Composting:

An Alternative for Livestock Manure Management and Disposal of Dead Animals

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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 ways, these two materials are similar; in other ways, they are quite different.

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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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 and 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 (C:N) in the compost pile. Composting usually is successful when the pile contains 20 to 40 parts of carbon per 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% after the original mixing. When the moisture content exceeds 60%, oxygen movement is inhibited and the process becomes more anaerobic. Below 40% moisture, the rate of decomposition decreases rapidly. The general recommendation is to keep moisture content between 40% and 65%. It may be necessary to add water if the compost becomes too dry or to cover the compost in winter if it is too wet. As a general rule, a mixture with 50% moisture will feel damp to the touch but not soggy.

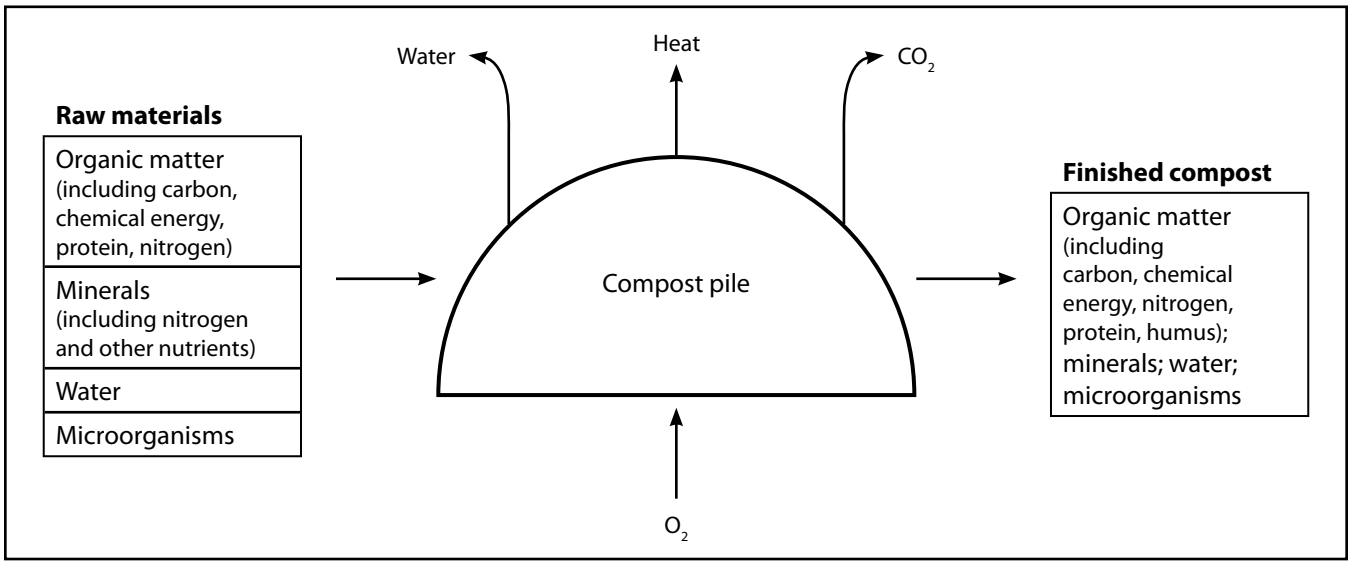

Figure 1. The composting process. The amounts of carbon, chemical energy, protein, and water in the finished compost are less than in the raw materials. The finished compost has more humus. The volume of the finished compost is 50% or less of the volume of raw material.

Adapted with permission from *On-Farm Composting Handbook* (NRAES-54). Natural Resource, Agriculture, and Engineering Service, Cooperative Extension, Cornell University, 1992.

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°F 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 that is used for livestock bedding or 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.

Figure 2. Windrows of compost.

Photo courtesy of USDA Natural Resources Conservation Service.

Equipment and 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.

Composting with **turned windrows** uses long, narrow piles, which are agitated or turned on a regular basis (figure 2). 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

Table 1. Recommended conditions for rapid composting

Condition	Reasonable range[1]	Preferred range
Carbon to nitrogen (C:N) ratio	20:1–40:1	25:1–30:1
Moisture content	40%–65%[2]	50%–60%
Oxygen concentration	Greater than 5%	Much greater than 5%
Particle size (diameter in inches)	0.12–0.5	Varies[2]
pH	5.5–9.0	6.5–8.0
Temperature (°F)	110–150	130–140

[1] These recommendations are for *rapid* composting. Conditions outside these ranges also can yield successful results.

[2] Depends on the specific materials, pile size, and weather conditions.

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

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

[1] For example, with a bucket loader.

[2] For example, with a special windrow turner.

will be released when the pile is turned. If the windrow is too small, it may lose heat too 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 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. A pipe or pipes running through the pile provide aeration. An air supply is hooked up to the pipe to blow or suck air through the pile, 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. Aerated piles occupy less land area and are easier to cover with a roof, if necessary.

Composting to Dispose 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 five 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).

Confined animal feeding operations (CAFO) registered to Oregon CAFO general or CAFO individual permits must include their composting operation in their animal waste management plan. Details of plan requirements and assistance are available from ODA.

All composting operations that compost 100 or more tons of feedstock per year (or more than 20 tons per year of animal carcasses or meat waste) must submit screening information to the Oregon Department of Environmental Quality (DEQ). The regional DEQ office can help you determine the size of your facility and assemble the required screening information.

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, plants use only about 15% of the nitrogen in compost 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 gardeners.

Advantages and Drawbacks of Compost

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, golf course operators, 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.

Drawbacks of composting 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, labor, and management. The initial investment may be low if existing farm equipment can be used. But 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% 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 the best composting system. Explore the different options and talk with others who are familiar with composting.

For More Information

Livestock Waste Facilities Handbook (3rd edition). MWPS-18. (1993) Ames, IA: MidWest Plan Service. *http://mwps.org*

On-Farm Composting Handbook. NRAES-54. (1992) Ithaca, NY: Plant and Life Sciences Publishing (formerly Northeast Regional Agricultural Engineering Service), Cornell University Cooperative Extension. *http://palspublishing.cals.cornell.edu/*

Oregon Department of Agriculture, Natural Resources Division *http://oregon.gov/ODA/NRD/*

Oregon Department of Environmental Quality Land quality, solid waste: *http://www.deq.state.or.us/lq/sw/* Regional offices: *http://www.deq.state.or.us/about/locations.htm*

The Oregon State University Extension Catalog offers many publications on agriculture, livestock, animal waste management, and related topics. *http://extension.oregonstate.edu/catalog*

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