# A Guide to Composting Animal Manure

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## Reasons for composting manure

Managing manure is a reality for animal agriculture. Manure can be stored with minimum effort in a passive system or a managed composting system. Composting manure changes the quality of manure, but composting may involve more management and costs than a passive storage system. The decision to compost can be a solution to other management problems, and the benefits of composting may compensate livestock producers for the additional costs and efforts. Reasons for a livestock producer to consider composting are summarized in Table 1.

**Table 1. Reasons for composting**

| Management problems | Benefits of composting manure |
|---|---|
| Manure has fly, insect, and pathogen problems. | The heat from composting will kill insect eggs, larvae, and pathogens. Flies can't breed in compost. |
| Neighbors complain about smells from the manure storage. | Composting reduces odor. |
| Manure needs to be transported for long distance; or manure is too heavy and wet to spread easily. | Composting reduces the volume and density of manure. Finished compost is drier, and thus is easier to transport and spread. |
| Weed seeds in the manure become a problem for raw manure land application. | The heat from composting will kill most weed seeds. |
| Neighbors complain about smells from land applied raw manure. | Land applied compost will have little to no odor. |
| There is not enough cropland to spread all the manure,and there is a local value-added market such as garden centers, landscaping companies, or golf courses. | Compost can be sold or used on other farms. It is generally more "consumer friendly" and preferred by commercial horticulture. |
| There is a need to meet environmental goals or permit requirements for nutrient balance. | Composting can reduce pollution and could be a useful tool in nutrient management plan. |
| The cost of rendering becomes prohibitive. | Composting can assist in carcass disposal. |

In summary, the benefits of composting include less odor, flies, weed seeds, and pathogens in waste, and less amount of waste. In addition, finished compost makes excellent fertilizers and soil amendments, which can improve soil health, fertility, and water-holding capacity.

## Basics of composting

Composting is a decomposition process, where oxygen-consuming microorganisms convert the organic waste to a stable compost under conditions with increased temperature (thermophilic conditions, 110 to 160 °F). Temperature is a result of the activity of the microorganisms in the compost. When microbes feast, they multiply and give off heat, which kills weed seeds and many disease germs in the manure.

While composting occurs naturally, the process requires proper conditions to occur rapidly and minimize odor generation. Properly managed compost provides optimum conditions for the microorganisms. These microorganisms need five things to work properly: carbon (C), nitrogen (N), water, oxygen, and proper temperature. Key variables in composting process that need to be managed are summarized in Table 2.

**Table 2. Key variables in composting process**

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| Carbon to nitrogen (C:N) ratio | • Carbon and nitrogen sources need to be balanced. The best composting occurs when C:N ratio is at 30:1, with a range of 20:1 to 40:1. Too much N (C:N ratio<20:1) can result in loss of N as ammonia. Too much C (C:N ratio>40:1) can immobilize N and slow the composting process.<br>• For most species, manure that contains a lot of bedding usually has a C:N ratio within range to compost. Raw manure with lower C:N ratio will require additional carbon material such as straw, leaves, or sawdust to properly compost. |
| Water | • Microorganisms need water. But too much water will result in low oxygen levels. The best composting occurs with a moisture level at about 50 percent, with a range of 40 to 60 percent.<br>• Moisture can be estimated from a simple "squeeze test". Squeeze the compost in a fist. It should be wet enough to stick together like a ball, but not too wet for water to drip out.<br>• To achieve the optimum moisture level, water may be added by spraying it on the pile periodically. |
| Oxygen | • Aerobic microorganisms need oxygen. The best composting occurs when oxygen content is in the range of 5 to 20 percent. Lower oxygen content will slow the composting process, and the anaerobic condition will generate odor.<br>• A decrease in compost pile temperature after the start of the process is often a sign that there is an inadequate level of oxygen.<br>• Turning compost is commonly used to incorporate oxygen into the system as well as to mix the ingredients. |
| Temperature | • Temperature is an important indicator that composting occurs optimally or has stopped. Temperatures lower than 80 °F indicate that the microorganisms are not thriving. Temperatures higher than 160 °F can destroy beneficial microorganisms and slow the process. The critical temperatures are 131°F for killing human pathogens, and 145°F for destroying most weed seeds.<br>• Monitoring temperature can indicate when to turn the compost. When temperatures drop below 110 °F, it is time to turn the compost to add oxygen.<br>• Ways of cooling over-heated piles include digging holes in the pile, turning or making the piles smaller, or adding carbon material. |

Composting is usually well suited for dry manure, or separated solids from liquid manure. Manure that contains a lot of bedding material (from beef feedlot, horses, goats, as well as poultry litter) will generally compost easily. Wetter or more concentrated manure (from pigs or egg laying hens) will need to have material mixed with it in order to compost properly. The composting pile usually needs to be turned three to six times (turning every one or two weeks) for aeration and homogenization over two to three months with a further two to three months of curing. More turning will improve the quality of the compost. The finished compost will be dark brown and crumbly and smell like good earth.

