

6 Composting methods

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6.1 Introduction

Composting does not fully decompose all degradable organic materials. Because of various conditions, composting depends on the purpose, scale of production, materials, site, and climate. But whether it is for a small farm or a commercial plant, the first consideration in composting is processing the farmyard manure and crop wastes into a safe compost. The composting method should be able to inactivate the weed seeds and animal and plant pathogens. Accordingly, maintaining a ceiling temperature is very important during the process. The starting materials consist of readily degradable, slowly degradable, and resistant components in suitable proportions. For on-farm scale, the procedures designed and the investment required to process composting should be as simple as possible, especially for remote areas.

6.2 Site selection and preparation

In choosing a place for composting wastes on-farm or off-farm, the first thing to consider is a downwind place where there is no flooding during the rainy season and no potential to pollute surface water and groundwater. A shelter is necessary in an area with high rainfall. A windbreak of slates or trees is also needed to counter strong winds and snow drifts. A concrete floor or at least a hardened soil surface is needed to make it easily workable manually or by machines, and to prevent wastewater from leaching into groundwater.

6.3 Pretreatment

Before composting, the raw materials, depending on their type, are stored and pretreated as follows:

- Straw and husk of grains/cereals (e.g., rice and wheat), corn stalk, bagasse, sawdust, and other materials (e.g., tree trunks and branches) with a high C:N ratio used as main component for soil organic matter additives should be dried and stored in a nearby place.

- Residues of leguminous plants and green manure are also dried before being stored for composting and kept away from the rain. These materials have high C and N contents, so they can be used as animal feed. The animal manure can be used as a composting material.
- Manure from an animal feeding farm should not be exposed to the rain and its water content must remain low before composting to avoid N loss and sanitation problem. Wet manure from the farm should be put directly into the composting process; otherwise, it must be kept covered with 10-cm layer of mature compost, rice husk, straw, or sawdust as biofilter to prevent the release of odorous gases.

6.4 Ingredient calculation

Almost all organic wastes, except those containing high toxins, can be used as composting materials. There are no set ingredients for making compost, but the most important principle is that the ingredients are decided based on what purpose the compost produced is for. The easiest way is to calculate the C:N ratio of the mixed materials, as follows:

- To increase the soil organic matter or make a growth media, materials with high C:N ratio will be the main ingredient. The materials should have high contents of cellulose and lignin, especially the latter compound. The starting C:N ratio of the mixed materials should be kept at around 40-50. Under this formula, the materials have to be composted for about 10-15 weeks. The final C:N ratio of about 30 is good enough for application into soil and as growth media. The product is also a good base fertilizer for fruit trees and root crops, but chemical fertilizers or other organic fertilizers with high N content are also needed as supplemental fertilizers.
- To grow leafy vegetables, the starting C:N ratio of the mixed materials should be around 25-30. Under this formula, the materials have to be

composted for about 6-10 weeks. The produced compost is ideal for organic farming of short-term vegetables. It is also a good base fertilizer for vegetables and fruit trees.

- To serve as supplemental fertilizer for vegetables (including leaf, fruit, stem, and root crops) and fruit trees, the starting C:N ratio of the mixed materials should be around 20-25. Under this formula, the materials have to be composted for about 4-6 weeks. The height of piles for this formula should be lower than the general suggestion.

Calculating the amount of ingredients is the most important step in the whole composting process. Rather than buying materials outside of the farm, composting wastes available on-farm is the better alternative to develop the required composted mixture of materials. Besides, because they are bulky, the transport cost is quite high for most organic materials.

6.5 Size reduction

To shorten the compost time, some raw materials should be chopped or ground into chips to reduce their sizes. The straws and green manure should be cut into lengths of 5-10 cm. The wood and shoots of fruit trees and vines should be cut with shredders, grinders, or chippers.

6.6 Composting systems

Different composting systems are widely used. Among these are static piles, turned windrows, forced-aeration static piles, in-vessel, and close-housing systems. Some systems require high investments in housing and equipment, but to save on costs for small farms, a simpler design is best. Static piles and windrow systems are the first two choices, while the forced-aeration static piles can be used either throughout the process or only for the first two weeks of composting raw materials with low C:N ratio.

