Example Composting Methods[0]

Note: *The procedures below are "general" composting procedures. Producers are advised to determine if there are any municipal guidelines for composting.*

1. What is Composting?

Composting is the aerobic (i.e., requiring oxygen) decomposition of manure and other organic materials. The temperature range in which this process occurs is 104-149ºF. The decomposition process is carried out by microorganisms that are already found in the manure. When environmental conditions are appropriate, the microbes grow and multiply by decomposing the organic materials found in the manure. The composting process is most efficient when it is managed and conducted in controlled environmental conditions. Properly composted manure is odorless, fine-textured and has a low moisture level. Composting enhances soil tilth and reduces environmental risk. It also helps to reduce the volume and weight of manure and destroys pathogens and weed seeds.

2. Factors Affecting Composting

a) Ratio of Carbon to Nitrogen (C:N)

Livestock manures compost rapidly under the conditions outlined in Table 1 (below). Nutrient balance is primarily determined by the ratio of carbon to nitrogen. If nitrogen is in excess, high levels of ammonia will be released into the atmosphere. However, when carbon is in excess, the composting rate will slow down. The carbon:nitrogen ratio (C:N) will vary based on the type of manure and bulking agent used. It is important to determine the amount of carbon and nitrogen in manure and bulking agent samples through laboratory analysis.

b) Moisture Level

The recommended moisture content is approximately 60%. It is important to note that the correct moisture level may be more difficult to maintain during the high-temperature phase of composting in open-air windrows and is affected by wet and dry climatic conditions. When the moisture level is too high, the windrows subside, lose porosity and become anaerobic. Once this occurs, the compost pile will begin to ferment and emit odours. If the moisture level is below 50%, the rate of decomposition decreases and nutrients are no longer available to the microorganisms. It is important to note that chicken manure, broiler litter and turkey manure often require the addition of water to reach the appropriate moisture level. Additionally, water may need to be added throughout the composting process in order to maintain the appropriate moisture level. Moisture levels may be easily determined through the hand (or squeeze) test. If the compost is too wet, water can be squeezed out of a handful of compost. If it is too dry, the material will not feel moist to the touch. Moisture probes are also available and can be used to monitor moisture levels.

c) Temperature

As the microorganisms decompose the organic matter in the manure, heat is generated and the temperature of the compost rises. The amount of heat released is directly proportional to the amount of microbial activity in the compost. Consequently, temperature is a good process indicator. The temperature pattern of composting manure typically follows a rapid increase to 49-60ºC (120-140ºF), which is maintained for several weeks. Once active composting slows down, there is a gradual

0 Canadian Horticultural Council, **Appendices to On-Farm Food Safety Manual**, Appendix C, pgs. 13-16, Version 4.1, 2010.

decrease in temperature to 38ºC (100ºF), and then a final leveling-off to ambient air temperature. Temperature probes can be purchased and need to be long enough to penetrate one-third of the way towards the center of the pile. Turn the compost if the temperature drops below 30ºC (indicating too little microbial activity) or if it rises above 60ºC (which may lead to the death of the composting bacteria and a subsequent halt in the composting process). Most pathogens and weed seeds will be destroyed if the temperature of the compost pile is sustained at 55ºC for a period of fourteen days.

d) Aeration

Aeration is also an important factor. Proper aeration removes heat, water vapour and gases trapped within the composting materials. The greatest need for oxygen is in the early stages of the composting process and decreases as the compost reaches maturity. If there is insufficient oxygen present, the compost becomes anaerobic and the process becomes slower, less efficient and results in the generation of little heat (i.e., the temperature of the compost pile does not increase at a proper rate). If there is improper aeration, odorous compounds may be generated during the composting process.

3. Bulking Agents

Because the carbon:nitrogen (C:N) ratio and nutrient content of manure varies depending on species, diet fed to the animals and manure handling system, bulking agents are used to increase carbon levels and porosity. Examples of bulking agents include corn stalks, straw, bark chips, newsprint, sawdust, wood chips and leaves. The choice of bulking agent depends on the nutrient content (chemical composition) of the manure being used. As a result, it is necessary to determine (through a laboratory analysis) what the chemical composition (amount of nitrogen and carbon, carbon:nitrogen ratio and moisture level) of the manure and bulking agent to be used is. If the C:N ratio needs to be adjusted, a recipe or formula can be calculated using various composting manuals or on-line calculators. In order to use these formulas, it is necessary to know the type and chemical composition of the manure being used, and the type and chemical composition of the bulking agent being used, in addition to the moisture level of these materials. Once this information has been obtained, it is used to calculate the amount of manure and bulking agent needed to make compost.

Table 1. Ideal Conditions for the Rapid Composting of Livestock Manure

Condition	Reasonable Range
Carbon:Nitrogen Ratio (C:N)	20:1-40:1
Moisture Level	40-65%
Oxygen Concentration	5%
Particle Size (diameter) of Material to be Composted	1/8-1/2 inch
pH	5.5-9.0
Temperature	110-150ºF

4. Curing

Composting is usually cured outdoors in windrows. Compost piles are ready for curing when there is no longer an increase in temperature within the pile. Curing takes one to two months. Do not disturb piles during this period. Once the curing process is complete, the compost may be screened to remove any non-degradable compounds and then analyzed to determine its nutrient value.

