NebGuide

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Composting of PEDv-Positive Swine Mortalities

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Porcine epidemic diarrhea virus (PEDv) and similar swine enteric coronavirus diseases (SECDs) can cause significant mortalities in swine production systems, presenting a mortality disposal challenge for producers. This NebGuide describes how to biosecurely dispose of PEDv-positive swine mortalities via on-farm composting.

Introduction to PEDv

Porcine epidemic diarrhea virus (PEDv) is a coronavirus that is transferred among pigs via the fecal oral route. The virus, which first emerged in United States swine herds in 2013, has been a significant economic risk to the swine industry due to losses of pigs, reduced productivity in swine herds, and increased costs of production. PEDv is highly infectious and can result in nearly 100 percent mortality in preweaned piglets with production delays observed in adult pigs. Mortalities can contain a significant amount of the virus in their digestive tract. Therefore, mortality disposal options should be carefully considered to ensure biosecurity and help prevent further transmission of the disease.

Mortality Disposal Options in Nebraska

In Nebraska, five methods are approved for disposal of livestock mortalities: land burial, incineration, composting, rendering, and landfilling. Livestock carcasses must be disposed of within 24 hours of the death of the animals unless the carcasses are disposed of by a licensed rendering service. Each of these accepted disposal methods presents benefits and risks in terms of environmental impact and biosecurity.

On-Site Burial. This is a simple method of disposal, but producers are obligated to protect groundwater resources so environmental conditions such as land topography, depth to groundwater, surface water drainage, soil type, and soil depth need to be considered. The survivability of the PED virus in leachate from carcass decomposition following burial is not known. However, the cool, moist soil conditions in a burial pit may be an ideal environment for the virus to survive and be a potential source for reinfection of animals on the site.

Off-Site Burial. Burial off-site may be appropriate in emergency situations authorized under the Nebraska Emergency Management Act.

Rendering. Licensed rendering services may be used to dispose of PEDv mortalities, but these services may not want to handle infected carcasses as they could serve as a farm-to-farm vector.

Landfill Disposal. Carcasses may be disposed at permitted municipal solid waste landfills. However, prior arrangements should be made with the landfill due to individual facility restrictions. The transportation from the facility to the landfill must be performed by a licensed rendering service. Again, disease transmission is a concern when transporting infected carcasses off-site.

On-Site Incineration. Disposal of animal carcasses by burning requires the use of an incinerator permitted by the Nebraska Department of Environmental Quality (NDEQ) and can be an expensive option. Because on-farm mortality incinerators are typically sized to accommodate routine mortalities, suitable capacity may not be available for emergency mortality disposal.

On-Site Composting. Composting is an economical disposal method that relies on bacterial activity to degrade carcasses and generate sufficient heat to inactivate disease-causing organisms like PEDv.

Benefits of Composting

When designed and managed to maintain appropriate pile conditions, composting results in a product that is free of disease-causing organisms and suitable for use as a soil amendment. Although basic parameters to support the growth of the bacteria necessary for driving the compost process must be achieved, the process is relatively straightforward.

When considering methods for disposal of mortalities due to a disease incidence, composting performed on-site can be a biosecure option that may be preferable to other disposal methods that require movement of infected carcasses off-farm. Composting involves placing mortalities within a mound of carbon material at an ideal moisture content of 50–60 percent and allowing microorganisms to consume the carcass material as a food source while producing heat and moisture in the process. The moisture produced helps drive the continuation of the composting process while the heat that is generated is responsible for destroying disease-causing organisms and weed seeds within the pile.

A properly constructed and operated compost pile reduces the potential risk for ground water impairment compared with carcass burial because composting utilizes sufficient carbon material to prevent the loss of leachate to the environment that burial may allow. When managed properly, compost systems generate minimal odor. Finally, composting can be performed in areas where burial may be restricted by depth to groundwater or geological restrictions and can be conducted year-round whereas excavation for land burial may be difficult during the winter season.

Composting PEDv-Positive Pig Mortalities

A UNL study conducted in 2015 revealed that PEDv-positive piglets composted over two 30-day cycles yielded final material that did not contain detectable PED virus after either of the two cycles. Although PEDv was not detected after the first 30 days of composting, sufficient soft tissue remained in the pile to warrant a second cycle. Typical compost pile temperatures will reach 130–140° F at the center of the pile for several days or even weeks, depending on the pile size, which appears to be sufficient to deactivate the virus. Depending on the volume of carcasses being composted, a composting cycle could require as little as 30 days to complete. Larger volumes of carcasses will require more time; 90 to 120 days may be needed.

