ID-166

On-Farm Composting of Animal Mortalities

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Composting can provide animal producers with a convenient method for disposing of animal mortalities and also provide a valuable soil amendment. In addition, the finished compost can be stockpiled and reused to compost other mortalities.

Composting is a natural decomposition process conducted by microorganisms that can be controlled under managed conditions. It reduces the size of the material by removing organic products, water, and energy as carbon dioxide, vapor, and heat. Also, the pathogens that cause approximately 80 percent of animal mortalities are destroyed by the high temperatures reached during the composting process.

Composting does require time and space, and some specialized equipment may be needed. If composting is not done correctly, pathogens survive and odors may occur, attracting flies and vermin, as well as vultures that can uncover the mortalities.

Use this publication as a guide if you decide to use composting as a way to manage on-farm mortalities.

Rules and Regulations

Kentucky Law KRS 257.160(1) (f) allows disposal of animal carcasses by composting if the disposal is performed in accordance with state administrative regulations (302 KAR). Composting facilities on agricultural operations do not need to register with the State Veterinarian if the composting operation is not being used for a commercial purpose. Any animal carcasses not composted should be disposed of in a manner consistent with KRS 257.160 (see the Cooperative Extension publication *On-Farm Disposal of Animal Mortalities* [ID-167]).

Kentucky Administrative Regulation 302 KAR 20:052 states that all facilities should be constructed to meet the requirements of the Kentucky Agriculture Water Quality Act.

Kentucky law (302 KAR 20:052) also requires that reasonable cost-effective efforts be taken to prevent odor, insects, and pests. This requirement can be met with simple management practices such as:

- Maintaining the proper moisture, aeration, and carbon-to-nitrogen ratio (C:N) during the composting process, which is discussed in detail later in this publication.
- Placing fallen stock in a compost pile immediately after they are discovered (Figure 1).
- Temporarily storing dead animals awaiting composting on floors constructed of concrete and in areas inaccessible to scavengers, livestock, and poultry. This storage method controls leaching (release of fluids from the carcass) and prevents other animals from moving the dead animal or being contaminated by it.
- Addressing the possible excavation of a compost pile by vermin by immediately adding more finished compost or manure to the top and sides of the pile.
- Reducing and cleaning up any spillage outside and around the composting facility. This will limit flies and the interest of animals passing by.

In addition to compost-specific regulations, Kentucky law also addresses waste disposal and odor in several other regulations. In 401 KAR 30:031, it is stated that no waste site shall cause a discharge of pollutants into waters of the Commonwealth, including wetlands and karst terrain. This means that leachate and runoff must be controlled and not allowed to enter surface water bodies, including lakes and streams, wetlands, or sinkholes. Also, 401 KAR 53:010 sets forth an odor standard in which a mixture of 1 volume unit of ambient air with 7 volume units of odorless air must have no detectable odor.

Figure 1. The two basic ingredients needed for composting animal mortalities are carcasses and bulking agent.

Choosing a Site

Ideally, a mortality composting facility should be located near animal housing. The composting area should not be built in a floodplain, within 300 feet of a water well, stream, sinkhole, pond, property line, or public road, or within 1500 feet of churches, schools, businesses, or any other public use area. When choosing a site, consider that any runoff lost from the compost pile should be diverted to an existing manure storage structure or to a vegetated filter strip. The leading edge of the filter strip and the low edge of the composting pad must be level, and the filter strip must be at least 30 feet long. The filter strip vegetation must be maintained as specified in the NRCS filter strip standard.

In addition, if the composting structure is located within a pasture, fencing is required to exclude livestock from both the composting pad and the filter strip.

Composting Structures

The type of composting structure used should be based on the type and size of the animal operation. Ideally, the structure should have a concrete pad, sides to facilitate loading and turning, and a roof to block precipitation.

A roof and sides are not required, but for operations with more than 100 animal units, the pad flooring shall be constructed using a "High Traffic Area" surface such as concrete, soil cement, sound bedrock, compacted clay, or heavy traffic pads using rock and geotextile fabric. All of these surface treatments prevent mud creation and reduce sediment in runoff.

