

# Composting

## An Alternative for Livestock Manure Management and Disposal of Dead Animals

A. Sandeen and M. Gamroth

Composting is a naturally occurring process that farmers have used for centuries. Under the right conditions, microorganisms grow and multiply, converting the original organic material into a more stable, usable product. Organic materials suitable for composting include leaves, yard and garden debris, grass or cereal straw, food waste, sewage sludge, and livestock manure. With proper

control, composting can produce the same products as would occur naturally, but much more quickly.

Livestock producers constantly face the challenge of managing manure and meeting environmental regulations. Composting is a possible alternative for handling manure. The benefits include reduced volume, enhanced soil fertility and texture, and reduced environmental risk.

### Composted vs. uncomposted manure

When you are looking for organic forms of nutrients for crop production, manure and manure composts are two logical choices. What are the pros and cons of using uncomposted or composted manure? In some cases, they have comparable properties; in other ways they are quite different. The table below compares the two materials.

#### Compost

- Slow-release form of nutrients
- Easier to spread
- Lower potential to degrade water quality
- Less likely to contain weed seeds
- Higher investment of time or money
- Reduced pathogen levels (e.g., salmonella, *E. coli*)
- More expensive to purchase
- Fewer odors (although poor composting conditions can create foul odors)
- Improves soil tilth

#### Manure

- Usually higher nutrient content
- Sometimes difficult to spread
- Higher potential to degrade water quality
- More likely to contain weed seeds
- Lower investment of time or money
- Potential for higher pathogen levels
- Less expensive to purchase
- Odors sometimes a problem
- Improves soil tilth



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*Andrew Sandeen, graduate student, The Ohio State University, and Mike Gamroth, Extension dairy specialist, Oregon State University*

## The process

Composting begins as soon as a pile of waste is made. Organisms immediately start to consume the available oxygen and convert the materials into carbon dioxide, water vapor, and heat (Figure 1).

Composting is more than just piling the material and letting it sit, however. Composting is the active management of manure and bedding to aid the decomposition of organic materials by microorganisms under controlled conditions. Effective composting is affected by four major factors:

- Aeration
- Nutrient balance
- Moisture content
- Temperature

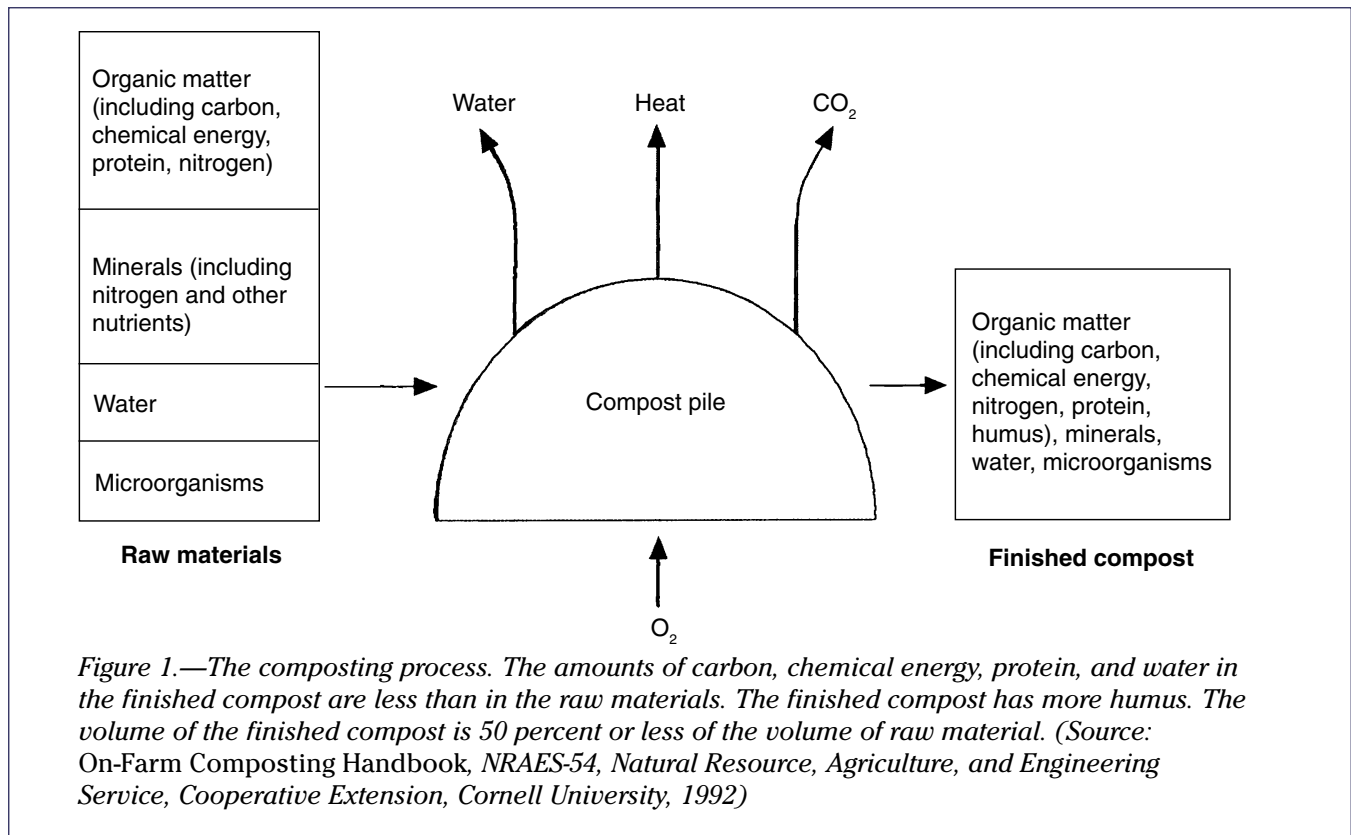
If these four factors are properly controlled, composting will take place at a very rapid pace.

