

on-farm composting of large animal mortalities

WASHINGTON STATE UNIVERSITY EXTENSION



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All photos were taken by Caitlin Price and Betty Matin.

On-farm Composting of Large Animal Mortalities

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Introduction

With proper management and materials, on-farm composting is an economical and environmentally sound method of routine or catastrophic mortality disposal. Composting allows for immediate, year-round carcass disposal with minimal costs and equipment. Composting also protects surface and groundwater, reduces pathogens, and keeps valuable nutrients on the farm.

Composting is a biological process: aerobic microorganisms (bacteria and fungi) convert raw organic waste into stable, nutrient-rich organic matter. In large numbers, these microorganisms produce enough metabolic heat to increase temperatures inside the compost pile and kill pathogenic bacteria and viruses. The basic requirements are organic raw materials (manure, straw, sawdust, etc.), a dedicated area, and careful management.

This bulletin contains the basic information needed to start a successful on-farm mortality composting operation for large animals. The same principles also apply to smaller animals (poultry, swine, etc.), but the time and materials required will be less.

Regulations

State requirements for permitting and reporting on-farm mortality composting vary depending on the size of operation and use of the final product. Most on-farm composting operations will be exempt from permitting, but check first! Contact the Washington State Department of Ecology or Department of Agriculture for more information. Department of Ecology guidelines for on-farm mortality composting are available online at <http://www.ecy.wa.gov/biblio/0507034.html>.

Equipment

The basic tools needed for on-farm composting of mortalities are:

1. Front-end loader for moving materials and carcasses, and for turning compost piles.
2. Logbook to record amount and type of compost materials, carcass weights, internal pile temperatures, dates that piles are built and turned, and other important observations.
3. Probe-type thermometer with a three-foot stainless steel stem to monitor internal pile temperatures.

Sources for Compost Temperature Probes

A thermometer is the most important tool for monitoring compost piles, and can be either a digital or dial type. The following companies manufacture thermometers that are designed for use in compost piles. We provide this information for your convenience and are not endorsing any company or manufacturer.

1. REOTEMP Instrument Corporation
Phone: (800) 648-7737
Web: www.reotemp.com
2. Wika Instrument Corporation USA
Phone: (888) WIKA-USA
Web: www.wika.com
3. Tel-Tru Manufacturing Company
Phone: (585) 232-1440
Web: www.teltru.com



Single mortality compost pile at field trial in Skagit County. This pile was built directly in the pasture with manure, hay, and silage.

Compost Materials

Compost materials can include many organic wastes commonly found on a farm. Attributes and values for some common compost materials are listed in Table 1. Whatever materials are used, they should be blended or evenly

layered to provide the best overall conditions and nutrient balance for the pile. Approximately ten to twelve cubic yards of raw material is needed to compost a full-size cow. When choosing materials, it is important to consider nutrient content, moisture content, and structure.

The most important nutrient factor to manage in raw compost materials is the ratio of carbon (C) to nitrogen (N), as both elements are essential for the growth of microorganisms. This ratio is called the Carbon-to-Nitrogen (C:N) ratio.

The ideal C:N ratio for compost materials is in the range of 30:1 to 40:1. Materials that are too high in nitrogen (low C:N) will give off ammonia and methane gases and/or nutrient-rich leachate. Gases and leachate both are significant sources of odor. Materials that are very low in nitrogen (high C:N) will slow the composting process by limiting microbial growth. Carcasses are very dense and high in nitrogen and moisture. Therefore, high-carbon, absorbent materials to surround the carcass are necessary to balance essential nutrients and provide the right environment

Table 1. Attributes of common on-farm composting materials *(adapted from Rynk and Dougherty)*

Material	C:N ratio	Moisture (%)	Structure	Notes
Animal Carcass	5:1	60	Poor	Very dense. High moisture content.
Cattle Manure	13–20:1	67–87	Poor	High moisture content. Uniform, small particle size.
Horse Manure	25–30:1	55–75	Poor	High moisture content. Uniform, small particle size.
Wheat Straw	100–150:1	10–14	Very Good	Best when chopped and mixed with denser materials. Needs moisture. Highly degradable source of carbon.
Corn Silage	38–43:1	65–68	Good	Good particle size. Poor structure when wet. Strong odor.
Hay	15–32:1	8–10	Very Good	Best when chopped and mixed with denser materials. Needs moisture. Highly degradable source of carbon.
Sawdust	100–250:1	--	Very Good	Absorbent. Maintains structure when wet but difficult to keep moist in dry climates. Low odor.
Wood Chips	100–250:1	--	Good	Adds structure. Excellent base under primary compost materials. Larger chips absorb less water and odor, and are slow to degrade.
Finished Compost	20–40:1	--	Good	Low available nutrients. Good as absorbent base or bio-filter cover.

for microbial growth. Finished compost is low in available nutrients for further composting, but is useful as a 'bio-filter' when layered over a new pile to reduce odors and insulate in cold weather.

