)

MSUE Equine AoE Team

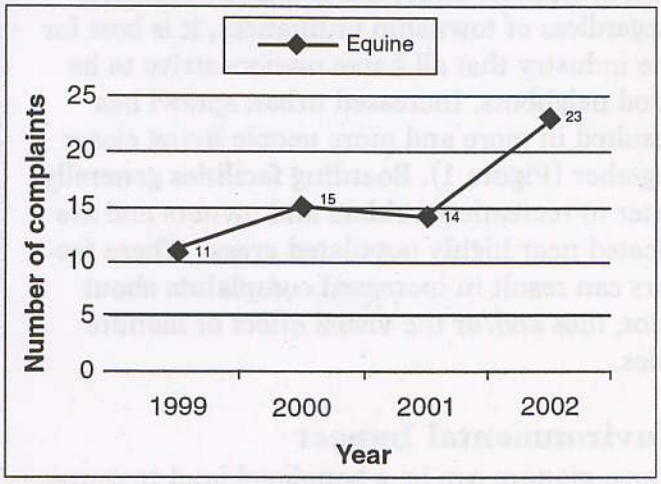
1 You are a farm

Do you consider yourself a farmer? According to Michigan's Right-to-Farm Act, if you have one horse or a hundred horses, you are a farmer. As a result, if you comply with manure management practices as outlined by the Michigan Department of Agriculture (MDA), the Right-to-Farm Act will protect you from nuisance lawsuits. This means that if your neighbor is offended by living next to horses and sues but you are following Michigan's manure management practices, it is unlikely that your case will make it to court, and even more unlikely that you will lose.

Many horse owners either don't know this or don't understand what it means, as the number of Right-to-Farm complaints MDA receives is increasing. The Michigan State University (MSU) Equine Area of Expertise Team and the MDA have worked together to develop a series of articles focusing on horse manure issues. They will cover water quality, zoning and management practices to help Michigan horse owners make the best decisions on manure management for their farms.

Traditionally, complaints lodged with the MDA have been against dairy, swine, beef and horse farms, in that order. Dairy farms have always had the highest percentage of complaints. In recent years, horse farm complaints rose from 8 to 16 percent, moving horse farm complaints from fourth in 2001 to second behind dairy in 2002. This is definitely not good news for the Michigan horse industry.

Table 1. Number of Right-to-Farm equine complaints involving manure management.



Complaints against horse facilities range from concern about surface water and groundwater contamination, to air quality issues such as odors and flies.

Impact on Horse Ownership

It is very important that horse owners develop and implement plans for handling and disposing of manure. To avoid or ignore the issue may be a long-term recipe for disaster to the Michigan horse industry.

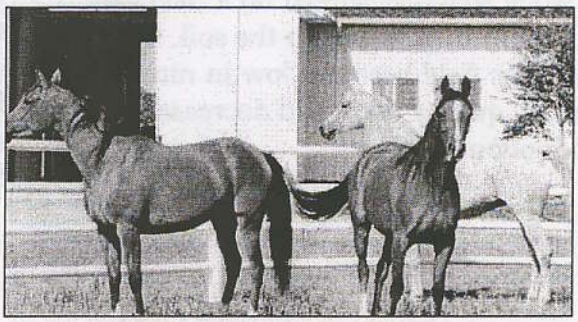


Figure 1. Horses are part of the landscape of agriculture.

ONE HORSE OR A HUNDRED

Complaints about horse manure could ultimately result in increased regulation of horse ownership at the township level. If enough complaints about equine properties are received, a township may rezone, which affects people's ability to keep horses. This will have the greatest impact on new and expanding horse operations. Existing farms will maintain their current protection under the Right-to-Farm Act. Regardless of township ordinances, it is best for the industry that all horse owners strive to be good neighbors. Increased urban sprawl has resulted in more and more people living closer together (Figure 1). Boarding facilities generally cater to recreational riders and owners and are located near highly populated areas. These factors can result in increased complaints about odor, flies and/or the visual effect of manure piles.

Environmental Impact

Horse manure can be a beneficial land resource, but if it's poorly managed, it can have a negative impact on the environment. The phosphorus in manure is the primary concern. Soil needs phosphorus to be productive, but an overabundance can be detrimental to surface water quality if it runs off into surrounding ditches, streams and lakes.

Wood shavings in horse manure present another concern (Figure 2). Horse manure alone can provide a rich organic source of nitrogen to the soil, but wood shavings spread on a field can actually remove nitrogen from the soil. As a pasture or crop field becomes low in nitrogen, plant growth, quality and yield decrease while weed production increases.

Figure 2. Feedstock is a combination of manure and bedding material.

Finally, air quality can be affected by the anaerobic breakdown of manure and ammonia from urine. Most horse owners don't consider horse manure odors offensive, but Murphy's Law ensures a strong wind blowing from your manure pile to your neighbor's backyard barbecue.

Horse Health

Equine health issues are inherent in the problem of manure management. Horses shed parasite ova (eggs) in their manure. Spreading raw manure on grazing land allows parasites to find their way back into different equine hosts and continue their life cycle.

A second health consideration comes from diseases spread via manure. Organisms that affect the horse's gastrointestinal tract (such as equine-specific *Salmonella*) can be passed in the feces. Other diseases that can contaminate the soil (such as *Rhodococcus* sp. and strangles or *Strep equi*) can be spread in a similar fashion.

Conclusion

Manure management is not simply a concern for livestock operations or large horse farms. Michigan's Right-to-Farm Act offers horse owners with guidelines for managing manure and protection if these guidelines are followed. Good manure management is a horse health issue, a water protection issue and a neighborhood harmony issue. Look for future articles on how you can better manage manure, improve your horse's health and be a good neighbor in the *One Horse or a Hundred* bulletin series. For more information on the Right-to-Farm Act, call 1-877-632-1783 or log onto < www.michigan.gov/mda > .