For more information about soil cement, see UK Cooperative Extension publication *Using Soil-Cement on Horse and Livestock Farms* (ID-176). To construct a heavy traffic pad as a composting surface, refer to UK Cooperative Extension publication *High Traffic Area Pads for Horses* (ID-164).

For operations with less than 100 animal units, composting can be conducted directly on the soil as long as the composting site is alternated with a crop rotation.

You can use traditional composting facilities like stack pads, bins, windrows, and vessels; however, a windrow system, using an uncovered stack pad made with a High Traffic Area surface is by far the easiest structure to manage and the cheapest to construct for composting large animals (Figure 2).

Figure 2. A windrow composting system for large animals on a concrete pad.

Unroofed Facilities

Unroofed facilities have the potential to discharge nutrients and pathogens from the site and may be scrutinized by state authorities under Kentucky laws that protect water quality. There are two types of potential discharge that originate from compost facilities: runoff and leachate. Runoff is water that simply sheds from the surface of the compost heap and contains only a small amount of nutrients from the bulking agent (wood chips, sawdust, etc.). Leachate contains fluids directly from the carcass and can contain pathogens and other water pollutants. Flat-top piles allow rainwater to infiltrate, possibly creating leachate. Instead, use mounded, cone-shaped piles with unroofed compost facilities. This shape, as shown in Figure 2, allows the pile to shed rainfall. Animal producers with large-scale, unroofed composting sites must divert runoff to an animal waste storage or treatment facility such as an earthen storage structure, lagoon, filter strip, etc. (Figure 3).

Figure 3. Mortality composting runoff entering drain to travel to existing lagoon.

Another disadvantage of an uncovered structure is that precipitation interferes with the composting process. Typically in Kentucky, winter and spring weather provide too much moisture, and when the moisture is high, air pockets are replaced with water. If you have too much water along with other less-than-optimal conditions such as decreasing temperature, the composting process begins to shut down, leading to a bad odor. With a roofed composting operation, water can always be added if needed.

Bin System

The bin system uses partitions to separate piles of compost (Figure 4). Typically, each bin represents a composting stage. Periodically, the bins are turned using a front-end loader, or the contents are moved to a new bin for further breakdown or curing. Bin walls should be constructed of concrete, hay bales, or treated lumber. If a front-end loader is to be used for loading, turning, or unloading, concrete push walls will retain their integrity longer than lumber will. The bin's width should allow easy access for loading equipment. To easily distribute bedding in the bin, make sure the structure's opening is wide enough for a manure spreader. The structure should also be high enough to load and dump material.

Figure 4. Example of a bin composting system constructed using soil cement flooring and construction barriers.

Vessel System

Probably the most expensive method of composting is the vessel system, which uses fans to force or pull air through the compost and a motor to turn the structure. Vessel systems have been shown to work well for poultry mortalities when the birds are frozen, run through a chipper, and placed directly in the vessel.

Sizing a Facility

To minimize problems, composting facilities should be sized for the operation. Base a facility's size on the estimated weight of average daily mortalities. Weights of animals typically found on the farm can be calculated based on farm production records or industry standards (Harper and Estienne, 2003). Use these weights plus mortality rates associated with age groups to calculate the weight of average daily mortalities. Sizing should not be based on the likelihood of single-event death losses such as disease outbreaks, lightning strikes, or barn fires.

For small operations with unroofed facilities without sides, follow the standard criteria for sizing based on total operation size: operations with up to 100 head, use a 60' x 32' composting pad; operations that have between 100 and 200 head, use a 80' x 32' composting pad; and operations that have between 200 and 300 head, use a 110' x 32' composting pad.

Figure 5. Example of an electronic thermometer. Note the temperature reading of 151°F.

Figure 6. Example of an analog thermometer. Note that this pile needs to be heated up.

Most operations involve the use of mechanical equipment (front-end loaders and manure spreaders) to load the bins with mortalities and bulking agent and turn and move/unload established piles. The height of the compost bin should accommodate a maximum compost pile height of 6 feet (leaving room for equipment access), and bin width should be at least one and a half times the width of mechanical equipment used to load and unload bins (Harper and Estienne, 2003). Keeping compost pile height at 6 feet or less is suggested to maintain internal pile temperature. Temperatures may rise above 160°F at excessive pile heights and become detrimental to the compost bacteria population (Harper and Estienne, 2003). High temperatures may also increase the risk of pile combustion.

