

Compost — the organic farmer's gold!

Extracted from COG's Organic Field Crop Handbook

COMPOSTING IS THE CONTROLLED DECOMPOSITION of organic matter by microorganisms, in the presence of oxygen. The organic matter can be manure, crop residue, or other organic material.

The organic matter is decomposed by the successive action of bacteria, fungi and actinomycetes. Microbial activity causes the temperature of the composting material to rise to 55°–60°C (130°–140°F) where it remains for several weeks.

Redworms (manure worms) are active in the final stages of decomposition, helping to transform the compost into humus.

Young compost is high in active organic matter and available nutrients, but low in stable humus. Mature compost has a higher proportion of stable humus, and is considerably reduced in bulk.

Compost at various stages, from young to fully-aged, may be used according to the needs of the soil and the crop. However, immature compost is similar to raw manure in terms of nutrient availability and the same guidelines should be followed to avoid water pollution and health risks.

Both contain a higher proportion of soluble nutrients than composted manure.

The nutrient content and other benefits of the compost depend on:

- the source materials,
- the conditions under which the compost was made, and
- the maturity of the compost when it is applied. Immature compost stimulates biological activity in the soil in the short-term, whereas mature compost contributes more to soil organic matter levels and soil structure. Applications of compost contribute more to long-term fertility than applications of raw manure.

During the composting process, the organic matter changes, from active organic matter containing highly soluble nutrients to the more stable nutrient states.

Four to five years after the manure or compost is applied, the material has transformed into humus. Fully composted manure adds more humus to the soil than raw or partially composted manure.

As described earlier, humus increases the soil fertility and improves soil structure. In the long-term, composted manure actually provides more humus than raw manure, with a reduced volume.

General methods

Making good compost depends on having the proper sources of nutrients with a balance of carbon and nitrogen, keeping the pile of compost moist and making sure that there is adequate aeration.

The compost pile can heat up to 60°-70°C (140°-158°F) due to the heat generated by microbial activity. However, high temperatures will result in substantial losses of nitrogen in the form of ammonia gas.

The Canadian Standards for Organic Agriculture's definition of compost stipulates that the compost must be held at temperatures greater than 55°C (130°F).

The most commonly used materials for the compost pile are manure mixed with livestock bedding.

To achieve the balance of carbon to nitrogen (25-35:1) needed to begin the composting process, mix bedding (which is predominantly carbon) with the raw manure (which is an excellent source of nitrogen).

Bedding materials vary in their carbon-to-nitrogen (C:N) ratio from about 80:1 in straw to 200:1 or more in sawdust or shavings. Bedding with a high content of wasted hay, typical for sheep pens, has a lower C:N ratio.

If the bedding-to-manure ratio is high, and the manure is very dry as with horse operations, it might be beneficial to water the material with a high nitrogen slurry. In practice, however, this is difficult to do.

Provided that it contains no hazardous substances and the correct C:N and moisture balance can be maintained, virtually any organic material can be composted.

However, organic certification bodies may not accept the use of certain off-farm sources of material, particularly if there are concerns about heavy metals, pesticides, pathogens or antibiotic residues in the material.

Possible materials for composting include sawdust, nursery wastes, fruit and vegetable residue from processing plants, feathers, grass and lawn clippings, vegetable market wastes, garden wastes, leaves, wood shavings, fish wastes and seaweed.

Municipal sewage sludge is not permitted according to the Canadian Organic Standard (CGSB, 1999:6.4.2.3).

Carbon:Nitrogen ratio (C:N) of compost materials

Dairy manure	20:1
Sheep manure	14:1
Poultry manure	10:1
Humus	10:1
Vegetable wastes	12:1
Seaweed	19:1
Straw	80:1
Corn stalks	60:1
Leaves	45:1
Alfalfa	13:1
Legume/grass hay	25:1
Grass hay	80:1
Rotted sawdust	200:1
Fresh sawdust	500:1
Newspaper	800:1

Approaches

There are several approaches to on-farm composting, including:

- Passive (open pile) composting,
- Aerated passive composting,
- Contained, in-vessel composting, and
- Windrow composting.

We will discuss these four systems, with emphasis on windrow composting. All four systems are described in detail in the On-Farm Composting Handbook (Rynk, 1992) and the Field Guide to On-Farm Composting (Dougherty, 1999).