### Composting structures

For medium-to-large scale composting, manure is commonly composted in piles or windrows. A pile 4 to 6 feet high usually have a base width of 10 to 12 feet. A windrow is essentially a long pile with a trapezoidal cross section, and is probably the most popular composting method. Windrows can be arranged in long parallel rows. The windrow dimensions are usually determined by the length of the pad and size of the turning equipment.

For smaller scale composting, using bunkers or bins may be feasible. A bunker or large bin will minimize the area needed to compost. A bunker with slatted walls will help provide the natural airflow between turnings.

**Composting turning or aeration**

Turning manure is essential for composting. Turning promotes composting by incorporating oxygen into the system, mixing composting materials and allowing more contact of manure with microorganisms. Turning frequency is depending on both temperature and moisture content in the pile. Turning may be needed when the pile temperature is either too low (<110 °F) or too high (>160 °F). And generally, the higher moisture level in the pile, the more turning will be required, since high moisture results in low oxygen levels. The turning process should break up big lumps and move material on the outside into the inside of the piles. Turning will generate heat in an active composting pile. After multiple times of turning, the piles will eventually stop heating up, indicating the active phase is over and the curing phase has begun. No turning is needed during the curing phase. The compost usually cures for the same amount of time it was active.

For most farm composting operations, a front-end loader is commonly used to build, move and turn the pile. With a front-end loader or bucket tractor, turning and aeration can be done by moving the pile back and forth in place or slightly off to the side. For larger operations, a compost windrow turner may be needed. Turners may be self-propelled or attached to a tractor or skid steer. Turners range in various sizes from 6 feet wide to as much as 20 feet wide. Some turners have water tanks plumbed into nozzles that add water while turning.

Other methods of aeration include passively aerated windrows, forced aeration static piles, and rotary drums. Passively aerated windrow systems can be established by adding peat moss, wood chips or other material to increase porosity. Forced aeration static piles can be established by locating compost materials on perforated pipes connected to aeration fans.

**Composting site selection**

Preventing contamination of surface and ground water due to runoff or leachate is an important factor for composting site selection. Composting can be done outdoors or under a roof. The roof prevents rainwater from reaching the compost and prevents runoff. Compost piles can also be surrounded by round bales and covered with a tarp or plastic. Covering the pile will not only reduce runoff but also help manure decompose faster. A concrete floor is optional, and will make emptying and turning the piles much easier. For outdoor composting, the composting area should be situated on relative high ground with a slight slope for drainage. Generally, composting can be done on the existing soil, but the surface should be hard and dry enough for a tractor to work around the pile in all weather. Windrows should be constructed parallel to the slope for better draining and implement access. Runoff or leachate from the composting area should not reach wells, streams, lakes, wetlands or shallow groundwater. An ideal composting area has slopes of 2 to 4 percent and has a surface of concrete, packed soil, or gravel that drains into a containment pond. A grass area at the lower end of the composting area can serve as a vegetative buffer to absorb runoff in some designs to limit runoff effect.

**Economics of composting**

Livestock producers may consider composting for various reasons or benefits. Nevertheless, comparing costs to expected benefits and alternate manure management options is important. The costs associated with composting are summarized:

- Costs for preparing the composting site (concrete pad, area stabilized with lime, shed, bins, or hay bale enclosure).
- Labor, equipment (tractor with loader or a compost turner) and fuel expenses for building and turning piles (a specialized compost turner can cost $20,000 to $60,000).

- Costs for monitoring the temperature and moisture levels in the pile (a compost thermometer with a long probe can be purchased for $75 to $100 through natural resource and agricultural supply companies).
- Costs for watering or additional aeration systems.
- In cold weather, pile may need to be insulated with an extra layer of material such as straw.
- Costs for delivering the compost to the end users (compost can be sold in bulk, or in 25 to 40 pound bags if a local garden market is present).

Although there are costs (fuel, labor, time) involved in turning the pile, more turning would cause more rapid stabilization of the manure and would likely result in more volume reduction, and therefore may reduce hauling costs. The final number of turns and additional processing may be determined by the end-use market. Home and garden markets prefer a finished product with a consistent quality that generally require more than six turnings, and free of trash and herbicides. A laboratory analysis and screening process may be required. Compost applications such as for construction site erosion control and land remediation may have less quality requirements.

**References**

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**Purpose of the factsheet**

The purpose of the factsheet is to provide guidance to livestock producers about management options of manure composting.