

# Dead Animal Composting<sup>1</sup>

H. M. Keener and D. L. Elwell

## INTRODUCTION

Animal agriculture is faced today with discovering innovative ways to dispose of livestock and poultry mortality. This need has been brought on by the disappearance of rendering plants, concerns over burial and ground water pollution, and the economic cost and other issues related to incineration. Composting of dead animals is one option that is now available.

Dead animal composting as a disposal method on U.S. farms began with poultry in the 1980's (Murphy and Carr, 1991, Fulhage and Ellis, 1994; Glanville and Trampel, 1997) and later was adapted to swine. Most recently it has been adopted for other livestock (cattle, sheep), exotic animals, and road kill. In the past specific recommendations were adopted for composting each species and failed to recognize the similarities for composting different species. This article describes the current procedures in composting animal mortalities, with emphasis on Ohio's program.

## COMPOSTING

Composting is a natural biological process of decomposition of organic materials in a predominantly **aerobic** environment (Rynk, 1992; Haug, 1993). During the process, bacteria, fungi and other microorganisms break down organic materials to a stable mixture called compost while consuming oxygen and releasing heat, water, and carbon dioxide (CO<sub>2</sub>). In conventional composting, one brings together ingredients and mixes them and then puts the material into a pile to compost. Generally the mix gets turned every three or four days, but sometimes every day or sometimes only weekly or monthly. In some systems air is forced through the compost to control temperature and keep the pile supplied with oxygen. When little or no further heat output is observed, the material is removed, remixed and put in a curing pile for several months. The four major factors controlled in the composting process are the material mix (nutrient balance, C/N 25-40:1), water content (50-60%), porosity (30-50%), and temperature (110-150F).

Control of these variables is important in dead animal composting. However, the reality is that a pile in which a dead animal is composted is an inconsistent mixture. Therefore composting a dead animal must be approached in a slightly different way (Keener *et al.*, 2000; NPPC, 1997).

## DEAD ANIMAL COMPOSTING

Figure 1 is a schematic showing the process followed for composting animal mortality. It is a two-stage process consisting of a primary and a secondary composting stage. The compost pile in the primary stage is an inconsistent mixture with a large mass of material (the animal carcass) having a low C/N ratio, a high moisture content, and nearly zero porosity surrounded by a material (the carbon amendment) with a high C/N ratio, moderate moisture levels, and good porosity. The animal and amendments are layered into the pile. After the high rate phase of composting has occurred and the animal has 'fully' decomposed, the material is removed and mixed and placed in a pile for further composting (secondary stage). Composting dead animals (primary stage) can best be described as "above ground burial in a biofilter with pathogen kill by high temperature."

Figure 2 shows possible cross sections of compost piles for animal mortality. The decomposition process is anaerobic (lacking oxygen) in and around the animal carcass. But as gasses are produced and diffuse away from the carcass, they enter an aerobic zone. Here the gasses are trapped in the surrounding material, ingested by the microorganisms, and degraded to CO<sub>2</sub> and H<sub>2</sub>O. Thus the surrounding material

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<sup>1</sup> The authors are **H. M. Keener**, Associate Professor, and **D. L. Elwell**, Senior Researcher, Dept. of Food, Agricultural, and Biological Engineering, Ohio Agricultural Research and Development Center, The Ohio State University. **Corresponding author: Harold M. Keener, Dept. of Food, Agricultural, and Biological Engineering, OARDC, 1680 Madison Avenue, Wooster, OH 44691; e-mail: <keener.3@osu.edu>.**

supports bacteria to form a biological filter, or a biofilter. With this scenario, turning the pile is to be avoided until the carcasses have been decomposed. For moderate size animals (poultry, pigs, sheep, etc.) this period is generally less than three months after the last carcass has been placed into the pile. After this time the compost is moved to a secondary area where it is allowed to compost for an additional time period of 10 days to several months. The secondary pile is then turned and placed in a pile for curing for 30 days or more. Moving the pile for secondary composting and curing introduces air back into the pile and mixes the contents of the pile, leading to more uniformity in the finished compost. Table 1 illustrates the relationship between the animal body weight and composting cycle times (Note: 10 days is a minimum cycle time). When composting larger mature animals, bone fragments remain after completion of the secondary and curing stage. These fragments are usually quite brittle and pose no health risks or danger to equipment when land applied. In some instances it may be desirable to recycle the larger bones back into the compost to allow more decomposition.