5. Different Composting Systems

a) Open/Turned Windrow Composting

This form of composting uses a mechanized turner and involves the placement of manure in long rows on an all-weather surface. Rows are typically three to six feet and two to six to sixteen feet at the base. Piles are turned periodically to mix the composting material, ensure that all material is composted evenly, and to introduce oxygen and rebuild bed porosity. Mixing can be done with either regular farming or specialized equipment. The recommended turning frequency is as follows:

Week 1 – 3 turnings
Week 2 – 2 to 3 turnings
Week 3 – 2 turnings
Weeks 4 and 5 – 1 turning per week
Week 6 and beyond – 1 turning per every 2 weeks **if heating still occurs**

This method usually takes one to two months. Once the composting process has finished and the temperature of the pile remains constant and at ambient temperature even after turning, the compost must then cure, which takes one to three months.

b) Passive Windrow/Pile Composting

This is the production of compost in piles or windrows. Rows are typically the same size as those used in the open/turned windrow composting method. Passive composting uses natural aeration over long periods of time (six months to two years). It is not necessary to turn the material, but it is recommended to occasionally turn the piles/windrows to allow moisture to be redistributed and expose fresh material to microbial activity.

c) Aerated Static Windrow/Pile Composting

Compost produced using this method involves mechanical aeration. Windrows or piles are located above air ducts, perforated pipes, aeration cones or perforated floors and aeration is achieved by blowing or drawing air (forced air) through the composting material. As there is no mechanical turning used in this method, it is not necessary to turn windrows/piles; however, it is occasionally recommended to improve the efficiency of the composting process. The optimum size of the compost pile is determined by the materials being composted, air flow capabilities and the type of handling equipment. Additionally, the timing, duration and uniform movement of the air are critical. Air flow requirements are dependent on the materials being composted, the size of the pile and the age of the compost.

d) In-Vessel Systems

Includes turned bins, rectangular agitated beds, silos and rotating drums. These systems confine the composting material within a container or building and use aeration (forced air) and mechanical turning to increase the rate of the composting process. The composting process takes seven to thirty days. One to two months are required for curing. In-vessel composting is costly when compared to other composting methods.

6. Factors to Consider When Selecting Compost and Curing Sites

In order to make the compost process as efficient as possible, consider the following:

• Amount of space required (determined by composting and curing method used; windrows require the most amount of land, followed by aerated windrows/static piles and in-vessel systems)
• Pile dimensions
• Proximity to manure source
• Wind direction and proximity to neighbors
• Topography (i.e., slopes, depressions, potential for run-off, etc.)
• Soil type
• Compost storage space

7. Pollution Prevention

To reduce the likelihood of compost polluting the environment and being a potential source of contamination to horticulture crops, it is highly recommended that:

• the compost site is located a minimum of 300 feet from a watercourse, well, pond, etc.,
• windrows are NOT located on coarse-textured soils,
• all clean SURFACE water is diverted away from the composting site,
• in areas where there is high rainfall, covering compost windrows/piles is recommended to prevent runoff and leaching (e.g., plastic covers are now available that can be used to cover open-air windrows, which protect them from climatic conditions but allow gas exchange),
• space is allowed for runoff structures and runoff containment structures.

8. Compost Tea Information

Note: *Producers are advised to determine if there are any provincial/municipal guidelines for composting.*

What Are Compost Teas?

Compost teas are liquid solutions made by steeping compost (produced properly by a managed process that includes a thermophilic phase) in water. It can be used both as a fertilizer and a spray to control plant disease.

Please refer to the following websites for further information on production and application of compost teas:

National Organic Standards Board, Compost Tea Task Force Report, April 6th, 2004.
http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5058470.

The Rodale Institute, Compost Tea Production, Application and Benefits, 2003.
http://fpath.cas.psu.edu/RESEARCH/CompostTeaFS.pdf

References:

Buckley, K., Penn, G. Producing Quality Compost from Livestock Manure. Agriculture and Agri-Food Canada. Brandon Research Centre. 2003-09-12 [Summary of the article retrieved December 31, 2007]. Summary available at http://www.prairieswine.com/database/all_details.php?id=789

Agriculture, Fisheries and Aquaculture: 4. Manure Storage. Prince Edward Island Department of Agriculture and Forestry and Prince Edward Island Department of Technology and Environment. 1999-01-07 [retrieved December 31, 2007]. http://www.gov.pe.ca/af/agweb/index.php3?number=70799

Government of Saskatchewan. Composting Solid Manure. May 2006 [retrieved December 31, 2007]. http://www.agriculture.gov.sk.ca/Composting_Solid_Manure

British Columbia Ministry of Agriculture, Food and Fisheries. Composting Methods. September 1996 [retrieved December 31, 2007]. http://www.al.gov.bc.ca/resmgmt/publist/300Series/382500-5.pdf