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On-Farm Composting of Animal Mortalities

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On-farm composting can provide animal producers with a convenient method for disposing of animal mortalities while providing a valuable soil amendment when land applications are made. The finished material can also be stockpiled and reused to help compost other mortalities.

Composting is a natural decomposing process conducted by microorganisms that can be controlled under managed conditions. Composting reduces the size of the material by removing organic products, water, and energy in the form of carbon dioxide, vapor, and heat. In addition, pathogens causing approximately 80 percent of animal mortalities are destroyed by the high temperatures developed during the composting process.

Composting also has several disadvantages: it requires time and space, nitrogen (N) is lost, and some specialized equipment may be needed. If composting is not done correctly, pathogens can survive, and odors may occur. These odors may attract flies, vermin, and buzzards that will uncover the mortalities. Both the positive and negative attributes of composting should be considered when managing on-farm mortalities. This publication was developed as a guide for on-farm composting of mortalities and can assist in troubleshooting composting systems.

Rules and Regulations

Kentucky Law KRS 257.160(1)(f) allows disposal of animal carcasses by composting if the disposal is performed in an approved facility and according to the Agricultural Board's administrative regulations (302 KAR). In order to legally compost mortalities, a permit is required, which is issued by the State Veterinarian. The cost of the permit is $25 and is renewed every five years. The permit application requires the name and address of the compost owner and/or the responsible party such as a farm manager, the location of the composting facilities, a description of the facilities, and the composting procedure. All animal composting facilities are subject to inspection by the State Veterinarian or his or her representative. Any animal carcasses not composted should be disposed of in a manner consistent with KRS 257.160 (see ID-167, *On-Farm Disposal of Animal Mortalities).*

Kentucky Administrative Regulation 302 KAR 20:052 states that a permitted composting facility should be constructed to meet or exceed the current United States Department of Agriculture Natural Resources Conservation Service, Conservation Practice Standard for Composting Facility, Code 317, (July, 1998) in Section IV of the Kentucky Field Office Technical Guide and shall meet the requirements of the Kentucky Agriculture Water Quality Act. All processing of dead animals shall be done within the permitted facility. Dead animals to be composted shall be temporarily stored indoors on floors constructed of concrete. This is allowed to control the leachate while preventing other animals (i.e., rodents and birds) from moving the dead animal offsite. It also prevents scavengers from becoming contaminated by the dead animal.

Kentucky law requires that reasonable and cost-effective efforts shall be taken to prevent odor, insects, and pests. Odors can be controlled by maintaining proper moisture, aeration, and the carbon-to-nitrogen ratio (C:N) during the composting process. (This is discussed in detail later in this publication.) To control pests, all carcasses shall be inaccessible to scavengers, livestock, and poultry. Typically, this means that the composting structure should have walls, doors, and a roof. This is also a good practice to prevent transport of contagious diseases. Composting is a controlled process that cannot be managed properly if scavengers are allowed to drag carcasses away from the composting site. Limiting odors, insects, pests, scavengers, and other animals takes a little skill, and having a secure facility helps. Reducing and cleaning up any spillage outside and around the composting facility will limit flies and the interest of animals passing by.

The Composting Process

Two basic ingredients are needed for composting animal mortalities: animal carcasses and a bulking agent. A bulking agent is the material most needed to control the decomposition process. A bulking agent is required to soak up the liquid produced by the decomposing carcass, to provide good aeration, and to increase the carbon-to-nitrogen (C:N) ratio. Some sort of ground-up wood product is best to use as a bulking agent because the carcass contains a high concentration of nitrogen and water. Therefore, you need to add a bulking agent that is high in carbon and that can wick up the moisture. Examples of traditional bulking agents are sawdust, wood shavings, wood mulch, horse muck, and corn stover. Typically, 1.5 to 2 feet of bulking material is placed below the carcass. At least 1 foot 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.