Needed Equipment

After you have constructed the composting facility you'll need several pieces of equipment, including:

- A cutting instrument should be used to vent rumens.
- A front-end loader can place carcasses in the pile, move the compost material from bin to bin, turn or flip the pile contents, and section carcasses.
- A thermometer, which is required by the composting permit, is needed to determine microbial activity and monitor the composting process. A long-stemmed hay bale thermometer works well. Figures 5 and 6 show two types of useful thermometers.
- A moisture probe can monitor the water status of the compost, but it's not as important as a temperature probe.

The Composting Process

Materials

Two basic ingredients are necessary for composting animal mortalities: animal carcasses and a bulking agent. The bulking agent soaks up the leachate produced by the decomposing carcass, provides aeration, and increases the carbon-to-nitrogen (C:N) ratio. Some sort of ground-up wood product makes the best bulking agent. The carcass contains a high concentration of nitrogen and water, and the wood product, high in carbon, wicks up the moisture. Traditional bulking agents include sawdust, wood shavings, and wood-based bedding and manure.

Sources for the bulking agent may vary based on location and local industries. Tree removal companies are a good source of chipped wood at little or no cost (Figure 7); however, the wood may contain green material and higher moisture content than wood shavings. Also, chipped wood particles may be too large to absorb enough moisture and retain enough heat for composting to occur. Chipped wood's shortcomings can be offset by making the pile larger or blending chipped wood with a fine-particle bulking agent. Using finished or stable compost as a bulking agent can fill the pile with beneficial bacteria to jump-start composting.

Size

Animal mortalities and bulking material should be added until the pile reaches adequate size. The size of the pile is dictated by the size of bulking agent particles and that of the composting facility. The smallest pile size would be no less than a 3-foot cube (1 cubic yard). Any pile smaller than that would not work well because it could not insulate and maintain the heat necessary to effectively break down the carcass. Larger piles are able to tolerate fluctuations in outside air temperature.

Figure 7. Wood chips being used as a bulking agent and carbon source.

Figure 8. A prepared compost bed for two large animals (more than 1,000 pounds each).

Figure 9. A 6-foot-tall pile created for two large animals (more than1,000 pounds each). The mounded, cone-shaped pile allows rainwater to shed.

At least 2 feet of bulking material should be placed below the carcass (Figure 8), and at least 2 feet of bulking material should cover and surround the sides of the animal. Completely covering animal parts will help control odors and deter scavengers from exhuming the carcass. A typical pile for a large animal (more than 1,000 pounds) should have a height of approximately 6 feet (Figure 9).

Adding Mortalities

Mortalities may be added until the pile reaches the upper limits of manageable height, which depends on the type of equipment you have and the composting structure itself. Mortalities can also be added by extending the pile, as in a windrow system. If a producer adds an additional fallen animal to an existing pile, the producer may expose uncomposted material that was on the inside of the pile to the outside, which will attract vermin and flies to the pile. Anytime uncomposted material is exposed to the outside, it should be topdressed with additional bulking material, manure, or finished compost.

If the bulking agent and carcasses are dry, consider adding a little water to provide the necessary moisture, but do not over-apply. Too much water can change the process from aerobic (with air) to anaerobic (without air), causing bad odors. A layer of finished compost as a blanket above the carcass and covering of bulking agent abates anaerobic gases as they rise up through the pile, and these gases will be removed by the bacteria in the finished compost. Pests and scavengers normally drawn to the decaying carcass will not be attracted.

The rumens of all ruminant animals may be vented before composting. This venting will prevent carcass explosion from trapped gases, which would expose it. If such an explosion should occur, add more bulking agent to fill the void.

Management

Composting of animal mortalities does not involve a lot of ongoing maintenance, but it does require active management. The pile should be periodically checked for temperature, moisture, odors, etc., as optimum conditions are needed for decomposition. The ideal C:N ratio for an initial pile is 30:1, with a range of 20:1 to 40:1 being acceptable. Other required conditions include a temperature of 140° to 160°F, moisture content of 40% to 60%, 30% porosity, and a pH range of 6.0 to 8.0. These readings can be determined with laboratory equipment and analyses, but moisture and temperature can also be estimated.