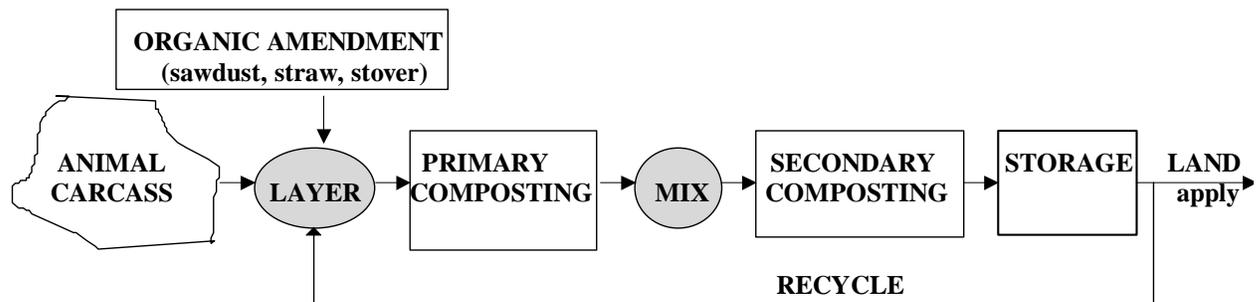


Figure 1. Material flow in dead animal composting. Forced aeration is not used. Materials are not mixed until flesh of the animal body is completely decomposed. Time can vary from 10 days (poultry) to over 100 days (>182 kg; 400 lb animal).

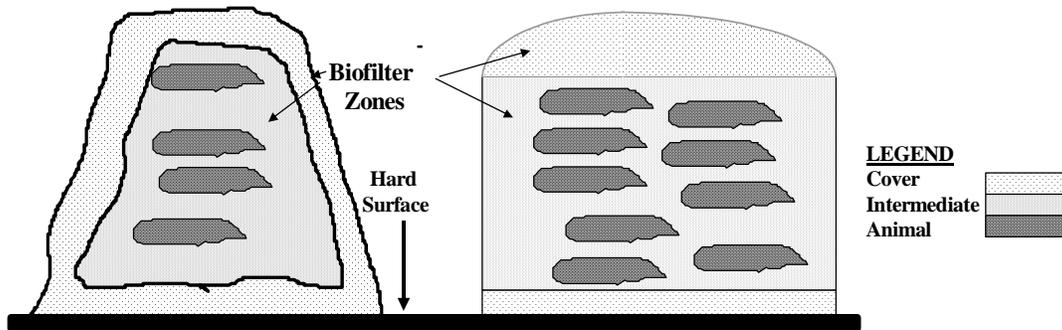


Figure 2. Cross Section Views of Composting in a Windrow or Bin For Animal Mortality. Layering of animal carcasses surrounded by material which not only provides carbon (energy) for the microorganisms, but also acts as a biofilter. The windrow/bin is not turned until carcasses are decomposed. Pile shape will depend on whether done in the open or in a bin.

Table 1. Cycle time for primary and secondary composting of animal mortality versus body size.

Mortality size (lbs.)	4	10	50	100	220	350	500	1000	1500
Primary stage (days)	10	16	35	50	75	95	115	160	195
Secondary stage (days)	10	10	12	15	25	30	40	55	65
Storage stage (Suggested minimum days)	30	30	30	30	30	30	30	30	30

## Data Collection

Monitoring temperature is necessary to measure progress of the composting process. It can be done easily with a three ft. probe thermometer (1/4 inch probe diameter is recommended). Temperatures should rise to 140-150°F and remain there for several weeks (pathogen kill occurs above 133°F for 3 days). Take temperatures at several points near the animals placed in the pile. Other data recorded should include date, size, number of animals added.

## Carbon/Bulking Agents

Dead animal composting requires addition of materials to provide acceptable C/N ratios and porosity for good biofiltration. To work well as a biofilter, material moisture level should be around 50%. Sawdust is widely used for composting animal mortality. It works well as a biofilter, allows high temperatures to be achieved and sustained during the primary phase, and good bone breakdown when doing large (> 182 kg; 400 lb) animals. Because of its ability to shed rainwater, sawdust works well for outside piles where exposure to rain and snow could result in high moisture levels leading to leachate or odors. When using sawdust, it is recommended 25-50% of the material be recycled compost from the curing pile as this reduces cost, improves the composting process, and leads to a higher quality finished compost. Recycle rates should not exceed 50% as this may limit carbon availability, thus interfering with the composting process. General rule of thumb for amendments with no recycling is 0.0069 cu. yd sawdust per lb loss. (Example: 5000 lbs mortality, 34.5 cu yd sawdust).

Other materials besides sawdust can be used for composting, such as straw or corn stover (Elwell *et al.*, 1998), but require additional management for water control. For poultry mortality, poultry litter and straw are recommended (Murphy and Carr, 1991). Peanut hulls have been utilized in North Carolina (cited in NPPC, 1997).