For more information and materials online, visit these Web sites:
www.emdc.msue.msu.edu
www.msue.msu.edu/aoe/equine/

ONE HORSE OR A HUNDRED

Equine Program

WO 1019 (No. 2 in Series)

MSUE Equine AoE Team

2 Perfect Planning Prevents Problems

Believe it or not, some people think horse manure stinks! People don't like to see it out their window or drink it in their water. By using some "perfect" planning suggestions, you can prevent water contamination, be a good neighbor and have healthy, happy horses (Figure 1).

Figure 1. Your horses can be part of your neighbor's landscape. Perfect planning is the first step in developing good

On Your Existing Farm

Let's start by asking a few questions: *Where is your manure pile located?* It may be easier to hide that manure pile behind the barn by the trees, but if that area is too close to a **water source**, then you will need to move it. Manure storage needs to be at least 150 feet away from water sources, including wetlands, streams, creeks, ponds, lakes and ditches. If your land is hilly, then you need to use your land contour to its best advantage to prevent water pollution. This may mean increasing the distance between storage and water sources. Other options might include storage containers such as cement pads with sides to contain runoff.

Water concerns don't end with the water that we can easily see. Manure piles can affect groundwater if left static for more than a year. To avoid runoff and groundwater contamination, move the location of your manure pile every year, if possible. If you have limited options or space, use cement or rubber pads or try to locate your manure on clay soil.

No water, no problem? You still need to consider your next-door neighbor. *Is your manure pile part of your neighbors' viewscape?* To keep in good standing with your neighbors and avoid problems or complaints, let common sense prevail. Keep your pile small and camouflage it by surrounding it with nontoxic shrubs or flowers or building a storage container. It's quite amazing, but neighbors usually don't smell what they can't see. Remember to think about manure runoff and make sure that manure and its nutrients don't leave your property.

So, you thought you were done — you now have clean water and happy neighbors. What about your horses? Manure can breed flies and provide a nice home for unwanted parasites and harmful bacteria. It may be easier to dump your wheelbarrow right out the backdoor. But don't forget that your horse now has to deal with additional pesky flies and increased risk of internal parasites and disease. Keep your manure away from where your horses live.

Manure doesn't just come in big piles — those small piles all over the turnout can lead to the same issues as the big manure piles. Make sure

that your paddock manure is not running off to surface waters or your neighbor's property, or causing a fly or health problem. Small paddocks should be picked out to avoid these problems. (Figure 2)

Figure 2. Manure in small paddocks, turnout lots or exercise pens may need to be picked out periodically.

If none of these options work, the last question to ask is, *Do I have too many horses on my farm?* On average, an adult horse needs at least 2 acres for quality grazing. It also takes about 2 acres per horse for spreading manure for proper nutrient use (this allows for both nutritional support for the horse and land to spread manure).

Planning Your New Farm

If you're in the position to start from scratch, survey your new property to find the best spot for your barn, manure storage and fence placement. Your township or county probably has guidelines or zoning ordinances for the number of horses per acre, barn location and size, and fencing procedures. You'll want to keep your horse operation as high and dry as possible and control horse access to surface water. For a manure pile location, make sure to follow the perfect planning strategies that were outlined above.

If you plan on building a new facility or expanding your old facility to house 25 or more horses, be sure to follow the Right-to-Farm Act's Generally Accepted Agricultural and Management Practices for Site Selection and Odor Control for New and Expanding Livestock Production Facilities (visit the Michigan Department of Agriculture Web site at www.michigan.gov/mda or call 877-632-1783).

Remember, a permanent mountain of manure is an environmental and health hazard as well as an eyesore. To make sure that you have the perfect plan, watch for the next article in the *One Horse or a Hundred* series to learn about manure management solutions.

For more information and materials online, visit these Web sites:
www.emdc.msue.msu.edu
www.msue.msu.edu/aoe/equine/

ONE HORSE OR A HUNDRED

Equine Program

WO 1020 (No. 3 in Series)

MSUE Equine AoE Team

3 Manure and Water Don't Mix

By Jane Herbert, MSUE District Water Quality Agent

What's the big deal about horse manure? Why are our neighbors so concerned about the manure from our horses getting into surface waters and groundwater? There are several reasons why *manure and water don't mix.*

Because they spend so much time around it, horse owners may not consider that horse manure contains pollutants and, under the right circumstances, can pose a threat to humans and the environment. A source of nutrients such as nitrogen and phosphorus, horse manure may also contain pathogens (including *E. coli*) that can be hazardous to human health. When manure is not managed properly, these contaminants can make their way into our water and cause problems.

Groundwater: Most rural Michiganians get their drinking water from groundwater wells. Light-textured soils make these drinking water supplies vulnerable to contaminant leaching. Excess nitrogen (nitrogen not used by plants) enters groundwater as *nitrates*, which have been linked to health problems in infants and the elderly. Horse manure that is piled up and left indefinitely or spread too heavily can leach nitrates to drinking water. Additionally, manure that washes overland and comes into contact with drinking water wells (Figure 1) can leach down around well casings, transporting both nitrates and pathogens to groundwater.

Surface water: The flip side of the groundwater issue is manure entering surface waterways, including lakes, streams, ponds, drains, ditches and wetlands. Horse access to waterways should be controlled to prevent damage to stream banks and shorelines. Hoof traffic compacts the soil, disturbs vegetation, and increases erosion and runoff. Restricting access also reduces the opportunity for "direct deposit events" (Figure 2).

The primary concerns about manure runoff are phosphorus loading, dissolved oxygen (DO) levels and increases in biochemical oxygen demand (BOD). We'll explore these one at a time.