Passive composting

Passive composting is a simple system appropriate for small farms. It consists simply of making piles of materials with an appropriate C:N ratio and moisture content, and letting the pile sit and heat.

This method requires little labour or equipment, and nutrient loss is minimal. However, the process is slow and fly problems can arise.

The success of this method relies on the initial mix of materials. It is essential to have an appropriate mix of materials with the ideal carbon-to-nitrogen ratio, moisture level and porosity.

To allow air to circulate through the pile, the pile must be small, less than 2 metres (6 ft) high and 3.5 m (12 ft) wide. Although not required, occasional turning will speed up the process. Passive composting of manure and bedding usually takes one year.

Aerated passive composting

Aerated passive piles are windrows that are not turned. Air circulates through the piles through perforated pipes. Compared to windrow composting, this approach requires a greater initial setup time but less labour afterwards.

As with other passive systems, it is essential to have a proper mix of materials in terms of C:N, moisture and porosity. The process is fairly rapid, with an average of 10-12 weeks required to compost manure and bedding, followed by a curing period of 1-2 months.

A windrow is constructed with open-ended perforated pipes (10 cm diameter with 1 cm wide holes). The pipes are laid in a bed of peat moss, wood chips or chopped straw at the base of the pile. The windrows can be 1.2 m (4 ft) high, 3 m (10 ft) wide and as long as desired.

The pipes are laid across the windrow, one pipe every foot, for the entire length. Or, an aerated static pile can be constructed with one pipe running the length of the windrow (less

than 21 metres), with a blower attached to the pipe. For more details, refer to the On-Farm Composting Handbook (Rynk, 1992).

In-vessel composting

With in-vessel composting, composting takes place inside a building or a container with forced aeration and mechanical turning. These systems have high capital costs and require skilled labour to maintain. There are however, many advantages to in-vessel composting.

Compared to other methods, in-vessel composting is faster, requires less labour and is less likely to have problems with flies or odours.

In-vessel systems can produce compost in just a few weeks, although the curing time is usually another two months. For more details on types of in-vessel systems, see The Biocycle Guide to In-Vessel Composting.

Windrow composting

Windrow composting is the most common form of on-farm composting. The compost materials are mixed or layered, and spread in a windrow (a long, narrow, flat row).

The windrow is turned periodically to aerate the pile and maintain the desired temperature. With frequent turning, manure and bedding can be composted within a few months, followed by a curing period of 1-2 months.

Building a windrow

The site chosen for building the compost piles or windrows should not be near water bodies or in areas with high water tables. Ideally, there should be a way to retain the liquids that will leach out of the pile and seep into the soil if the pile becomes too wet during heavy rainfall.

This can be done if the site is on a slight slope (1-3%), with a receptor pit to catch the runoff. Otherwise, use level land and do not use the same place each year. Heavy clay soil is ideal, because it prevents leachate (liquid that leaches from the compost) from reaching the water table.

A front end loader is usually used to remove the solid manure from storage and to load the manure spreader. The manure spreader should be a 'power-take-off' type so that it can discharge its load while parked.

The tractor pulls the spreader, parks and unloads the manure through the beaters, which shred the manure and add air as the pile is being built. The spreader is then pulled ahead about 1 metre (3 feet) and the procedure is repeated. This method is used to form the windrow and for the turning of the pile.

Windrows created from cattle manure should be made about 1.25 metres (4 feet) high and 2-2.5 metres (6-8 feet) wide.

Horse manure can overheat, so plenty of straw should be added and windrows should only be 0.5 metre (1.5 feet) high for efficient cooling. However, because of the large surface area, shallow windrows can dry out quickly in drought conditions or suffer from leaching in heavy rainfall. It is more practical to add layers of horse manure every few days.

Hog manure is very dense and large quantities of straw need to be added to facilitate air circulation.

Any liquid manure that seeps out of the windrow should be pumped back onto the drier materials and allowed to percolate through.

Manure from loose-housing bedding may overheat, due to the large straw to manure ratio. Limiting the amount of air in the pile prevents this and can be accomplished by using a dump trailer to create windrows instead of a manure spreader. Air can also be expelled by tramping down on the pile.

To reduce loss of nitrogen to the air, cover windrows with a 5 cm (2 in) layer of finished compost. A thicker layer of compost 15 cm (6 in) will insulate the pile and allow composting to continue during cold winter weather.