**Aeration** is the key element in efficient composting. Composting is an aerobic process, meaning that it requires lots of oxygen. Air can be provided by stirring or mixing the pile or forced in with fans or blowers (see “Equipment/strategies,” page 3).

Turning is important for good aeration of windrows that don’t have forced air running through them. It restores pore space so that air can move through the pile more easily. It also mixes in the sections of the pile that have not reached the desired temperature.

**Nutrient balance** is determined by the ratio of carbon to nitrogen in the compost pile. Composting usually is successful when the pile contains 20 to 40 parts of carbon per 1 part of nitrogen. The ideal ratio is 25:1 to 30:1. If the ratio is too low, excess nitrogen is converted to ammonia and escapes into the atmosphere, causing undesirable odors. If the ratio is too high, the rate of composting decreases.

The **moisture content** of the compost pile ideally should be around 60 percent after the original mixing. When the moisture content exceeds 60 percent, oxygen movement is inhibited and the process becomes more anaerobic. Below 40 percent moisture, the rate of decomposition decreases rapidly. The general recommendation is to keep moisture content between 40 and



65 percent. It may be necessary to add water if the compost becomes too dry or to cover it in the winter if it is too wet. As a general rule, a mixture with 50 percent moisture will feel damp to the touch but not soggy.

The **temperature** is expected to increase in a compost pile due to the breakdown of organic material by microorganisms. The pile will start out at the outside temperature when it is first mixed and can reach 150°F in less than 2 days. The maximum composting rate occurs when the temperature is between 110 and 150°F. It has been shown that a temperature of 131°F for 3 days will kill all parasites, weed seeds, and disease-causing organisms. It is important to turn the piles frequently to ensure that all parts of the pile are exposed to these temperatures.

All of these recommendations for efficient composting are summarized in Table 1.

It often is necessary to add amendments, or bulking agents, to manure for effective composting, although manure solids from a mechanical liquid–solid separator can be composted without additional material. Amendments are added to adjust moisture content, texture, or the C:N ratio. These materials help provide structure to the pile, which maintains adequate pore space for aeration. Common materials used are straw, spoiled hay, shavings, or dry leaves. Chopping materials for smaller particle size makes

more surface area available to the microbes, which speeds up the composting process.

Curing is the final stage of composting. When available nutrients are used up and bacterial activity decreases, the compost will heat very little after aeration. This starts the curing process. Compost used for livestock bedding, gardening, or packaged for sale should be cured for 4 to 6 weeks. At this point, it is stable and less likely to harm plants. Compost applied to fields as fertilizer doesn't need to be cured before application.

## Equipment/strategies

There are several methods of composting. This publication discusses the two most practical for livestock operations: turned windrows and aerated piles. The typical composting times for a variety of methods are given in Table 2 (following page).

Composting with **turned windrows** uses long, narrow piles, which are agitated or turned on a regular basis (Figure 2, following page). Eight weeks is the common period for complete composting with windrows in dairy operations, with the piles being turned at least five times.