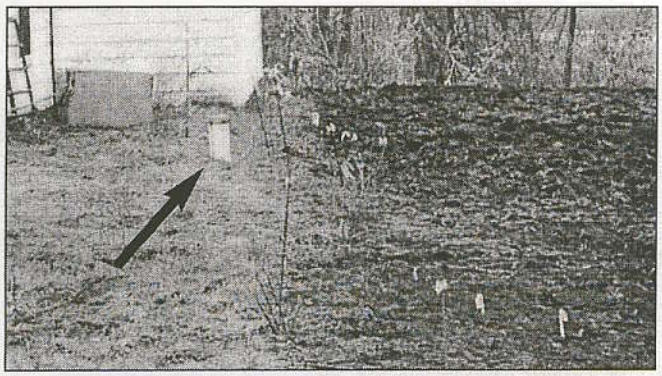


Figure 1. Horse lot within the 50-foot recommended isolation distance from well.

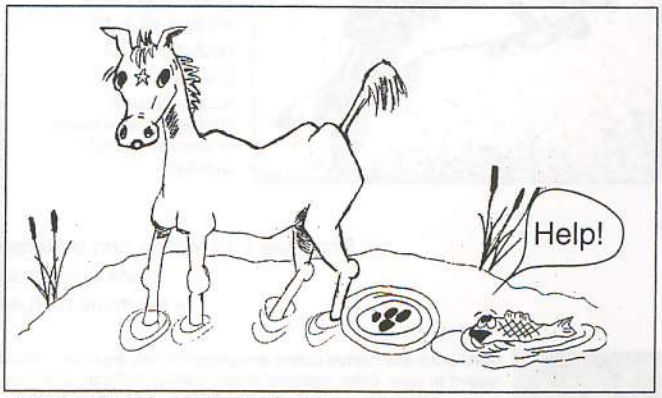


Figure 2. A direct deposit event.

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ONE HORSE OR A HUNDRED

- **Phosphorus** — This naturally occurring element is the limiting factor for aquatic plant growth. That means that, in healthy aquatic ecosystems, this natural plant food is present in very small amounts, limiting plant and algae growth. When excess phosphorus enters the system, it can quickly cause overgrowth. This can lead to nuisance plant communities that reduce the recreational and aesthetic value of the waterway and put stress on aquatic ecosystems (see below). The main sources of phosphorus loading from horse operations are manure runoff and soil erosion. Phosphorus chemically binds to soil particles — when soil moves, so does phosphorus.
- **Dissolved oxygen** — Fish and other aquatic critters need certain levels of dissolved oxygen (DO) in the water to breathe. Some fish, such as trout and salmon, require higher DO levels than others, such as carp and catfish. During the day, aquatic plants and algae undergo photosynthesis and generate dissolved oxygen. Problems start at night, when these same plants undergo respiration and take up oxygen, lowering DO levels. Nuisance plant and algae overgrowth can create major fluctuations in DO, stressing and even killing fish (Figure 3).

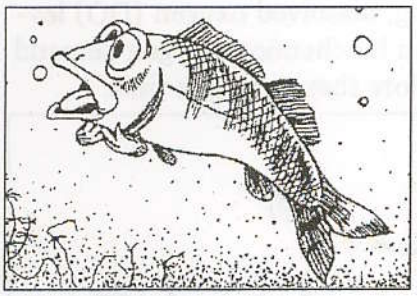
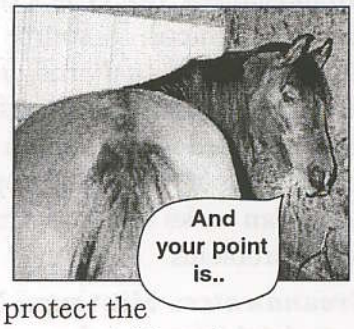


Figure 3. Fish stress due to reduced DO levels.
(Image source: Michigan Department of Environmental Quality)

- **Biochemical oxygen demand** — Naturally occurring aerobic bacteria act as waterway scavengers, constantly breaking down waste and organic matter in the water. But when a large and sudden amount of organic matter enters surface water, it can cause sharp increases in biochemical oxygen demand. This means that when manure, bedding and/or horse feed enter a pond, lake or stream, these scavenger bacteria multiply very rapidly to clean up the mess. Their need, or demand, for oxygen also increases rapidly, and suddenly the bacteria are competing with fish for oxygen. If the bacteria win, the result can be a quick and extensive fish kill.

By now, you may be saying, "OK! Enough with the science lesson! How do I know if I'm doing a good job managing my horse manure? If I'm not, what kinds of changes should I make?"



Stay tuned to the *One Horse or a Hundred* series. Future articles will contain useful information on managing horse manure to protect the environment *and* keep your neighbors happy.

For more information and materials online, visit these Web sites:
www.emdc.msue.msu.edu
www.msue.msu.edu/aoe/equine/

ONE HORSE OR A HUNDRED

Equine Program

WO 1021 (No. 4 in Series)

MSUE Equine AoE Team

4 Manure Management Solutions

You've got the horse, you've got the farm and you've got lots of plans. One thing you may not have, however, is a plan for handling the manure your horses will produce. What are the options for responsible manure management?

Stockpiling

One of the most common manure-handling methods is putting it in a pile and leaving it alone (Figure 1). Though this option is appealing to many, it is not the most environmentally friendly or neighborly solutions. Putting manure in a pile and leaving it is not the same as composting it, no matter how long it sits.

Figure 1. Stockpiling manure is not composting.

Composting is an active process that involves a decrease in volume and an increase in nutrient quality, and it produces an end product with many uses. Manure that sits in a pile may be slowly decomposing, but it's also attracting flies and generating odors, and it has potential for environmental pollution through runoff or leaching to groundwater. All of these factors can ultimately result in unhappy neighbors and increased complaints. (For more information on composting horse manure, read No. 5, "*One Horse or A Hundred:* What is Composting, Anyway?")

Hauling Away

Another option involves short-term storage of manure that will eventually be hauled away. Local farmers may spread manure on hay fields or crops. A composting operation or nursery in your area may also be willing to accept horse manure. In some areas, manure may be hauled to a commercial landfill. This option is expensive and is not a long-term or environmentally-friendly solution.