Compost Pile Design and Operation

The basic parameters for constructing and successfully operating a compost pile for mortalities infected with PEDv is no different than what is recommended for non-PEDv-positive mortalities. State-specific practices for disposal of livestock mortalities (regardless of species) via composting in Nebraska are regulated by the Nebraska Department of Agriculture and are described in Title 23, Chapter 17 of the Nebraska Administrative Code. General requirements for the design of a composting facility under this regulation require the operator to:

- Prevent stormwater runoff from entering the composting facility;
- Control the movement of leachate;
- Grade the facility to prevent ponding of liquids;
- Ensure the surface of the facility can support equipment and minimize leachate infiltration;
- Ensure that the facility can facilitate the composting process; and
- Construct the facility in such a way that inclement weather will not produce excessive leachate.

Additional operational requirements outlined in the regulation dictate that composting facility owners or operators:

- Control disease vectors, dust, and litter;
- Ensure that livestock carcasses are not visible from public roads or habitable structures;
- Protect the facility from scavenging by animals;
- Begin processing all livestock carcasses within 24 hours after death;
- Keep carcasses in the composting facility until completely composted; and
- Remove all finished compost within 12 months of completion of the composting process.

Common Nebraska Mortality Compost Systems

Compost piles are typically constructed in windrows (Figure 1) or in bins or bays (Figure 2). Both system types require similar design and operational parameters; they differ primarily in the shape and size of the pile.

A windrow is a linear compost pile that is constructed by building on to one end of the pile each time additional mortalities need to be added. Mortalities are placed in the centerline of the carbon material base and covered with additional carbon material. In Nebraska and similar areas with relatively little rainfall, windrows are often built on a soil base with no roof structure. Construction and turning of a windrow can be achieved using a front-end loader or tractor with a bucket, implements that are often readily available on livestock farms.

Compost bins and bays can be temporary or permanent structures designed to process compost in batches. A typical arrangement includes several bins or bays, each large enough to accommodate mortalities generated over a period of 30 to 60 days. Once a bay is filled, the completed pile is left to compost for an appropriate period of time based upon the volume of carcasses in the pile (typically a minimum of 30 days). While the first bay is composting, the next bay in the system is being filled as mortalities occur. Once the second bay is filled, the first bin is turned by moving the pile of material to an open bin for a secondary composting cycle, and the original bin is used to start a new pile. One advantage of the bin/bay process is that the permanent structure ensures repeatable results.

Regardless of the composting method used, the key parameters for successful composting by either the windrow or bin method are carbon, nitrogen, and moisture. An ideal carbon-to-nitrogen ratio (C:N) for a compost pile is about 30 parts carbon to 1 part nitrogen (30:1). The carcasses of animals have much more nitrogen than the 30:1 ratio, so a carbon-rich material needs to be added to bring the C:N ratio into the ideal range. Carbon material also absorbs liquids released during carcass decomposition. Examples of acceptable carbon materials include sawdust, wood shavings, chopped hay bales, shredded crop residue, livestock bedding, and even spoiled silage or feed refusals. Mixing multiple types of carbon materials provides a variety of particle sizes, which can improve pile strength, air movement within the pile, and insulation to retain heat generated during composting. About 3 to 5 cubic yards of carbon material is needed per 1,000 pounds of carcass.

To prevent leaching of liquid from the pile and to absorb added moisture from precipitation, a base of at least 18–24 inches of dry carbon material needs to be in place before adding the carcass(es). Materials for the base layer can include any of the previously mentioned carbon materials alone or in combination. On top of the base, a layer containing carbon material with added nitrogen (from manure, finished compost, granular fertilizer, or another source) should be placed 8 to 12 inches deep. It is important to add moisture to this layer as dry material will not compost and objectionable odors may be generated from carcasses rotting rather than composting. When adding moisture to the pile, the goal is to achieve a "wet sponge" feel in the pile material. The material should be sufficiently wetted so that it clumps together when squeezed but water cannot be squeezed out of it.

