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Organic Burial Composting of Cattle Mortality

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Composting is accepted and approved as an environmentally sound method of mortality disposal that also addresses animal health and disease concerns. Normally, this method involves the use of primary and secondary bins with a fairly high degree of management. With these systems, management can be the limiting factor that slows the decomposition of mortality.

This slower decomposition rate results in a lower throughput rate for the composting facility. Information from Maine, New Mexico and Ohio indicates that if longer decomposition times and the increased space requirements are acceptable to the producer, composting with lower management requirements is an effective mortality disposal method.

This alternative approach can best be expressed as organic burial composting (OBC). In concept, it is simply the aboveground burial of mortality in a sufficient amount of organic carbon source (such as sawdust or hay) to ensure decomposition takes place in a manner that is acceptable from an environmental and animal health perspective.

Composting Principles

Composting is the biological decomposition of organic materials under aerobic, or oxygen rich, conditions. While it occurs naturally under a wide range of conditions, to achieve rapid decomposition specific conditions are required. When these conditions are met, the microbial populations will increase rapidly, resulting in elevated temperatures in the composting mix. These "proper" conditions are often thought of in terms of the compost "recipe." The primary consideration in determining the proper recipe is the carbon to nitrogen (C:N) ratio and the moisture content. These and other factors that are used to define an ideal "recipe" are listed in Table 1.

One of the critical elements of the disposal of animal mortality is disease control. Composting exposes

Table 1. Range of Conditions for Rapid Composting[a]

Condition	Reasonable Range[a]	Preferred Range
Carbon to nitrogen (C:N) ratio	20:1 – 40:1	25:1 – 30:1
Moisture content	40 – 65%[b]	50 – 60%
Oxygen concentrations	Greater than 5%	Much greater than 5%
Particle size (diameter in inches)	1/8 – 1/2	Varies[b]
pH	5.5 – 9.0	6.5 – 8.0
Temperature (ºF)	110 – 150	130 – 140

[a] These recommendations are for traditional rapid composting. Conditions outside these ranges can also yield successful results.
[b] Depends on the specific materials, pile size and/or weather conditions.

Adapted from *On-Farm Composting Handbook*, NRAES-54. 1992. Northeast Regional Agricultural Engineering Service. Ithaca, NY.

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disease-causing organisms to heat, the toxicity of decomposition products and microbial antagonism. Of these, heat is probably the most effective in destroying disease-causing organisms. It is generally considered that temperatures of 122-140ºF will kill most viruses. These temperatures are also effective in killing the bacteria that cause anthrax and tuberculosis. It should be noted that while these temperatures kill the anthrax bacteria, they will not kill anthrax spores. Some bacteria such as clostridia can survive these temperatures. For this reason, while elevated temperatures are generally effective, composting sites should be isolated from the rest of the farm and properly managed. Proper management will help ensure elevated temperatures and prevent the access of such disease vectors as flies and animals to the mortality.

In the traditional method of determining the ratios of the compost ingredients, it is assumed that the ingredients are thoroughly and uniformly mixed. However, when composting animal mortality, it is not practical to grind the mortality to achieve a uniform mixture. As a result, for larger carcasses, there are pockets of low C:N ingredients (the carcass) buried in a larger volume of higher C:N ingredients (the carbon source material). The moisture content within the compost pile is also not uniformly distributed and tends to be highest within and around the mortality.

As a result of these conditions, there are likely to be pockets of anaerobic, or oxygen limited, decomposition in and immediately around the mortality. There may also be a tendency for water from the mortality to saturate the carbon material next to the mortality, resulting in moisture migration within the compost mixture.

This means additional carbon material, above the requirements for an ideal recipe, needs to be placed under, to the side of and on top of the mortality. The extra carbon material serves as a sponge to absorb excess water from the mortality. It also serves as a "biological" filter to treat odors and objectionable gases prior to their being released to the air.

The Organic Burial Composting (OBC) Concept

Considering these factors, the composting of large animal mortality should be thought of as above-ground burial of animal carcasses in an organic material, or organic burial composting (OBC). The basic concept is to bury the mortality in sufficient carbon material to provide the minimum C:N ratio needed for decomposition, absorb excess moisture from the mortality and filter odors.

In practice, it is simply placing the mortality in the center of a pile of carbon bedding material and leaving it for an extended period of time. After building the compost pile, management would likely be limited to adding additional carbon material, if needed, to maintain a cover over the carcass. Mixing and repiling is an option to increase the decomposition rate. However, mixing would only be done if there is a limited area that can be dedicated to mortality disposal. After decomposition, the composted material is suitable for land application as a soil amendment or reuse as a portion of the carbon material for the next mortality.