Land Application

If you're lucky enough to have adequate land and the right equipment, you may have the option of spreading manure on your own property (Figure 2). Composting before spreading will increase the nutrients' benefits. If the manure is not composted before spreading, the low nitrogen content in common bedding material may reduce soil quality and pasture production potential.

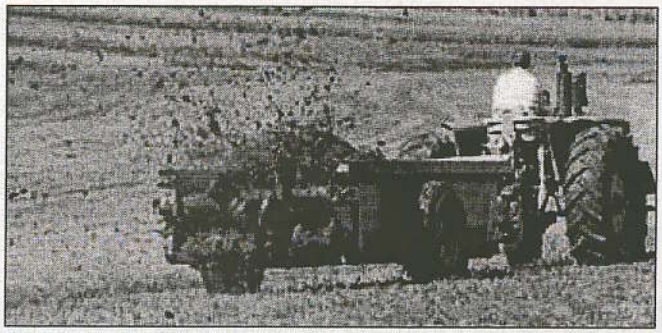


Figure 2. Spreading compost can add beneficial nutrients to the pasture.

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ONE HORSE OR A HUNDRED

Some people have the option of spreading manure and bedding on arenas. Depending on your soil type, adding some waste material may improve footing or soil consistency, but this is a limited solution. Spreading raw manure on pastures may increase harmful bacteria and parasite levels in the soil. The composting process reduces these risks.

Anytime manure and bedding are spread on land, horse owners should take several factors into consideration. These include timing spreading to avoid neighborhood events, family gatherings and holidays. It is also important to consider weather conditions when spreading manure. If the ground is frozen or heavy rain is predicted, spreading should be avoided because of runoff potential and surface water contamination.

To reduce the amount of manure handled and improve horse health, keeping your horses on pasture continuously may be a solution. Manure may still build up in certain areas, however, and may need to be spread out or removed. The best time to drag a pasture is when the weather is hot and dry — this helps to control parasites in the manure.

Manure is a fact of your horse-managing life. Fortunately, solutions are available for dealing with it. Depending on your setup, one or more of the options outlined above may work for you.

Photo sources: USDA online photo library < www.usda.gov/oc/photo/opchomea.htm > .

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ONE HORSE OR A HUNDRED

Equine Program

WO 1022 (No. 5 in Series) MSUE Equine AoE Team

5 What is Composting, Anyway?

Every horse owner has to deal with the same by-product of horse ownership — manure. Horse owners have a common obligation to practice sound environmental practices. Michigan is fortunate to have a strong Right-to-Farm Act to address many of these issues. Composting is one of the manure management options that horse owners can employ as a viable manure management strategy that also complies with Right-to-Farm guidelines.

Why Compost?

The most common answer given to the question "Why should I compost?" is probably that true composting reduces a manure pile's volume by up to 50 percent. This is a major benefit, but composting horse manure has many other advantages, too. Once manure is properly composted, it is no longer considered manure — it is simply organic material and natural nutrients critical to plant growth (Figure 1). When manure is composted, the nutrients are converted into a more stable form. This conversion makes the nutrients more readily available for plant growth. Manure contains nitrogen, one of the most important nutrients for grass growth, and grass is an important crop for most horse owners. Increasing nutrient availability decreases the need to use synthetic fertilizers to improve pasture yield and quality.

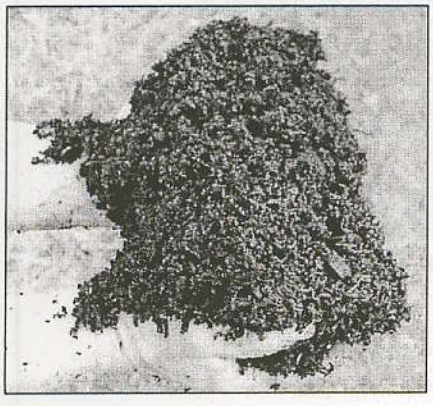

Figure 1. Raw horse manure and bedding can produce good quality compost.

Another benefit of composting is the reduced moisture content of the pile. Reducing moisture also decreases the odors and flies normally associated with piled manure. During the composting process, the material should reach temperatures of 130 to 170 degrees F. At these temperatures, fly larvae, parasites, fecal coliform bacteria and many pathogens cannot survive. Many weed seeds are destroyed at these temperatures as well, such as quackgrass, foxtail and tall buttercup (a potentially toxic plant).

Compost makes an ideal additive to a productive horse pasture (Figure 2). Other uses for compost include landscaping projects, nursery crops, lawns and gardens. Some horse owners have been able to market compost to others for these uses. Many others spread the wealth in their

Figure 2. Spreading quality compost can increase pasture fertility.

communities by giving away compost. In this way, horse owners can improve neighbor relations while reducing manure volumes on their farms.

What is Composting?

Composting is NOT a pile out behind the barn that sits there until it is hauled away or turns to dirt sometime in the next century. Composting is a process that requires time, management and some equipment. Composting is a biological process that creates an ideal environment for naturally occurring microbes that digest organic material. These microbes require air to survive (aerobic), so the pile must be turned or have air forced into it. Moisture and the pile's temperature are also important factors. Ideal composting occurs when the moisture is around 50 percent and the temperature is between 130 and 170 degrees F. A handful of good compost should feel like a wrung-out sponge. If the manure contains a high amount of shavings, water usually has to be added to approach a 50 percent moisture content, and the expected high temperature is apt to be closer to 140 degrees F.

Composting Methods

Several composting methods are currently in use. Not all methods will work on every farm. Time, space, equipment cost and volume of manure to be composted will dictate the method used. In most cases, a water source will be necessary to keep the compost pile from drying out. Because of the increased popularity of environmentally friendly manure management alternatives, composting equipment and methods are constantly being improved. The following methods are arranged from least to most technical.