## Mortality Composting Procedure

The practices of composting animal mortality are simple. Recommendations are (OSUE, 2000):

1. Construct a base from sawdust or acceptable amendment at least 30 cm (1 ft) thick. (This may not be enough for very large animals.) This base will collect liquids that are released during carcass decomposition. It also permits air and microbial action underneath the carcass. If liquids begin to leach out of the pile, spread sawdust (or suitable amendment) around the pile to absorb the liquids and increase the depth of the base when constructing new piles.

2. Place a layer of carcasses on the sawdust base. A single layer of carcasses should be centered on the base and be spaced evenly across the base. Do not stack carcasses on top of one another. An exception is small animals such as fish or lab animals, where mortalities can be layered up to 10 cm (4 in.) thick (White *et al.*, 1989). Ten to 15 cm (4-6 in.) of amendment should be maintained between layers.

3. Cover the carcasses with 30 to 60 cm (1-2 ft) of damp amendment (30 cm in enclosed bins, 60 cm in outside piles). This cover acts as the biofilter for odor control around the pile and insulates the pile to retain heat. Odors may be released when an inadequate cover is used or when it is too dry. The released odors may also attract scavenging animals and pets to the pile.

When additional carcasses are placed in the pile the following steps should be followed:

1. Hollow out a hole in the amendment (in the 30 to 60 cm (1-2 ft) of cover material). Maintain 10 to 15 cm (4-6 in) of amendment over carcasses already in the pile.

2. Place a new layer of carcasses in the pile.

3. Cover the new layer of carcasses with 30 -60 cm (1-2 ft) of damp amendment.

Pile (bin) management is a simple cycle, based on a primary stage (primary stage compost time =T1), secondary stage (T2), and storage stage (T3). A minimum of two primary piles (bins) is required. The secondary pile is the same size as the primary pile. The storage pile size is dictated by how long the compost will be stored before land application.

Each pile is constructed for T1 days, composted for T1 days, and then is turned and composted for T2 days. Finally the material is placed in the storage area where it is kept for T3 days. Each primary bin gets

filled at (2 \* T1) intervals. A more complete description of the design and operation is presented in OSUE (2000).

## **Siting**

The Ohio Livestock Mortality Composting Development Team identified four basic objectives for composting animal mortalities in Ohio. These objectives are: 1. Protect ground and surface waters from pollution; 2. Reduce the risk of the spread of disease; 3. Prevent nuisances such as flies, vermin, and scavenging animals; and 4. Maintain air quality. Selecting a proper composting site is an important step in meeting these objectives as it helps protect water quality, prevent complaints and nuisance problems, maintain bio-security, and minimize the challenges in operating and managing the composting process. Specific information on site selection is given by OSUE (2000) and the NPPC (1997).

## **Mortality Facilities**

Mortality composting is commonly conducted in one of three primary facility types: a bin, static windrow (pile), or mini-composter. Each facility's has unique advantages and disadvantages. Below is a brief description of each.

### **Bin Composting**

Composting in a bin usually involves construction of a facility with a concrete floor, wood or concrete sidewalls on at least 3 sides, and a roof over the facility to eliminate rain water infiltration. In a bin system the front dimension is generally 60 cm (2 ft) wider than the loading bucket width. Recommended depth for a bin system is 1.5 m (5 ft). With bin composting there will be a minimum of three active bins in operation at any given time. (1 primary being filled, 1 primary composting and 1 secondary). A static pile is sometimes substituted for the secondary bin in two bin systems. Figure 4 is a bin composting system designed for poultry mortality.



Figure 4. Four Bin Arrangement For Poultry Mortality. Bins are for primary (2), secondary and amendment storage. Additional space is for storage of material prior to land application.

### **Static Windrow ( Pile) Composting**

The windrow composting system is established on a concrete, geotextile fabric lined gravel base or low permeability soil to control water infiltration. In these systems, walls and roofs are not used, so access to the pile from all sides is possible to load, unload and mix the compost material. Producers using this design will load the dead animals for a specific time period while continually extending the length of the compost pile and will mound the compost material to shed rainfall, control moisture loss and maintain adequate biofilter cover. Turning of any portion of the pile is delayed until that portion has met acceptable times for the primary stage (1<sup>st</sup> turn) or secondary stage (2<sup>nd</sup> turn). Specific size and number of windrows and management will be based on site parameters of layout and loading rates. Recommended depth for a windrow system is 1.5 to 2.1 m (5 to 7 ft). Static pile composting is similar to windrows except the pile is not extended in length. Turning of any pile is delayed until it has met acceptable times for each stage.



Figure 2. Windrow (pile) system used for swine mortality. Site is well drained and all surface water is diverted away from windrow.

### Mini-composters

Mini-composters are a smaller version of a bin composter. Generally these facilities are about one meter square (40 x 40 in.) and 91 cm (36 in.) high and handle disposal of very small animals and/or birth materials. Animal size is usually limited to under 18 kg (40 lb) and primary bin requirements would be less than two cubic meter (70 ft<sup>3</sup>). For a Northern climate, some additional insulation under winter conditions may be needed to enable the composter to reach the desired temperatures (> 55°C; 131 °F) for pathogen destruction and effective degradation.