Plastic tarps are sometimes used to cover windrows; they reduce waterlogging but they may cause problems with reduced aeration.

Microbial activity generates heat and the pile can warm to about 60-70°C within one week; then decrease over the next few weeks. The compost should be kept at a temperature above 55°C for a period of at least 15 days.

The optimal temperature for composting reflects a compromise between minimizing nutrient loss and maximizing the destruction of pathogens, weed seeds and fly larvae.

At temperatures above 50°C, nitrogen is converted to ammonia and lost to the air. Overheating stops microbial action and causes excessive nutrient loss, so temperatures above 60°C should be avoided.

However, to destroy pathogens, temperatures should be held at 55°C for at least fifteen days. To destroy weed seeds, the temperature should reach 63°C.

The temperature in the pile can be monitored with a temperature probe 0.5-1 metre (2-3 feet) long.

Overheating may indicate deficient moisture levels, too much nitrogen or too large a pile. Adding soil helps to reduce temperature but may reduce air flow.

In cold weather, warmer conditions can be maintained by covering the pile with black plastic. This will also prevent nutrient loss by leaching. Turning is also used to control the temperature.

Turning the pile

Turning the pile is not needed if optimal conditions are met. Turning may be required to aerate the pile and is recommended when the temperature of the pile falls below 50°C or exceeds 60°C.

As well, turning during fly season reduces fly problems. Some people advocate turning the pile to speed the decomposition process and obtain mature compost in about ten weeks. This however, will likely cause high nutrient losses.

The simplest turning method is to use a front-end loader to push the piles over and reform them. However, a manure spreader does a better job of remixing the compost. Commercial-brand compost turners are available, but are not essential.

Moisture and aeration

The moisture content of the pile often determines if turning is necessary. Ideally, the moisture content should be 50%.

If a moisture meter is not available, test by squeezing the material in your hand — if it glistens and small moisture droplets appear, the moisture content is sufficient.

Beginners at composting tend to have piles that are either too dry or too wet.

For dairy, hog and other types of wet manure, a dry bulking agent, such as chopped straw, is added at a rate of 1-2 parts bulking agent to manure. Consider the carbon-to-nitrogen ratio of the bulking agent and aim for the 30:1 ratio.

If the pile is too moist, water replaces the air in the pile, leading to a lack of oxygen in the pile (i.e., anaerobic conditions). Turning the pile adds air, and changes the pile from anaerobic to aerobic.

Sweet-smelling compost indicates ideal, aerobic conditions whereas an unpleasant smell indicates that anaerobic decomposition is taking place.

In wet regions, either build a roof over the pile or cover the pile with straw or black plastic to avoid leaching of potash, nitrates and trace elements. A thin layer of finished compost covering the pile will help reduce nutrient losses to the air.

On the other hand, if the pile is too dry, biological activity will cease. In this case, water will have to be added. This is best done when the compost is being turned.

Curing

The final stage of composting is the curing phase when immature compost is converted into mature compost.

During the curing phase, the microbial community within the compost changes. The resulting mature compost is low in phytotoxins, and contains slowly releasing nutrients.

The mature compost can be used safely on all stages of plant growth, and can even be used in potting mixes. In contrast, immature compost contains more readily available nutrients, but can harm plants, particularly seedlings, by releasing toxins or tying up available oxygen or nitrogen.

The ability of compost to reduce the incidence of plant diseases is due to the bacteria which proliferate during the curing phase.

Compost is ready for curing when it no longer reheats after being turned.

To see if the compost is ready, moisten a sample of compost and store it in a sealed plastic bag at room temperature. One week later, open the bag and smell the compost. If there is a foul odour, the compost will need to be turned again and is not yet ready for curing. The compost is ready for curing if there is no odour after one week.

To cure the compost, turn the pile. If the compost is dry, add additional moisture. The compost can be stacked higher than an actively-composting pile.

The pile can be covered with fleece or a breathable cover. The pile is then left to sit, for several weeks or months. A minimum of one month of curing is recommended.

This article was extracted from Chapter 10 of COG's Organic Field Crop Handbook.

The chapter also includes **more information** on the advantages of composting; composition of fresh manure; storage of solid manure; application of compost; and liquid manure systems. Plus a **trouble-shooting guide** for on-farm composting systems.

You can order a copy of this **outstanding resource book** at the COG website (www.cog.ca).