1. **Passively aerated pile** — For this method, vented pipe is used to allow natural air currents to flow through the pile, keeping it aerated (Figure 3).

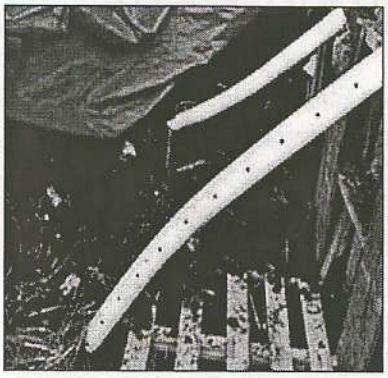

Figure 3. Passively aerated pile using PVC pipe.

2. **Actively aerated pile** — In this method, air is forced through a vented pipe with a fan or leaf blower.
3. **Transfer bins** — This method involves multiple bins. Manure is moved from one bin to the next when aeration is needed. The last bin in the row should yield finished compost (Figure 4).

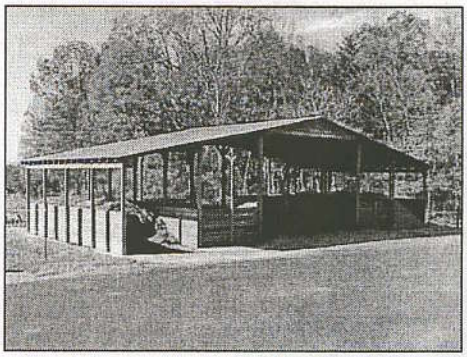

Figure 4. Transfer Bin System.

4. **Turned windrows** — For this method, manure is piled in long, narrow, peaked rows. These rows can be turned using mechanical turners or by simply moving them from one place to another using a front-end loader (Figure 5).

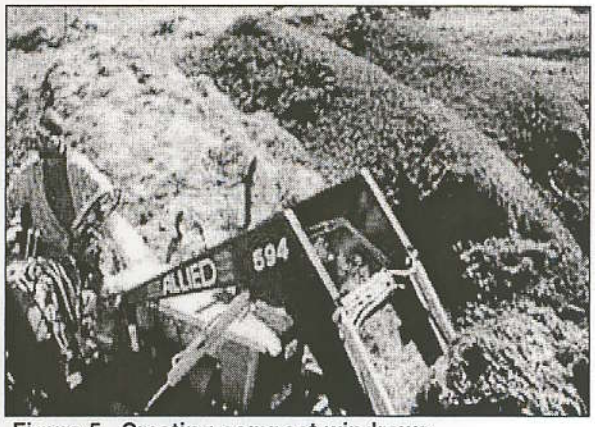

Figure 5. Creating compost windrows.

5. **Vermicomposting** — For this method, manure is piled in small windrows and redworms are added. The worms digest the material to create very high-quality compost. The limitation of this method is that the worms survive only in temperatures above 50 degrees F (Figure 6).

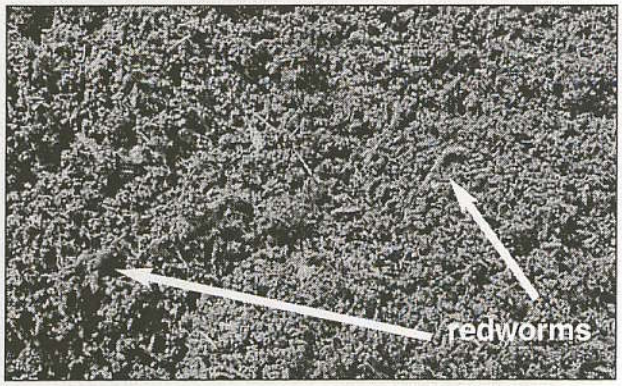

Figure 6. These redworms are aerating the manure pile.

6. **In-vessel composting** — For this method, manure is placed in a large container that can be turned or aerated with oxygen.

Conclusion

Although several viable manure management solutions are available, composting is perhaps one of the most beneficial opportunities for horse owners. The ability to turn a product that can strain neighbor relations into a product that has positive environmental impacts and may enhance neighbor relations can benefit the entire horse industry. For more technical assistance on any of these composting methods, contact the MSU Extension Equine AoE Team and read the last bulletin in this *One Horse or a Hundred series.*

For more information and materials online, visit these Web sites:
www.emdc.msue.msu.edu
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ONE HORSE OR A HUNDRED

Equine Program

WO 1025 (No. 6 in Series)

MSUE Equine AoE Team

6 Composting — How do I do that?

If you have been following the "One horse or one hundred" series closely, you may have already decided that composting is the answer to many of your manure management problems. You may now be asking, "How do I do that?" The objective of this article is to look at several methods of composting from a "how-to" perspective so that you can begin your composting project.

Composting does not have to be a complicated process, but it does require management. **Remember that compost is NOT just a pile behind the barn.** Composting is a biological process that creates an ideal environment for naturally occurring microbes that digest organic material. With this in mind, let's take a look at how to create the ideal environment.

General Composting Requirements

Aeration — The microbes that make the composting process work are aerobic; this means that they require oxygen. The composting process produces heat. Therefore, the pile needs to be aerated to provide the microbes with oxygen and to remove excess heat from the pile. If oxygen levels get too low, an increase in anaerobic bacteria occurs, resulting in increased odor from the pile. Excess heat can be fatal to the microbial population. The ideal temperature range of compost is between 130 and 160 degrees F. At these temperatures, most weed seeds, parasites and pathogens will be killed.