Sources of these materials may vary based on location and local industries. A good source of chipped wood can be acquired at little or no cost through tree removal companies. However, this material may contain green material and higher moisture content than wood shavings and may have a particle size that is too large to provide adequate moisture absorption and temperature retention. This can be offset be making the pile larger or blending the material with a fine-particle bulking agent.

Animal mortalities and bulking material can be added until the pile reaches an adequate size. The size of the pile is dictated by the particle size of the bulking agent and size and type of equipment and facility used to compost the mortalities. The smallest pile size would be a 3-foot cube (1 cubic yard). Any pile smaller than 3 cubic feet will not work as well as a larger pile because it cannot insulate and maintain the heat necessary to break down the carcass effectively. Larger piles are able to tolerate fluctuations in outside air temperature. Additional mortalities may be added until the pile reaches the upper limits of a manageable height, which depends on the type of equipment and structure available.

Using finished or stable compost as a bulking agent will fill the pile with beneficial bacteria to jump-start the composting process. If the bulking agent and carcasses are dry, consider adding a little water to provide the necessary moisture content, but do not overapply. Too much water can change the composting process from aerobic (with air) to anaerobic (without air) causing bad odors. Adding a layer of finished compost as a blanket above the carcass layer provides a method to abate anaerobic gases as they rise up through the pile. Anaerobic gases are then removed by the bacteria that exist in the finished compost. Since gases are abated or removed, pests and scavengers that would normally be drawn to the location of the decaying carcass are not attracted.

To facilitate composting, animals weighing over 300 pounds should be cut into pieces small enough (quartered in some cases) to ensure complete composting. The rumens of all ruminant animals should be vented prior to composting. This will prevent the carcass from exploding from trapped gases and exposing the carcass. If such an explosion should occur, add more bulking agent to fill in the void.

Although composting of animal mortalities is somewhat of a passive process, the pile should be periodically checked for temperature, moisture, odors, etc. As a part of the decomposition process, shrinking of carcasses occurs and requires topdressing with a bulking agent or finished/stable compost.

Optimum conditions are needed to keep the compost pile decomposing properly. The ideal C:N ratio for an initial pile is 30:1, with a range of 20:1 to 40:1 being acceptable. Other optimum conditions for composting include a temperature of 140° to 160°F, moisture content of 40 to 60 percent, 30 percent porosity, and a pH range of 6.0 to 8.0. Many of these optimum conditions require laboratory equipment and analyses or practical experience. However, there are indicators that can be used to determine optimum conditions.

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

Figure 2. Wood chips being used as a bulking agent and carcass source.

Figure 3. A layer of finished compost used as a blanket, providing a method to abate anaerobic gases.

Moisture Content

The most important condition to meet when composting is moisture. You do not want excessive moisture leaching from the pile, which could potentially pollute surface or ground water. Moisture can be determined by collecting some compost in your hand and squeezing. If moisture drips from your hand, the pile is too wet. If the palm does not get wet, the pile is too dry. Optimum moisture is when the hand is wet.

Temperature

Temperature can be approximated by the steam that rises from the pile or by digging a hole in the side of the pile and placing your hand near the pile to feel the heat. The surface of the compost will feel approximately the same as the atmosphere. However, closer to the location of a carcass within the pile, the compost should be warm to the touch. A thermometer is suggested for accurate monitoring of carcass decomposition and to ensure that temperatures are sufficient to destroy pathogens. A long-stemmed compost thermometer will suffice and should be placed near the carcass to determine internal pile temperatures. High temperatures of 140° to 160°F ensure the destruction of pathogens if maintained for five days. Temperatures will increase within two to four days of loading carcasses in the pile or after mechanically turning the pile. Temperatures will remain at levels stated for approximately two weeks, followed by a gradual decline in internal pile temperature.