The ideal moisture content for compost materials surrounding the carcass is about 50% water by weight. Carcasses are approximately 60% water and therefore require drier, more absorbent compost materials than non-mortality compost. Too much moisture will limit oxygen availability in the pile, cause odors, and increase the potential for nutrient leaching. Too little moisture will limit microbial metabolism and slow carcass decomposition.

Moisture Management:

A helpful rule of thumb: Pick-up a small handful of your raw material and squeeze it tightly in your fist. It should have the feel of a wrung-out sponge. If the material does not feel moist and crumbles, it is too dry. If you can squeeze water from the material by hand, it is too wet. If it sticks together slightly and leaves a few drops of water on your hand, it's just right (about 50 to 60% water by weight).

Structure of a compost pile is determined by the particle size of raw materials. Good structure allows oxygen to circulate through the pile while maintaining moisture and containing odors. There must be a loose enough structure to allow some air flow, but not so much as to cause rapid drying or cooling of the pile. A particle size between 0.25 and 1 inch is best. Coarser materials help maintain porosity but do not absorb moisture or insulate as well, so a mixture of particle sizes is ideal. Too many large particles will allow heat and odor to escape, causing cold (inactive) piles and attracting pests. Woodchips and straw can be mixed with finer materials to improve structure, but generally do not make good composting materials alone.



Compost windrow at field trial in Yakima County. Primary materials: feed refusals, straw, silage, and dry manure.



Compost windrow at field trial in Grant County. Primary materials: manure and straw on a base of woodchips.

Location and Method

When choosing a location for compost piles, drainage and accessibility are primary concerns. The site must allow for leachate and run-off water management. Poor site drainage can cause problems with saturated materials and muddy working conditions, increasing

the potential for pathogens and odors. A land slope of 2–6% is optimal. Ditches or berms can be used up-slope to divert rain water around the piles, minimizing the total amount of leachate and run-off that must be managed. Piles should be mounded to shed moisture in wetter climates. If low moisture is a concern, piles can be built with a depression on top to collect water. Avoid sites with rocks or gravel, as these get mixed with the compost when it is turned. Compost piles should be at least 300 feet away from all surface water and wells.

Two basic compost management methods are single piles and windrows. A single pile is built for one mortality and remains separate from other piles throughout the composting process (Figure 1). A windrow is an extended pile containing several mortalities added side by side that can be added to as needed (Figure 2). Determine which compost system will work best for the site and number of mortalities expected. Plan enough space between windrows or piles to maneuver equipment. In most climates the compost pile or windrow does not need to be covered, but a simple three-sided building or covered area will make

moisture and leachate management easier, especially in wet climates. Other compost management methods include bins and aerated piles. For more information on these methods see “Additional Resources.”

Additional Resources:

1. Cornell Waste Management Institute. *Natural Rendering: Composting Livestock Mortality and Butcher Waste*. Available on-line at <http://compost.css.cornell.edu/naturalrenderingFS.pdf>.
2. Iowa State University, Department of Agricultural and Biosystems Engineering. <http://www3.abe.iastate.edu/cattlecomposting/index.asp>.
3. University of Maryland Cooperative Extension. *Composting Animal Mortalities on the Farm - Fact Sheet 717*. Available on-line at <http://extension.umd.edu/publications/PDFs/FS717.pdf>.
4. Minnesota Department of Agriculture. *Composting Animal Mortalities*. Available on-line at <http://www.mda.state.mn.us/news/publications/animals/compostguide.pdf>.