Carbon to nitrogen ratio (C:N) — Carbon is supplied by the bedding material (shavings and straw) and the fibrous portion of the manure. Nitrogen is found in both manure and urine. Nitrogen is "food" for the microbes. Too little nitrogen will slow the composting process. Too much nitrogen can increase odors because of the buildup of ammonia gas. Because most horse owners use wood shavings for bedding, the amount of nitrogen is usually limiting. The desired C:N range for composting is 25 to 40 parts carbon to 1 part nitrogen. Minimizing the amount of dry bedding going into the compost pile will improve the C:N ratio. Mixing active compost with new raw material can help balance the ratio. When carbon is in excess, a nitrogen source such as urea fertilizer can also be added to provide nitrogen for the microbes.

Average carbon to nitrogen ratios

Horse manure — 30:1
Straw — 80:1
Softwood shavings — 641:1
Hardwood shavings — 561:1
Grass clippings — 17:1
Leaves — 54:1

Materials such as meat, dog and cat feces, sand, oils or other household wastes should not be added to the horse manure compost. Leaves and grass clippings could be added to the compost pile on a limited basis. Because of their high moisture content, they should be well incorporated into the compost. Other yard and garden waste should be avoided.

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Moisture — Achieving the correct moisture content is another critical part of generating quality compost. During the composting process, the pile should be around 50 percent moisture. The best way to estimate moisture content is to dig into the pile, take a handful of compost and squeeze it. The compost should feel like a wrung-out sponge. Compost that is too wet will have lower oxygen levels and increased odors. If the compost gets too dry, the composting process will slow or stop before the compost is finished. Most horse manure with wood shavings for bedding is too dry and will require additional water to complete the composting process. One easy way to add moisture is to dump the water bucket into the raw material while cleaning stalls.

It is a common misconception that compost should be left uncovered to take advantage of rain or snow to increase the moisture content. The water from precipitation comes too fast to penetrate the pile and can lead to nutrient runoff. Additionally, sun and wind will dry out an uncovered pile. Therefore, the pile should be covered and additional moisture added during aeration. Unless a specially designed compost cover is used, the cover should not be in direct contact with the compost.

Location — Because compost starts out as raw manure and bedding, all Michigan Right-to-Farm guidelines apply when locating a compost pile. For a copy of the most recent guidelines, visit www.michigan.gov/mda and search for the manure management generally acceptable agricultural management practices (GAAMP). In general, compost piles should be easily accessible from the source of the manure and for easy removal of the finished product. Horses should not have contact with the pile. Depending on the composting method to be used, it may be necessary for the pile to be close to electricity and a water source. Compost piles should be located on relatively level ground and away from any water runoff from barns or hillsides.

Space requirements — The amount of space required for composting will vary with composting methods, willingness to manage the pile, the composition and quantity of the raw material, and environmental factors. Starting composting when temperatures are below 50 degrees F is very difficult. Therefore, additional space may be needed for winter stockpiling.

Performing some rough calculations to estimate annual composting volume will help determine which composting method to use. As an example, assume two horses are housed in stalls. They will produce 0.8 cubic foot of manure and urine per day (about 50 pounds). In addition, 1 to 5 cubic feet of wood shavings will be removed from the stalls daily. That is 0.8 cu. ft. manure/urine + 2 cu. ft. bedding per horse X two horses X 365 days = 1,168 cu. ft. (43.26 cu. yds.) per year. This volume can be significantly reduced if the horses are turned out on pasture for even a portion of the day. If a significant amount of wasted hay is expected, that volume should be added to the calculation.

Equipment — Regardless of composting methods, a couple of pieces of equipment are necessary. A long probe thermometer (dial or digital) is necessary to monitor temperature. Another helpful piece of equipment is a compost maturity test kit. This relatively inexpensive test kit will help determine if the compost is finished and ready to use.

ONE HORSE OR A HUNDRED

Composting Methods

Turned windrow

This method of composting involves piling raw material in long, arched rows. The length of the row depends on the amount of material to be added. The rows should be created on a well drained base with no more than a 1 to 2 percent slope. The base could be, soil, gravel, or crushed limestone. Cement or asphalt could also be used under the windrows, as long as runoff water is either contained or filtered through a grassy area surrounding the composting area. The windrows should be 5- to 8-feet high and from 8- to 10-feet wide. Smaller rows will lose heat more quickly, and this heat loss can slow the composting process. It is important that the rounded top of the row has no flat spots that can hold water. These rows can be created by unloading a manure spreader at the end of the row as needed, or by simply using a wheelbarrow or other means to dump the material at the end of the row. Then a tractor with a front-end loader can be used to shape the row. Again, it is ideal to cover the rows. One method for covering the rows is to place 6 inches of finished compost or peat moss on the top of the row each time it is turned.

As the row is being formed, it will begin to heat up. The temperature should be monitored regularly and the row turned as the temperature approaches 160 degrees F (usually in 7 to 10 days). Turning can be accomplished by using a front-end loader to simply move the pile from one place to another — for example, pushing the row over, right next to where it was, and then back. The row should be reshaped each time it is moved. This is also a good time to add any needed water. A sprinkler can be used to wet the material as it is being moved from one place to another. Another way to wet the rows is to insert a tree root waterer in numerous places in the row before turning.

Another method is to use a mechanical compost turner to turn the windrows. Many sizes and types are available. This type of equipment will greatly reduce the amount of time required to turn the rows and will generally speed up the composting process. Although compost turners are relatively expensive, they greatly reduce labor. They would generally be used only on large farms.

Compost made with this method will generally take about 8 to 12 weeks to complete. The more the row is turned, the more quickly the row will compost. If the compost is not close to maturity and the pile's temperature drops below 130 degrees F, stop turning to allow the pile to heat up again.