The appropriate size of piles depends on the equipment used for aerating them and the composition of the material. If the windrow is too large, the center of the pile will be anaerobic and bad odors will be released when the pile is turned. If the windrow is too small, it may lose heat too

**Table 1.—Recommended conditions for rapid composting.**

<b>Condition</b>	<b>Reasonable range<sup>a</sup></b>	<b>Preferred range</b>
Carbon to nitrogen (C:N) ratio	20:1–40:1	25:1–30:1
Moisture content	40–65% <sup>b</sup>	50–60%
Oxygen concentration	Greater than 5%	Much greater than 5%
Particle size (diameter in inches)	0.12–0.5	Varies <sup>b</sup>
pH	5.5–9.0	6.5–8.0
Temperature (°F)	110–150	130–140

<sup>a</sup>These recommendations are for *rapid* composting. Conditions outside these ranges also can yield successful results.

<sup>b</sup>Depends on the specific materials, pile size, and/or weather conditions.

**Table 2.—Typical composting times for selected combinations of methods and materials.**

Method	Materials	Active composting time		
		Range	Typical	Curing time
Windrow— infrequent turning <sup>a</sup>	Leaves Manure + amendments	6 months–1 year	9 months	4 months
Windrow— frequent turning <sup>b</sup>	Manure + amendments	1–4 months	2 months	1–2 months
Aerated static pile	Sludge + wood chips	3–5 weeks	4 weeks	1–2 months

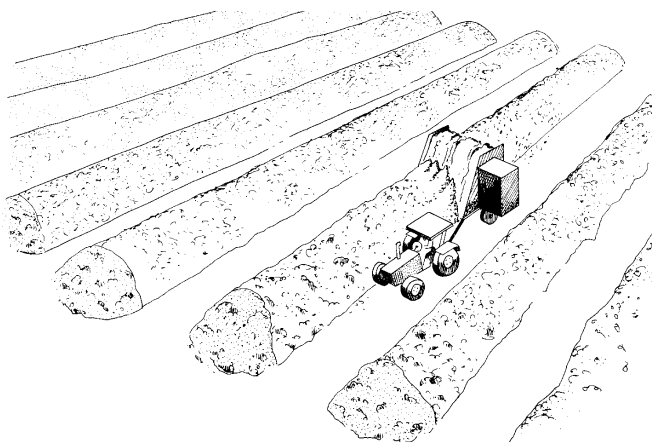
<sup>a</sup>For example, with bucket loader

<sup>b</sup>For example, with special windrow turner

quickly and the pile will not achieve temperatures high enough to evaporate moisture and kill pathogens and weed seeds.

Frequent turning of windrows helps maintain the desired porosity and release trapped heat and gases. Turning also exchanges the material so that all of the material can be exposed to high temperatures. When the temperature drops below 110°F, the microbial activity has declined and the pile should be turned. When the temperature doesn't increase after turning, the composting process is complete.

For small amounts of material, a front-end loader or tractor with a bucket can be used to turn



*Figure 2.—Windrow composting with an elevating face windrow turner. (Source: On-Farm Composting Handbook, NRAES-54, Natural Resource, Agriculture, and Engineering Service, Cooperative Extension, Cornell University, 1992)*

the windrows. For large amounts of compost, it may be more efficient to purchase special equipment, which will create neat windrows and bring the bottom of the pile to the top. Machines vary dramatically in size, efficiency, and cost.

A second method of composting uses static (unturned) **aerated piles** that are not moved until the process is complete. Aeration is provided by a pipe or pipes running through the pile. An air supply is hooked up to the pipe to blow or suck air through the pile, thus maintaining a constant supply of air to the whole pile. This process allows composting to be completed in 3 to 5 weeks. The odors are minimal, but a common frustration is the clogging of the holes in the pipe.

Windrow composting is fairly labor-intensive, requiring attention on almost a daily basis. Aerated piles, on the other hand, require labor mostly when they are created or removed. The aerated piles occupy less land area and thus are easier to cover with a roof, if necessary.

## Can I use the compost pile for disposal of dead animals?

It is legal to compost dead animals in Oregon; however, you must have a composting plan on file with the Oregon Department of Agriculture. The plan must include a drawing of your composting area, a description of how runoff from the compost piles will be contained, a description of the

composting process you will use, and a description of how the compost will be used on the farm.

Composting of animal carcasses must be done on concrete or a similar impervious surface that prevents nutrient leaching. In western Oregon, it is wise to have a roof to protect the pile from rainfall. Bins or walls around the compost pile make turning the compost easier.

The basic composting process is relatively easy. Start with a 12-inch layer of dry straw or dry manure solids. Drag or lift the carcass onto this layer. A small opening in the body cavity will prevent bloating. Cutting open the body cavity and large muscle groups speeds decomposition; however, livestock farmers report this is not necessary. Cover the carcass with 3 feet of manure solids.