If all goes well for the producer, approximately six months after the pile was loaded to 6 feet, the mortalities will be sufficiently broken down to allow storage or application to agricultural land. The time frame will vary with what the pile contains. Typically, the primary pile can be left for two or three months to decompose. If the pile has several large carcasses or a large number of carcasses, expect to leave it for at least three months. Afterbirth or piles containing mostly small pigs 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 with the addition of moisture to increase temperatures and establish composting bacteria again. At the end of another two to three months after turning, a land-applicable product should be present. Any larger bones left in the compost should be easily broken, relatively odor free, and inert. As with anything in agriculture, environmental conditions may speed up or slow down the composting process. Heavily loading the piles or issues with moisture and temperature will also have an effect on the process. The issues are addressed within the troubleshooting section of the publication.

Types of Composting Structures

The type of composting method used will depend on the type and size of the animal operation. Ideally, the composting structure should have a roof to control precipitation, sides to keep out scavengers and facilitate loading and turning, and a concrete pad to control leachate loss.

Composting animal mortalities can be accomplished using traditional composting facilities like stack pads, bins, windrows, and vessels. A stack pad is the simplest method of composting. Ideal stack pad facilities have a roof and a flooring material that is impervious, such as concrete, to operate without creating a discharge. A heavy traffic pad using geotextile fabric also works well as an alternative to concrete.

Unroofed facilities have the potential to discharge nutrients and pathogens from the site and will be scrutinized by Kentucky laws that protect water quality. Therefore, unroofed compost facilities should create piles with a mound shape (in the shape of a teepee or tent). This will allow rainwater to shed compared to a flat-top pile that allows rainwater to infiltrate, thereby creating more leachate. A requirement of the Kentucky Division of Water is that the runoff of a 24-hour, 25-year storm be collected and detained. Animal producers using unroofed composting sites may want to consider plumbing runoff

Figure 4. Example of an electronic thermometer. Note the temperature reading of 151°F.

Figure 5. Example of an analog thermometer. Note that this pile needs to be heated up.

Figure 6. A three-bin shed with roof and doors.

Figure 7. Mound-shaped compost pile (in the shape of a teepee or tent). This will allow rainwater to shed.

Figure 8. Mortality composting leachate entering drain to travel to existing lagoon.

to an animal waste storage structure (earthen storage structure, lagoon, etc.). A disadvantage of an uncovered composting structure is that precipitation controls the composting process. Typically, in Kentucky, weather conditions in the winter and spring months provide too much moisture. High moisture causes air voids to be replaced with water. Combined with less optimum composting conditions, like decreasing temperature, the composting process begins to shut down, leading to anaerobic conditions and a putrid smell. This is why a roofed facility is one of the best to use when composting mortalities. You can always add water to a roofed composting operation.

The bin system is a structure that uses partitions to separate piles of compost. Typically, each bin represents a composting stage. Periodically, the bins are turned using a front-end loader or moved to a new bin for further breakdown or curing. Bin walls should be constructed of concrete or treated lumber. If a front-end loader is to be used for loading, turning, or unloading bins, then concrete push walls will retain their integrity longer than lumber. If lumber is to be used as a push wall, consider using bolts to fasten rather than nails. The width of the bin should allow easy access of loading equipment. Having an opening wide enough for manure spreaders provides the ability to use the spreader to distribute bedding into the bin. The height of the structure should be able to accommodate the loading and dumping of material.

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

Choosing a Composting Site

The State Veterinarian is responsible for permitting animal composting facilities (302 KAR 20:052). The facility should meet or exceed the current USDA NRCS standard (Code 317) and the Kentucky Agriculture Water Quality Act. Ideally, a mortality composting facility should be located near animal housing and should have a concrete floor.

The composting area should not be built in a floodplain or within 300 feet of a water well, stream, sinkhole, pond, property line, or public road. The compost area should be covered with a roof to control precipitation. A hydrant should be nearby to add water to the pile as needed. Ideally, any leachate lost from the compost pile should be diverted to an existing manure storage structure or grass filter strip.