Transfer bins

Composting using transfer bins is very similar to windrow composting. Raw material is added to a bin and turned with a front-end loader or by hand. Bins can be constructed of almost any material that can withstand pressure from the loader. Large cement blocks, railroad ties, landscape timbers or treated lumber can make good bins. For ease of turning, the bins should be constructed on a well compacted base of gravel or crushed limestone. Cement or asphalt could also be used as long as the bins are constructed to prevent water pooling. Four to eight bins are needed to complete the composting process. As shown in Figure 1, bins are typically open-fronted, 8 feet by 8 feet, and 3 to 6 feet high. For a farm with just a couple of horses, the bins can be even smaller, but the depth should be a minimum of 3 feet. Leaving some small gaps in the wall materials will allow air flow into the pile. The bins should be covered. If a roof is too expensive, a tarp can be used to create a tent over the bin. The tarp should not touch the compost and should not be allowed to sag and collect water.

In bin composting, raw materials are added to the first bin, and temperature and moisture are monitored. When the bin gets full and/or the

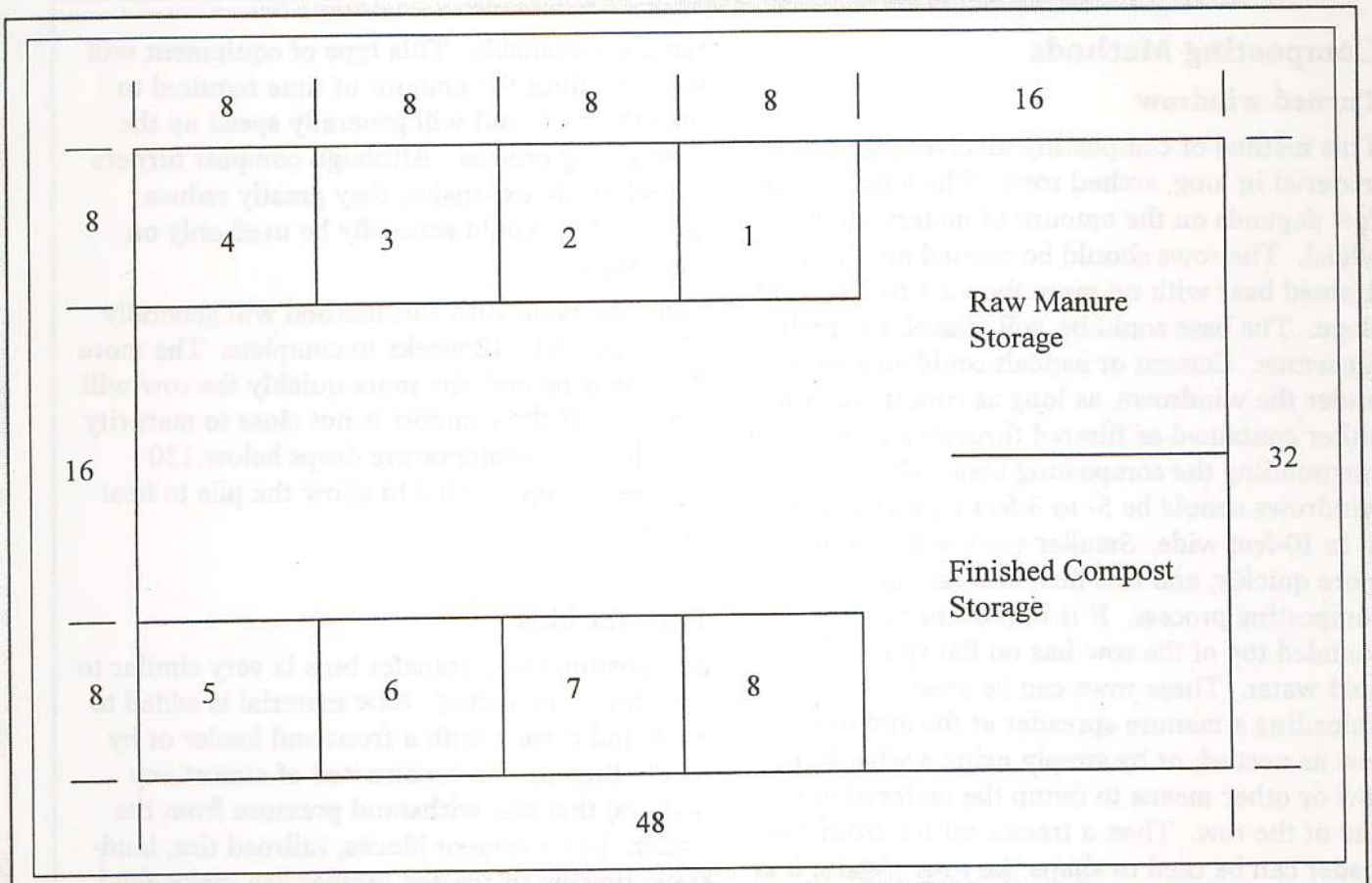

Figure 1. 32 X 48' Transfer bin compost structure with raw manure and finished compost storage.

temperature gets close to 160 degrees F, the material is transferred to the next bin. Raw material is then added to the first bin. All bins need to be monitored regularly and transferred as needed. As the volume of the material begins to decrease, bins can be mixed together to conserve space. By the time the material reaches the final bin, it should be finished compost. The length of time required will depend on how rapidly the bins are filled. Once the process is initiated, active compost can be added to the first bin to introduce microbes to the pile and speed the process. If additional moisture is needed, it can be added during the transfer or before the pile is moved.

Passive or active aeration

These two methods of composting require the least equipment but the same amount of monitoring as the other methods. For both passive and active aeration, a windrow 5- to 8-feet high by 8- to 10-feet wide will be created, as shown in Figure 2. This material should be well mixed because it won't be turned again. Again, this windrow should be covered.