### Sizing Guidelines

Proper sizing of a composting facility is critical to minimize cost and to prevent problems with leachate, odor and flies, thus making the management and operation of the composting process easy. Procedures developed for sizing of the composting system are given in OSUE (2000). They are based on the following assumptions: 1. Two stages for composting mortality – primary and secondary; 2. Storage of compost for recycle and flexibility in land application; 3. Weight of largest animal controlling time for the primary and secondary composting; 4. Daily mortality rate and composting time determining total loading for each primary bin; 5. All systems having a minimum of two primary bins or equivalent; and 6. All primary bins using a biofilter cover of 30 to 60 cm (1 to 2 ft) and a minimum of 30 cm (1 ft) base material.

Procedures developed for sizing of the composting system are given in OSUE (2000). Equations used (English units) are:

$$T_1 = 5 \times W_1^{0.5} \geq 10, \text{ days.} \quad (1)$$

$$V_1 \geq 0.2 \times \text{ADL} \times T_1, \text{ ft}^3. \quad (2)$$

$$V_1 = 0.2 \times W_1 \times \text{Integer}(\text{ADL} \times T_1 / W_1), \text{ ft}^3. \quad (2a)$$

$$T_2 = 1/3 \times T_1 \geq 10, \text{ days;} \quad (3)$$

$$V_2 \geq 0.2 \times \text{ADL} \times T_2, \text{ ft}^3. \quad (4)$$

$$V_2 = 0.2 \times W_1 \times \text{Integer}(\text{ADL} \times T_2 / W_1), \text{ ft}^3. \quad (4a)$$

$$T_3 \geq 30, \text{ days;} \quad (5)$$

$$V_3 \geq 0.2 \times \text{ADL} \times T_3, \text{ ft}^3. \quad (6)$$

$$V_3 = 0.2 \times W_1 \times \text{Integer}(\text{ADL} \times T_3 / W_1), \text{ ft}^3. \quad (6a)$$

where ADL is average daily mortality (lb/day),  
and  $W_1$  is design mortality weight (lb).

## Ohio's Experience with Program

Over 1200 farmers have participated in a three hour training program and received certification. A survey (Bender *et al.*, 1998) of the swine industry showed 51% of 151 respondents found that composting saved them money, 46% found that it increased bio-security, 68 percent found it was easy to manage, and 44 % felt it exceeded their expectations. Only 0.6 percent found composting to be less successful than expected.

## SUMMARY

Mortality composting can best be described as **“above ground burial in a biofilter with pathogen kill by high temperature.”** This article describes the procedures for composting dead animals based on this concept. Included are descriptions of the systems in use today and the basic equations for sizing the system.

## References:

- Bender, R.F., S.J. Moeller and S.S. Foster. 1998. Composting mortality: An environmentally friendly dead animal disposal option. In: Proceedings of Animal Production Systems And The Environment. Des Moines, Iowa. pp 3-8.
- Elwell, D.L., S.J. Moller and H.M. Keener. 1998a. Composting large swine carcasses in three amendment materials. In: Proceedings of Animal Production Systems And The Environment. Des Moines, Iowa. pp15-20.
- Fulhage, C. and C.E. Ellis. 1994. Composting Dead Swine. WQ 225. University of Missouri Extension.
- Glanville, T.D. and D..W. Trampel. 1997. Composting alternative for animal carcass disposal. JAVMA 210(8). pp.1116-1120.
- Haug, R.T. 1993. The Practical Handbook of Compost Engineering. Lewis Publications, Ann Arbor, Michigan.
- Keener, H. M., D. L. Elwell and M. J. Monnin. 2000. Procedures and equations for sizing of structures and windrows for composting animal mortalities. Applied Engineering in Agriculture 16(6): 681-692.
- Murphy, D.W., and L.E. Carr. 1991. Composting dead birds. Fact Sheet 537. Cooperative Extension Service, University of Maryland System.
- NPPC. 1997. Swine mortality composting module. National Pork Producers Council, Clive, IA.
- OSUE. 2000. Ohio's livestock and poultry mortality composting manual. Extension Publication. Ohio State University Extension, Columbus, Ohio. (January)
- Rynk, R.(Ed.) 1992. *On-farm Composting Handbook, NRAES-54*. Northeast Regional Agricultural Engineering Service, Ithaca, N.Y.
- White, D.G., J.M. Regenstein, T. Richard and S. Goldhor. 1989. Composting Salmonid fish waste: A waste disposal alternative. Sea Grant publication. Cooperative Extension NY State, Cornell University, Ithaca, N.Y.