Maintain the moisture content of the pile about like silage: damp, not wet. Add manure solids and water as needed. The pile must heat to above 131°F for 3 days to kill pathogens dangerous to humans. The pile will be ready to turn in about 30 days and will need to be turned about 5 times. The carcass should be fully composted in about 180 days. Bone residue is not a problem. The compost can be spread on crop fields, as the heating destroys disease-causing bacteria.

## Regulations

If all of your compost material is generated on the farm and none of it leaves the farm, you are not required to have a compost management plan on file with the Oregon Department of Agriculture (ODA). If you are composting large animals or have materials coming onto or leaving the farm, you may need to prepare a plan, as mentioned above. Details of plan requirements and assistance are available from ODA (503-986-4776).

## Uses for compost

Two common uses for compost in livestock operations are as fertilizer or for livestock bedding. The stable forms of nutrients in composted manure are released more slowly to plants than are the nutrients in fresh manure. Typically, only about 15 percent of the nitrogen in compost is used by plants in the first year. This slow release may be

beneficial in the long run, as the material will continue to release nitrogen to the crops in succeeding years. The material is odorless, sterile, and weed-free. It does not cause leaching problems unless applied excessively.

Many dairy farmers have questioned the value of compost as a bedding material. They are concerned that the material will be contaminated with bacteria, causing mastitis or other health concerns. However, if properly composted so the material has been heated and dried, compost is no more risky than any other bedding from a plant source, such as sawdust. Furthermore, the materials are already on the farm, don't have to be purchased, and provide a very comfortable bed for cows.

Compost can be sold to nurseries, garden stores, and directly to gardeners.

## Advantages/drawbacks of compost

The **advantages** of composting include soil conditioning, a marketable product, improved manure handling (reduced volume), lower risk of pollution and nuisance complaints, pathogen destruction, and possible bedding for animals.

- When applied to pastures, compost adds organic matter and can reduce the need for fertilizers. It also reduces the potential for soil erosion. The nitrogen in compost is more stable than that in manure and is less susceptible to leaching. Some ammonia is lost during the composting process, but less nitrogen is lost after fertilizing than from manure. Properly prepared compost is free of viable weed seeds.
- One of the greatest advantages may be the potential to have a marketable product. Potential buyers include gardeners, landscapers, vegetable farmers, turf growers, operators of golf courses, and ornamental crop growers. The price will depend on the demand in your area and the quality of the product.
- Compost is easier to handle than other forms of manure. The volume and weight of material are reduced because of the loss of moisture. Thus, compost can be easily stored and used when needed.

- Composting can reduce odor complaints, runoff into streams, and flies. Compost is a desirable product to most people, whereas manure is not to some.
- Disease-causing organisms can be destroyed through the composting process.
- Compost has been shown to be a safe and effective bedding material for livestock, including milking cows.

Although there are many benefits to composting, there also are **drawbacks**. Drawbacks include time, space, and money requirements; odor; the need for protection from rain; increased salinity; herbicide carryover; potential loss of nitrogen; and slow release of nutrients.

- Composting requires equipment as well as labor and management. The initial investment may be low if existing farm equipment can be used. On the other hand, if a lot of composting is done, it may be necessary to buy special equipment, which can be expensive.
- If a considerable amount of waste is composted, it can occupy a large area and might require a building to cover it in high-rainfall areas.
- Marketing takes time, and many producers do not want to deal with selling compost.
- Composted manure contains less nitrogen than fresh manure.
- As manure and wastes are composted and dried, the salt concentration of the mix can increase. Some plants are very sensitive to soil salinity and may be damaged by compost used as a fertilizer. Likewise, many herbicides in plant residues are not broken down in compost. Some persistent herbicide residues in compost can harm crops. If soils are already high in salts or you notice crop damage, seek advice from a local crop advisor.
- Most of the nutrients in compost must be mineralized in the soil before they are available to

plants. Often less than 15 percent of the nitrogen is available in the first cropping season. This might be a problem if fields require a lot of nitrogen the first year. However, the nutrients will be there for future years.

## Conclusion

Composting is a natural process that can be accelerated by proper management. The result is a stable, volume-reduced product that can be sold, applied to fields, or used as livestock bedding. The land area, type of equipment already available, market potential in the area, available labor, and many other factors play a role in determining which composting system would be best. Explore the different options and talk with others who are familiar with composting.

## References

- Mid-West Plan Service. 1993. *Livestock Waste Facilities Handbook*. MWPS-18, third edition. Northeast Regional Agricultural Engineering Service. 1992. *On-Farm Composting Handbook*. NRAES-54.
- Oregon Department of Environmental Quality. *Waste Prevention and Management*. <http://www.deq.state.or.us/wmc/solwaste/rsw/htm>.

## For more information

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