Passive aeration involves using 4-inch drain pipe with two or three rows of ½-inch holes drilled every 12 inches. With passive aeration, air flow through the pipes is forced out through the holes by wind currents, aerating the row. Ideally the row is created on a 6-inch-deep mat of finished compost, straw or peat moss. As the row is formed, a pipe is added perpendicular every 12 to 18 inches near the base of the row. It is important that both ends of the pipe stick out from the row. Rows can be any length. If the pile begins to heat up too much because of lack of air flow, simply cap one end of each pipe

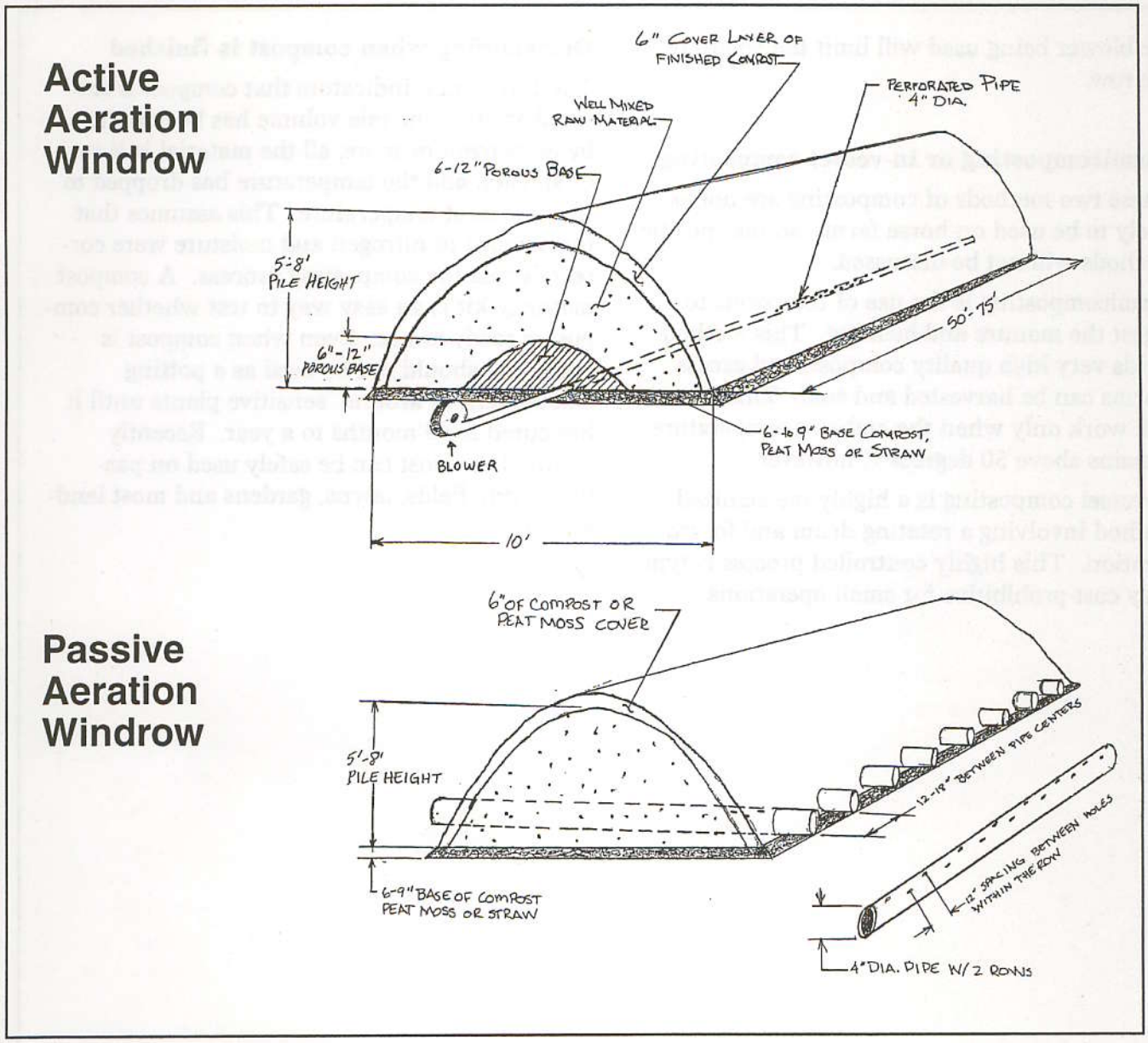

Figure 2. Active and passive aeration windrows.

and insert a leaf blower or another type of fan in the other end to force more air into the pile. Additional moisture can be added, as needed, using a tree root waterer or another similar device. Although this may be the slowest type of composting, it requires the least labor once the pile is made and the process is started.

Active aeration is similar to passive aeration except that the system is designed for forced air through the entire process. For this method, the row is created with the perforated pipe at the center of the row, running parallel to it. The pipe should stop 5 to 8 feet from one end of the row and stick out from the other end. As with passive aeration, the pipe should be placed on a 6-inch-deep base material. A mechanical blower hooked to the pipe blows air through the row. Temperature should be monitored regularly to determine the amount of time the blower needs to be operated. For this method, the capacity of

the blower being used will limit the length of the row.

Vermicomposting or in-vessel composting

These two methods of composting are not as likely to be used on horse farms, so the specific methods will not be discussed.

Vermicomposting is the use of redworms to digest the manure and bedding. This method yields very high quality compost, and excess worms can be harvested and sold. This process will work only when the ambient temperature remains above 50 degrees F, however.

In-vessel composting is a highly mechanized method involving a rotating drum and forced aeration. This highly controlled process is typically cost-prohibitive for small operations.

Determining when compost is finished

The three main indicators that compost is finished are that the pile volume has been reduced by 50 percent or more, all the material is ½ inch or smaller, and the temperature has dropped to near ambient temperature. This assumes that the amount of nitrogen and moisture were correct during the composting process. A compost maturity kit is an easy way to test whether compost is ready to use. Even when compost is mature, it should not be used as a potting amendment or around sensitive plants until it has cured for 6 months to a year. Recently matured compost can be safely used on pastures, crop fields, lawns, gardens and most landscaping.

For more information and materials online, visit these Web sites:
www.emdc.msue.msu.edu
www.msue.msu.edu/aoe/equine/