Figure 1. Building a Compost Pile for Large Animal Mortalities

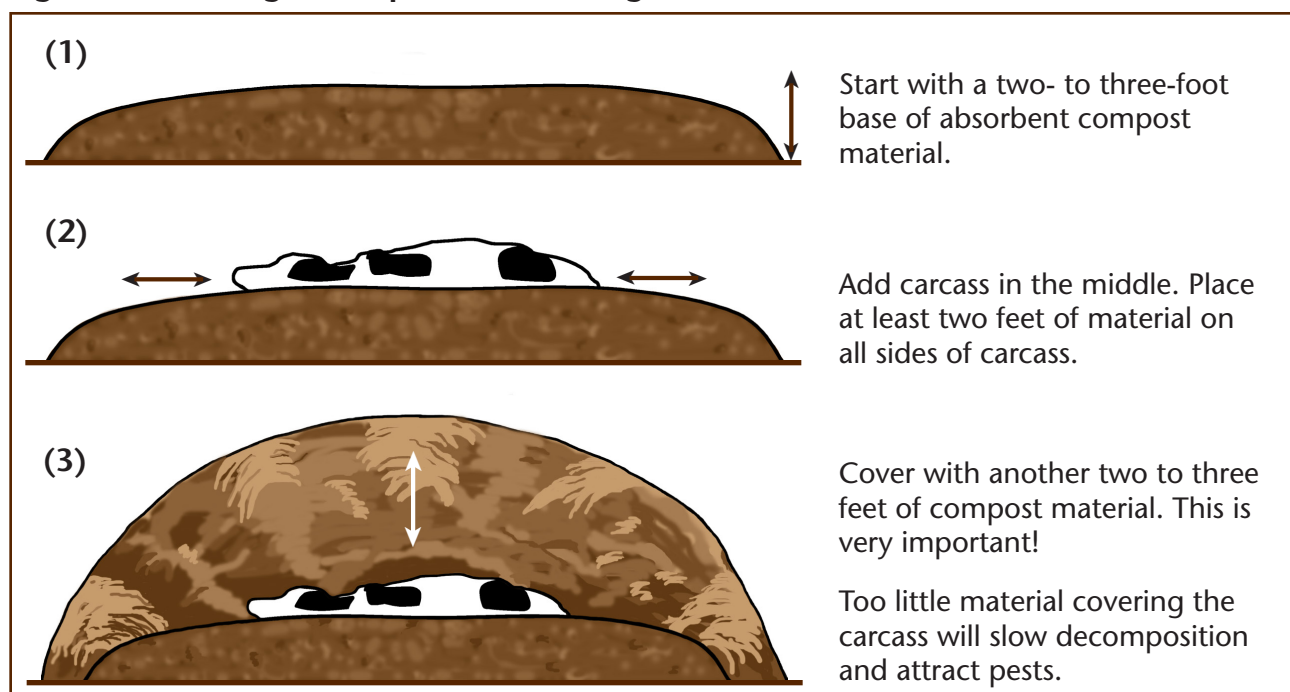
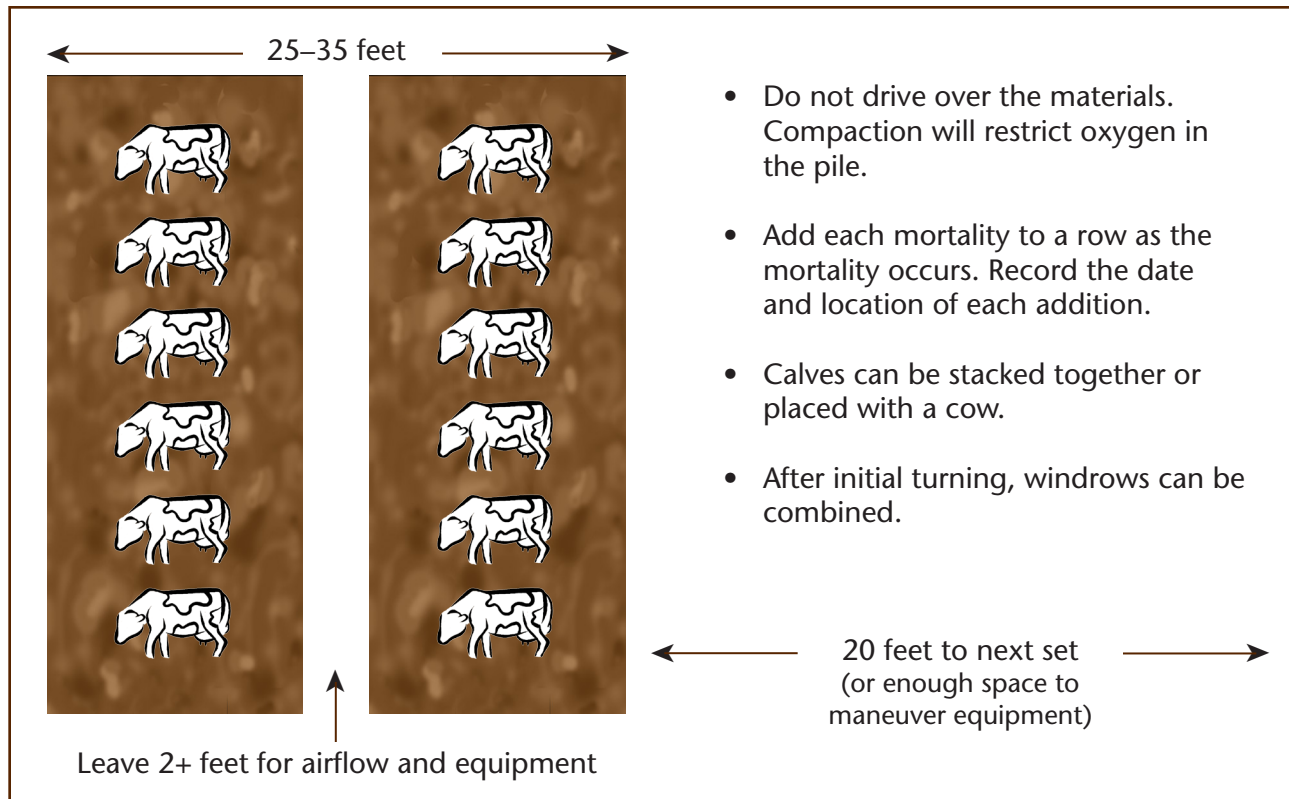