Table 1. A troubleshooting guide for carcass composting.

Problem/ Symptom	Probable Cause	Suggestions
Improper Temperature	Too dry	Add water.
	Too wet	Add bulking agent, turn pile, and re-cover with additional "new" material.
	Improper C:N ratio or bulking agent used is too porous	Evaluate bulking agent and adjust amount as necessary. Wood material preferred.
	Adverse environment	Ensure adequate cover with bulking agent to provide insulation.
Failure to Decompose	Improper C:N ratio	Turn pile, adjust amount of bulking agent, and re-cover.
	Carcasses layered too thickly	Single-layer the carcasses.
	Carcasses placed on the outside edge of the pile	Maintain 2 feet of space between carcasses and outside edge of bins.
Odor	Too wet	Add bulking agent, turn pile, and re-cover with "new" material.
	Too low C:N ratio	Evaluate type of bulking agent used. Add bulking agent.
	Air flow restricted	Divide and rebuild pile into separate piles. Add larger bulking material chips. Cover with "new" material. Maintain 2 feet of bulking agent near outside of bin. Turn pile.
	Inadequate cover over carcasses	Cover and surround carcasses with at least 2 feet of material on the sides and 3 to 4 feet above.
	Extended periods of low temperature in the pile	Maintain proper temperature in pile.
Flies	Inadequate cover over carcasses	Cover and surround carcasses with at least 2 feet of material on the sides and 3 to 4 feet above.
	Poor sanitation conditions	Avoid leaching from pile by increasing bedding layer and cover thickness. Maintain a clean, debris-free area near the pile.
	Failure to achieve proper temperature	Maintain proper temperature in the pile.
	Too wet	Open/remove pile contents and add more bulking agent and then cover with "new" material.
Scavenging Animals	Inadequate cover over carcasses	Maintain 2 feet of cover around carcasses and 3 to 4 feet above; avoid initial entry by establishing a fence or barrier.

Source: Modified from the National Pork Producers Council Swine Mortality Composting Module.

Moisture

Moisture is the most important condition when composting. You do not want excessive moisture to leach or run off and potentially pollute surface or groundwater. To estimate moisture level, collect some compost in your hand and squeeze it. If moisture drips from your hand, the pile is too wet. If your palm does not get wet, the pile is too dry. When your hand is wet but not dripping, moisture is optimum.

Temperature

Place a long-stemmed compost thermometer near the carcass to determine internal pile temperatures, which need to reach temperatures of 140° to 160°F and be maintained for five days to ensure destruction of pathogens. Temperatures will increase within two to four days of loading carcasses in the pile. Temperatures will remain at 140° to 160°F for approximately two weeks, followed by a gradual decline in internal pile temperature.

Finishing

If all goes well for the producer, the mortalities will be sufficiently broken down approximately three to six months after the pile is loaded to 6 feet. The time frame will vary depending on the size and surface area of the carcass. Typically, the primary pile can be left for two or three months to decompose. If the pile has several large carcasses or many carcasses, expect to leave it for at least three months. Afterbirth or piles containing mostly small pigs or calves will take considerably less time. At the end of the two-to-three-month period, the moisture level and temperature will have substantially decreased. The pile may need to be turned and moisture added to increase temperatures and re-establish composting bacteria. Two to three months after this midpoint turning, you will have a product that can be stored or applied to land. It should be possible to easily break any larger bones left in the compost, and those bones should be relatively odor free and inert. As with anything in agriculture, environmental conditions may speed up or slow down the process. Heavily loading the pile or changes in moisture and temperature will also affect it. These issues are addressed in Table 1.

Using the Compost

If the composted material is to be land-applied, it should be applied as a fertilizer source and incorporated into your nutrient management plan. The material will have bones, but they should be brittle and have no flesh. When a rear-tine manure spreader is used to apply the material, bones typically are shattered, but some sifting before application may be required.

Along with land application, composted material is also good for topdressing new additions to the compost pile, which prevents foul odors from escaping.

Additional Resources and References

Additional resources are available through your local Cooperative Extension office or from the Kentucky Office of the State Veterinarian (online at http://www.kyagr.com/statevet/index.htm or by phone at (502) 564-3956).

References

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