Fresh water and lagoon effluent are suitable sources for moisture addition to the pile. Carcasses can then be placed at the center of the pile, leaving at least 24 inches of space between the carcasses and the edge of the pile. With small piglets, a mound of carcasses may be created to a depth of 12 to 18 inches. Once the carcasses have been placed in the pile, an additional layer of carbon material with added nitrogen should be added to provide at least 12 inches of cover on all sides and on top of the carcasses. This material will provide energy for the microorganisms responsible for decomposing the pile material and generating heat that is needed to inactivate pathogens.

When composting small carcasses such as pre-weaned piglets, a second layer of carcasses can be added to the pile as previously described with another layer of carbon- and-nitrogen material covering this second layer of carcasses. Finally, a layer of dry carbon material should be added to cover all surfaces of the pile to a depth of at least 24 inches. This layer helps insulate the pile so that the proper temperature can be reached and maintained.

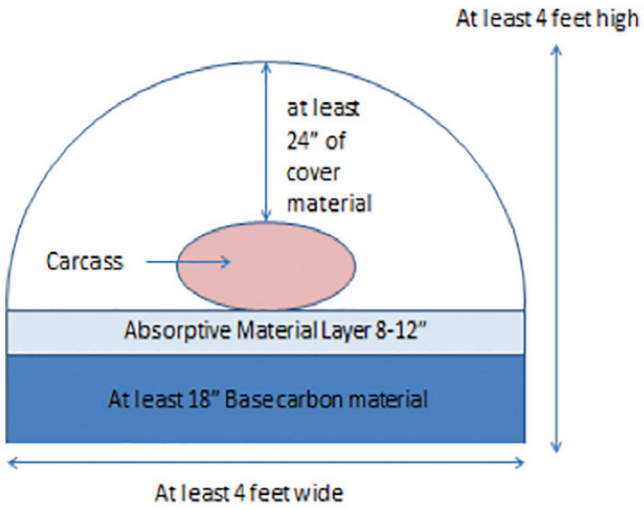

Fig. 1. Profile view of a compost pile

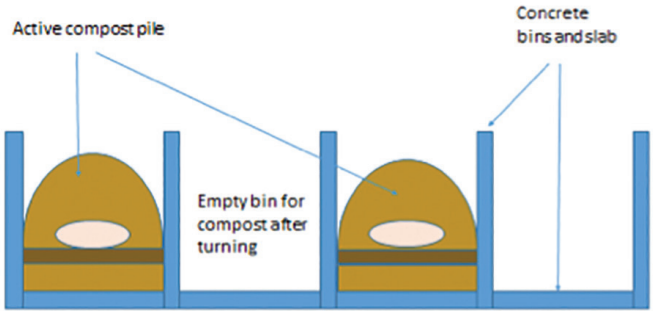

Fig. 2. Compost bins

Monitoring the Compost Pile

The compost pile material should be maintained at a moisture content of 50 to 60 percent by weight (a "wet sponge" feel as described above). Adding water to the top of the pile can help achieve the desired moisture content of a pile that seems too dry, but caution should be used to ensure that too much water is not added as this could lead to excessive leaching of liquid from the pile. A compost pile naturally creates its own heat as the thermophilic microbes decompose the carcasses. The pile should reach a temperature of 130° to 150°F within a few days and maintain a temperature above 120°F for several days or even weeks. Pile temperature can be measured with a long-stemmed (36 inch) thermometer.

Ideally, temperature should be checked in multiple locations within a pile to confirm that heat is being generated beyond the "core" of the pile. Measuring the temperature at the middle, or core, of the pile and at two or three additional points near the middle and outside edge of the pile should provide a good indication of overall pile heating. If a thermometer is not available, an alternative is to dig a small hole into the pile to feel for heat being produced. (Remember to fill the hole back in after checking the temperature!) Alternatively, if there are no objectionable odors emanating from the pile, this is a good indication that the compost process is proceeding as it should and the pile can be left undisturbed.

Compost piles will heat rapidly as microorganisms begin utilizing the pile materials for energy and produce heat during this process. As the decomposition process progresses, the food source for the microbes is consumed and the microbes begin to die off. As this happens, the pile temperature decreases. Once the temperature at the pile core falls below about 120°F, the pile should be turned (or mixed) and rebuilt to facilitate a second composting cycle. When turning a pile, moisture should be added to achieve a "wet sponge" feel and any remaining carcass remnants should be piled in the center of the new pile.