Sizing Composting Facility

Composting facilities should be sized for the operation it will accompany. Adequate sizing can reduce the management issues associated with the other topics previously mentioned. Sizing should be based on an estimated weight of average daily mortalities. Weights can be calculated based on farm production records or industry standards (Harper and Estienne, 2003). Mortality rates associated with age groups and weights typically found on the farm can lead to weight of average daily mortalities. Sizing should not factor in the likelihood of single event death losses from disease outbreaks or barn fires.

Using the approximate weight of average daily mortalities, calculate the necessary volume of the composting bins. There should be on the order of 20 cubic feet of primary bin volume for every pound of average daily mortality. Subsequent bins should be sized similarly, with an optional bin for the storage of bulking agent.

Most operations will 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). It is suggested to keep compost pile height at 6 feet or less 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.

Figure 9. Compost mounds at varying stages of decomposition.

Table 1. Managing/troubleshooting compost facilities: A troubleshooting guide for carcass composting.

Problem/ Symptom	Probable Cause	Suggestions
Improper Temperature	Too dry	Add water.
	Too wet	Add bulking agent and turn pile.
	Improper C:N ratio, or bulking agent used is too porous	Evaluate bulking agent, and adjust amount as necessary.
	Adverse environment	Ensure adequate cover with bulking agent to provide insulation.
Failure to Decompose	Improper C:N ratio	Turn pile and adjust amount of bulking agent.
	Carcasses layered too thickly	Single layer the carcasses.
	Carcasses placed on the outside edge of the pile	Maintain 1 foot of space between carcasses and outside edge of bins.
Odor	Too wet	Add bulking agent and turn pile.
	Too low C:N ratio	Evaluate type of bulking agent used. Add bulking agent.
	Air flow restricted	Maintain 1 foot of bulking agent near outside of bin. Turn pile.
	Inadequate cover over carcasses	Cover carcasses with 1 foot of bulking agent.
	Extended periods of low temperature in the pile	Maintain proper temperature in pile.
Flies	Inadequate cover over carcasses	Cover carcasses with 1 foot of bulking agent.
	Poor sanitation conditions	Avoid leaching from pile. 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.
Scavenging Animals	Inadequate cover over carcasses	Maintain 1 foot of cover; avoid initial entry by establishing a fence or barrier.

Adapted from the National Pork Producers Council Swine Mortality Composting Module.

Equipment Needed

Obtaining permits and constructing the composting facility are essential steps to beginning the process. Several tools are necessary to manage composting facilities. A front-end loader may be needed to place carcasses in the pile, move the compost material from bin to bin, and turn or flip the pile contents. It is also an excellent tool for sectioning carcasses. In order to section other animals, a cutting instrument may be necessary to facilitate decomposition. The rumen should be lanced to expose contents. A temperature probe is useful to determine the activity of the microbes and monitor the composting process. A long-stemmed compost thermometer is made specifically for this use and is recommended for any mortality compost facility when used according to instructions described above. A moisture probe is also useful to monitor the water status of the compost but is not as important as a temperature probe.

Utilizing the Compost

If the material is to be land-applied, it should be applied to crop fields as a fertilizer source using the NRCS-590 standard. There will be bones present in the material. However, they should be brittle and have no flesh on them. Typically, bones are shattered when a rear tine manure spreader is used to apply the material, but some sifting prior to application may be required.

The material can also be stored and reused to decompose more animal mortalities. It also is a good material to topdress new additions to the pile to prevent foul odors from escaping and drawing unwanted pests and scavengers.

Additional Resources and References

Additional resources are available through your local Cooperative Extension office and the University of Kentucky College of Agriculture Extension Service. Permit applications, as well as additional information, can be obtained from the Kentucky Office of the State Veterinarian.

Harper, A.F., and M.J. Estienne. 2003. Composting for Mortality Disposal on Hog Farms. Virginia Cooperative Extension Publication 414-020.

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