General OBC System Design

In following with the concept presented above, the total required volume of carbon material is based on the volume required for composting plus additional material to absorb excess water and malodors. Design calculations indicate that surrounding a 1,400-pound cow with 18 inches of sawdust will exceed the carbon requirements while providing the necessary moisture and odor control. However, for a lower density and lower C:N ratio carbon source such as rice hulls and straw, a minimum of 24 inches will likely be required to ensure adequate carbon for decomposition to occur and adequate moisture and odor control.

There are two basic configurations for outside composting of large mortality: pile/bin and windrow. In the pile approach, each carcass is buried in its own pile and managed independently of other carcasses. The windrow approach starts as a pile; however, new carcasses are added repeatedly to one end, forming a windrow. Both approaches can be done without the use of sidewalls, such as fencing or wooden walls. However, the use of sidewalls will reduce the volume of carbon material required and the total footprint of the pile. Sidewalls also help ensure the needed 24 inches of cover is attained. If used, sidewalls will also help prevent pets and other animals from digging in the pile.

After burial, the pile temperature should increase to about 130 to 140ºF. Once this peak temperature is reached, the temperature will decrease over a period of several weeks to about 110ºF. At this time, most of the soft tissue will be decomposed. If the pile is left undisturbed, decomposition will continue, but at a greatly reduced rate. If space is limited, the pile can be turned and mixed after the temperature drops to about 110ºF. If the moisture of the mixture is below 50 percent, water can be added at this time. The pile should then reheat to the 130-140ºF range for a period of time. This turning helps aerate and mix the pile to accelerate decomposition. If space is not limited, it is possible, and requires less management, to leave the carcass undisturbed in the pile or windrow, although it will require significantly more time to completely decompose the mortality.

Once decomposition is complete, up to half the compost may be reused as a source of active, preheated carbon/compost. The remainder is suitable for land application. Any bone fragments that are left should be brittle and easily broken. If needed or desired, the bone fragments may be added to the next compost pile to complete their decomposition.

Demonstration Findings

The time required to decompose a carcass depends on the size of the carcass, the initial heat of the pile, the moisture content of the material and whether the pile is turned. Based on a demonstration in Maine, for a mature cow placed on a pad of actively composting material (110+ºF), most of it should be decomposed in 3 to 4 months. It may then be turned and allowed to compost an additional 2 months. If the carcass is placed on a pad that has not yet started to heat, the decomposition will be slowed so that it may take up to 6 months before most of it is decomposed. At this point, turning the pile should complete the decomposition in an additional 2 months. If the pile is not turned, the total time to complete decomposition may take as long as 8 to 12 months.

In an Arkansas demonstration, using green sawdust and a 1,400-pound dairy cow, 31 days was sufficient time to reduce the carcass to a few large bones. However, as more mortality was added to the pile and other carbon sources used, the rate of decomposition decreased. However, decomposition did take place at a rate that exceeded the originally projected rate of 6 to 9 months per animal.

Procedure for OBC Pile Method

- Select the location of the compost pile. Care should be taken to ensure that the pile will be isolated from the rest of the farming operation, on dry high ground that is not in the path of runoff water after rains. The location should also be accessible to the equipment that will be used to move the carcasses and carbon material. Ideally, the site should not be visible, or conspicuous, to neighbors and the public.
- Using your available source of carbon (such as sawdust or hay) make a 24-inch thick pad that is large enough so that when the carcass is placed there will be at least 24 inches from the carcass to the edge of the pad. For a mature cow, this results in a pad that is about 9 feet wide by 10 feet long. If the pile will be exposed to the weather, *regulations based on water quality concerns prevent the carbon material from containing manure. This means materials like chicken litter or bedding with manure should not be used. If these are the materials that you want to use, then the pile will need to be put under roof. Contact your county Extension office for additional information.*
- Add water to the pad as needed to ensure the pad has a moisture content of about 50 percent. When adding water to the pad, it is best to only wet the surface of the pad after it is formed. The correct moisture is reached when the pad surface is moist to the touch but you can't squeeze any water out of a handful.
- Place the carcass on the center of the pad.
- *(Optional)* Some form of retaining wall can be used. One inexpensive method is to set a Tee-Post at each corner. Then wrap a 48-inch high welded net wire around the four posts and secure to the posts. The post will hold the wire in place until the enclosure is filled. The use of the fence will reduce the amount of carbon material needed to cover the carcass and reduce the chances of pets and wild animals digging into the pile. It will also reduce the land area required to compost. Other types of fencing such as stock panels will also work. Another approach would be to use waste round rolls of hay as the retaining wall. If this is done, the hay should not be fed to animals.

OBC pile with no sidewalls. The barbed wire fence on one side and stock panels on the remaining side prevented cattle access to the pile. Dogs and other animals digging in the pile proved not to be a problem.