The second composting cycle will follow a heating cycle similar to the first cycle, with relatively rapid heat generation over the first few days, followed by sustained heat for several days or weeks, and then a steady decrease in pile temperature. When the temperature of the secondary composting pile decreases below about 120°F, the process is complete and the finished material can be land-applied. If any large bones remain following the secondary compost cycle, these should be collected and disposed of in a dumpster or by burial. Research conducted at UNL has shown that the PED virus is inactivated during composting when the pile is managed as described to achieve the desired temperature.

Troubleshooting Issues with a Compost Pile

If the compost pile is not heating within a few days, the pile may too dense and not getting enough oxygen for the microbes to grow or the pile may be too dry. If pile density is suspected as the problem, replace the cover carbon material with more coarse material to improve aeration. If the weather is especially cold, add a few inches of cover material to increase insulation. If insufficient moisture is suspected, water can be added to the top of the pile. Lack of proper heating may also occur in piles less than 4 foot by 4 foot by 4 foot. Smaller piles often do not contain enough volume to generate and retain heat.

Odor and scavengers can be a problem with compost piles when the composting process is not proceeding as it should. In both of these situations, additional coarse covering material can be added to the surface of the pile until the odor decreases to an acceptable level and scavengers no longer take interest in the pile. Other causes of odor can be a pile that is too wet or lacking sufficient nitrogen or carbon. Wet piles may need to be opened to allow dry carbon material to be added. If inadequate nitrogen or carbon are suspected as culprits, granular fertilizer can be added to the center of the pile to provide nitrogen or additional carbon material can be added. Both of these solutions require opening the pile temporarily to adjust the pile content.

Surface ponding of leachate may occur for piles built on less than a 1–2 percent slope or those built with an inadequate base of carbon material. In these cases, adsorbent carbon material needs to be added and permanent corrections can be made for future compost piles. Pile leachate should not be allowed to leave the site and enter surface waters.

Biosecurity Considerations

The development and use of biosecurity protocols is especially important when handling PEDv mortalities to prevent cross-contamination and disease transmission. Vehicles and equipment used to move carcasses should be cleaned of residual manure and organic material before washing. The vehicle and equipment should be washed with soap and then rinsed prior to disinfection. Follow the disinfectant's label directions to ensure that the product is used at the correct concentration and temperature. Apply disinfectant to both the interior cargo areas and exterior of vehicles and trailers. Allow for proper contact time to ensure that the disinfectant is effective.

After the recommended contact time, thoroughly rinse the vehicles and move them to a clean area to dry. Heat may be applied to increase drying speed. Personnel responsible for handling mortalities and managing the compost pile should change into clean clothes/coveralls and boots after transporting PEDv mortalities or conducting activities related to pile management.

It is not known yet how long the PED virus may remain viable in soil beneath a compost pile or soil where leachate runoff or ponding occurs. If a temporary pile is utilized to accommodate mortalities when a large loss of animals occurs, it may be desirable to add lime to the soil once the finished compost has been removed as lime has been shown to increase pH to a level that is detrimental to the virus.

Utilization of Finished Compost

The end product of the composting process depends somewhat upon the goal of the compost efforts. Simply composting to reduce disease transmission risk will yield a product that is a beneficial soil amendment, but is likely not a highly consistent and marketable product. Additional composting and material handling (screening, for instance, to remove undesirable materials like bones) is typically necessary if the finished compost is expected to be marketed to the public.

Regardless of the intended end use of the product, the finished material will be high in organic matter and contain a relatively low concentration of nutrients, including phosphorus and organic nitrogen. As a general rule of thumb, finished mortality compost will yield a 1–1–1 nutrient profile. Because the nitrogen is in an organic form, it is not readily available to plants and is slowly released as the compost is further degraded by microbes. This slow release of nitrogen is beneficial to plants. The organic carbon that makes up most of the compost adds humus to soils and thus helps improve soil quality. Regardless of where finished compost is utilized, keep in mind that Nebraska regulations require that finished compost be utilized within 12 months.

Summary

- When compost piles are properly constructed and operated, sufficient temperatures should be reached in the pile during two consecutive heating cycles to inactivate the PED virus.
- Leachate from compost piles may carry the PED virus into soil. If leaching of compost liquid is suspected, application of agricultural lime to the potentially infected soil can inactivate the virus in the soil. The goal should be to apply a sufficient amount of lime to raise the soil pH to at least 8.0.
- Finished compost should be utilized within 12 months of completion of the compost process.

Resources

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