Figure 2. Windrow Layout for Large Animal Mortality Composting



Building the compost pile :

1. Start with a base of absorbent compost materials at least two to three feet deep. If high moisture or poor drainage are concerns, a base of large wood chips or similar coarse material under the primary composting materials will increase air flow and drainage.
2. Place the carcass on this base so that no part of the carcass is less than two feet from any edge. Puncture the rumen in a few places to prevent bloating and to speed up decomposition.
3. Bury the carcass completely with another two to three feet of compost material. Again, make sure all parts of the carcass are buried at least two feet from any edge. The pile may settle as decomposition occurs, or it may be disturbed by wind or animals. Observe carefully and add more material as needed; an exposed carcass will create odors and attract pests.

4. Record the date, size of carcass, and types of compost material used for each pile in the log book.



Base for mortality compost windrows. Primary materials include dairy solids and feed refusals.

Management

It is very important to monitor compost piles regularly for odors, pests, settling, or disturbance. Record temperatures and observations weekly in a log book. Temperature is the best measurement of compost “success”—as long as the pile stays hot the compost microbes are still working.

As compost microbes become active, the internal temperature of the pile will rise. For the most efficient decomposition, internal temperatures should be between 105°F and 155°F but can get as high as 170°F. Outside temperatures can affect the internal temperature of the pile. In extremely cold weather, additional compost material may be needed to insulate the pile.

The Washington Department of Ecology guidelines for mortality composting require that temperatures above 131°F be reached at points all around the carcass, at a two-foot depth from the surface, for at least three days. This procedure kills potentially pathogenic bacteria and viruses in the carcass or compost materials. Note: there is no evidence that prions (Mad Cow Disease, Scrapie, etc.) are destroyed at normal composting temperatures.



Measuring internal pile temperature on a mortality compost trial at the WSU compost yard.

After several months of active composting, the pile can be turned to mix and aerate the materials. The majority of the soft tissues and small bones will be gone, but some large bones will remain. After turning, rebuild the pile and let it continue to compost. Internal temperatures should increase again after each



Cow hip bone, after four months of active composting, showing significant deterioration along bone margins. Bone is soft and easily broken and will continue to decompose if covered in an active compost pile.



Large bone after ten weeks of active composting.

turning as oxygen and a fresh food source stimulate microbial growth. While not required by law for non-commercial operations, it is recommended that internal temperatures again reach 131°F after turning, to further reduce pathogens. Continue to monitor and turn the pile until the compost is finished. Most compost operations will turn a pile three times or until internal temperatures no longer exceed 105°F, indicating the compost is finished.

Large bones are a challenge with large animal mortality composting. Bones can be removed from the finished compost by hand and discarded, or added to a new pile to continue composting. Eventually, even the largest bones will become soft enough to be easily broken when put through a manure spreader, or driven over by a tractor. The most important factor for bone management is exposure. If the bones are exposed to air and dry out, they will immediately begin to harden. Once bones have hardened, decomposition is very difficult and slow.

The Final Product

The final compost product should have no trace of tissues or unpleasant odor. Some of the bones may still be left but should be brittle and easily broken. The compost should be brown or dark brown in color and have a pleasant earthy odor. The texture should be crumbly and allow air to penetrate, but still hold moisture. The finished compost can be stored in large curing piles on-site until it is land-applied or transported. Depending on materials and management, the entire process can take anywhere from four months to over a year.



Finished compost.

References

- Cornell Waste Management Institute and Cornell Cooperative Extension. *Natural Rendering: Composting Livestock Mortality and Butcher Waste*. Fact Sheet. 2002.
- Dougherty, Mark (Ed). *Field Guide to On-farm Composting*. Natural Resource, Agriculture and Engineering Service, Ithaca, NY. 1999. NRAES-114.
- Rynk, Robert (Ed). *On-farm Composting Handbook*. Natural Resource, Agriculture and Engineering Service, Ithaca, NY. 1992. NRAES-54.
- Washington State Department of Ecology. *On-farm Composting of Livestock Mortalities*. Publication No. 05-07-034. 2005.



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