- Cover the carcass with at least 24 inches of carbon material. Note that if a fence is not used, 24 inches of cover over the center of the carcass will likely result in less than 24 inches of cover part way down the slope on the side of the triangular pile. Therefore, more than 24 inches will be required at the top. When finished, the pile should be mounded and shaped so that the amount of rainwater that infiltrates the pile is minimized.
- Maintain the carbon cover. It is likely that there will be shifting and settling of the cover material as the carcass decomposes. Therefore, as needed, additional material should be added to maintain cover and water shedding ability.

- After 3 to 4 months, the pile may be mixed and restacked for an additional 2 months. If the pile is not mixed and restacked, then the total duration of the composting needs to be 9 to 12 months. If a compost thermometer is used, the pile can be turned and mixed when the temperature falls below 110ºF for faster decomposition. The composting period is considered finished when there is no soft tissue remaining. If any of the larger bones are left, they should be brittle and easily broken. These bones can be added to future piles to complete their decomposition.

The shovel indicates the former location of rib cage area of decomposed cow carcass 31 days after placement of carcass. Note that the only visible remains of the carcass at this location is discoloration. This rate of decomposition is quicker than would normally be expected.

These are the remains of the rear legs near the hip joint of a decomposing cow carcass. It is typical for the muscles and other soft tissue to decompose more quickly than the larger bones. When turning the pile, bones like this should be placed back into the pile for further decomposition.

- After the composting period is over, the mixture may be land applied or reused. When reusing the composted material, no more than half of the carbon source should be reused compost.

Recommended OBC: Windrow Method

- This approach uses the same dimensions for pad thickness, edge distances and moisture requirements as the pile method above. The advantage of using windrows is a possible savings in carbon material and a reduction in the land area required to compost the mortality.
- Start the windrow with the process described for the pile approach above.
- With each new mortality, the end of the pile is opened.
- If desired, some carbon material from the existing windrow can be pulled down to form a pad for the new morality. Ideally, the original carcass is not disturbed, unless it is ready for mixing.
- Moisten the new pad as needed.
- Place the carcass in the center of the new pad.
- *(Optional)* Add two new Tee-Posts at the new corners of the pad, then wrap additional net wire around the new length and end of the windrow.
- Cover the carcasses with the carbon material.
- Maintain the cover.
- Since a windrow is built over time, the original mortality will eventually be decomposed and ready for disposal before the most recent mortality. This provides the management options of leaving the windrow alone until the last mortality is decomposed and then utilizing compost or starting at the older end of the windrow and utilizing the compost as the mortality is decomposed.

Additional Management Tips

- With sufficient carbon material as a cover, odors will be similar to background levels. If excessive odors do occur, add additional cover material and make sure the carcass is completely covered.
- When enough cover material is used, there should be little odor to attract dogs and other animals to dig into the pile. However, if this is a problem, a fence-style retaining wall can be used or a fence placed around the free standing pile or windrow.
- Due to a concern about water leaching from the pile into ground and surface water, the pile should be shaped so that it tends to shed water. It should not have depressions on the surface that trap and pond water. It is also important that the carcass is surrounded by the full 24 inches of carbon material.

- Because sawdust is prone to blow and slide off the pile, a layer of waste silage or other carbon material, which is less likely to be blown off by the wind, can be applied over the sawdust to help hold it in place.
- Of the various carbon sources available, green sawdust tends to perform the best in terms of rapid decomposition. However, waste hay and waste silage also work, but at a significantly reduced rate.
- It is normal for large carcasses to initially bloat, swell and then rupture during decomposition. In this process, the cover material often shifts and the thickness is reduced, increasing the potential for odor. In some states, it is recommended that the carcass be cut open to prevent this from occurring. However, an acceptable alternative is to simply add more cover if needed. Another option is to prevent the swelling process by using a sharp object to puncture the body cavity, especially the belly, to allow gases to escape.

Regulatory Requirements

Based on an Arkansas demonstration and similar results in other states, on March 4, 2004, the Arkansas Livestock and Poultry Commission amended its large animal disposal regulations to permit the composting of animal mortality and removed the 60-pound limit. As a result, organic burial composting (OBC) for large animals is an acceptable alternative to traditional in-ground burial where disease control concerns are at a minimum.

For infrequent mortality disposal, such as on cow-calf operations, burial of the mortality in a carbon source such as waste hay at an appropriate site is recommended.

However, larger sources of mortality, such as larger dairies and beef backgrounding operations, should consider the use of sawdust and some type of structure to minimize sawdust requirements and to facilitate all-weather access to the pile. It is anticipated that the combination of sawdust and controlled moisture additions will increase the "throughput" to help reduce the size of the structure. If a concrete pad and a roof are utilized, the regulations allow the use of less carbon material due to the potential increased control of the composting process. A concrete pad and roof also allow the use of carbon material that contains manure, such as chicken litter. Contact your local Extension office for additional information.

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