6.6.1 Static piles

The least equipment is required in managing this system. After the raw materials are wet with suitable water content (60-75% depending on the material used), they are mixed thoroughly then piled up as a round type (Fig. 1), the bottom part measuring about 2.5-3.5 m in diameter and 1.5-1.8 m in height. A square-type pile measuring 2.5-3.5 m x 2.5-3.5 m x 1.8-1.8 m is also acceptable. The scale of piles depends on the season: in hot season, a smaller scale is better for diffusing extra heat, while a larger pile is more suitable for the cold season. The pile can also be covered with a plastic sheet or organic material to keep the heat under reasonable levels. Piles are generally turned manually with fork or by machines like a front-end loader or bulldozer equipped with a bucket, rake, or blade. The most effective way of turning these piles is moving them by bucket from its original site to an adjacent area. Turning using a rake can aerate the pile on-site.

6.6.2 Windrow system

For the windrow system, its bottom width is around 2-3 m with a height of 1.5-1.8 m, but its length depends on the scale of the place. A multi-windrow system placed side by side (Fig. 2) is also allowed. The preparation process is the same as that for static piles.

6.7 Turning

Turning composting materials gives the benefit of forcing aeration, homogenizing materials, releasing excess heat, and adjusting water content. Since a high quantity of heat may be released to the media (23 MJ/kg dry weight of volatile solids) during the decomposition of organic matter, the rise in temperature is inevitable. As such, the faster and higher the temperature rises, the lower is the C:N ratio of the materials formulated. To inactivate the

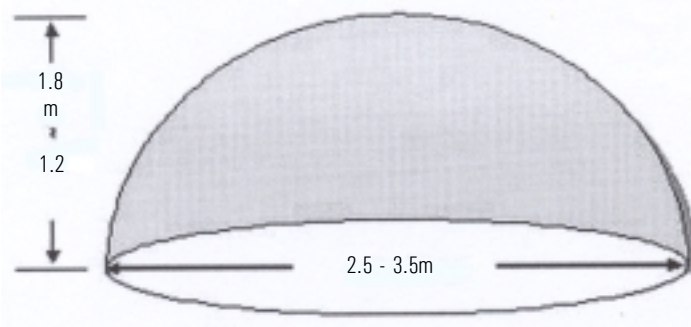


Fig. 1. Wet raw materials piled up as a round type, the bottom part measuring about 2.5-3.5 m in diameter and 1.5-1.8 m in height.

pathogens, the ceiling temperature must be kept at 60°-70°C for the first two weeks. After which, the ceiling temperature can be kept at 45°-55°C for maximum biodegradation. Therefore, at the different stages, especially when the temperature rises higher than the ceiling temperature, the composting materials must be turned over.

Most soil-borne plant viruses are more heat-resistant than other pathogens. Materials infected by the tobacco rattle virus, for instance, require a ceiling temperature of 70°C. Otherwise, a ceiling of 55°-60°C is suggested.

6.8 Terminating the composting process

Much literature has been written on determining the maturity of compost using chemical, physical, and biological methods. The following are key factors that can help determine when to end the composting process:

- The compost no longer has odorous gases.
- The temperature of the composting materials no longer rises after turning.
- The compost is easily crushed by hand.
- The compost is already of dark color.
- The extracts of the compost already allow a high seed germination rate. Taiwan's Pak-choi seeds

are acceptable for the test. When the germination rate is higher than 80% that of the control, then the composting process is ready to be terminated.

6.9 After composting

If the produced compost is not used immediately, it should be kept with water content lower than 35%. This can be done by spreading the compost over a drying surface to avoid continuous decomposition during storage.

6.10 Adding microbial compounds

Microorganisms are present everywhere, and it is organic materials that nourish them. Usually, it is not necessary to add commercial microorganisms in composting materials. For initial materials with a high C:N ratio, adding some readily decomposable components such as rice bran, soybean meal, or young green manure is enough. Sometimes, applying urea stimulates microorganism growth. Adding 1-2% of surface soil or old compost to introduce microorganisms may also be done.



Fig. 2. A multi-windrow system.