Composting
FACTSHEET

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COMPOSTING METHODS

Some basic composting methods which have been developed include those that use bins, passive windrows, turned windrows, aerated static piles and in-vessel channels. The proper approach depends on the time to complete composting, the materials and volume to be decomposed, space available, the availability of resources (labour, finances, etc.) and the quality of finished product required. The Table on page 6 summaries the interplay between these factors.

Bin Composting is the production of compost in a bin. The compost is produced by natural aeration, and through turning. The compost mix is turned using a tractor front-end loader. Bin composting represents a low technology, medium labour approach producing a medium quality product. This option is primarily used for mortality composting.

Passive Windrow Composting is the production of compost in piles or windrows. Compost is produced by natural aeration, over long periods of time. Passive windrow composting represents a low technology and labour approach. Attention to details such as the porosity of the initial mix, uniform product mixing and particle size greatly improves the speed of the process and product quality.

Turned Windrow Composting is the production of compost in windrows using mechanical aeration. The compost mix is aerated by a windrow turner, which can be powered by a farm tractor (PTO), self-powered or self-propelled. Turned windrow composting represents a low technology and medium labour approach and produces a uniform compost.

Aerated Static Pile Composting is the production of compost in piles or windrows with mechanical aeration. The windrow or pile is located above air ducts, and aeration is achieved by blowing or drawing air through the composting material. Aeration systems can be relatively simple, using electrical motors, fans and ducting, or sophisticated, incorporating various sensors and alarms. Aerated static pile composting offers a medium technology and low labour approach, sometimes resulting in a non-uniform product. In some systems, mechanical aeration may occur near the end of the active compost period.

In-Vessel Composting is the production of compost in drums, silos or channels using a high-rate controlled aeration system, designed to provide optimal conditions. Aeration of the material is accomplished by: continuous agitation using aerating machines which operate in concrete bays, and/or fans providing air flow from ducts built into concrete floors. In-vessel composting represents a high technology and low labour approach, producing a uniform product.

BIN COMPOSTING

Bin composting methods are commonly used for yard waste; smaller amounts of manure; and for poultry, or pork mortalities. Turning compost can reduce decomposition time to two months or less.

Wastes in bins must be mixed on a regular basis. Frequent turning speeds up the composting process by providing aerobic bacteria with the oxygen required need to break down materials. A set-up often includes a series of bins, as shown in Figure 1. High temperatures, from 32º to 60ºC (90º to 140ºF), are produced when piles are turned every five to ten days. These actions are necessary to kill disease organisms and fly larvae, to help kill weed seeds, and to provide an environment necessary for the most efficient decomposer organisms.

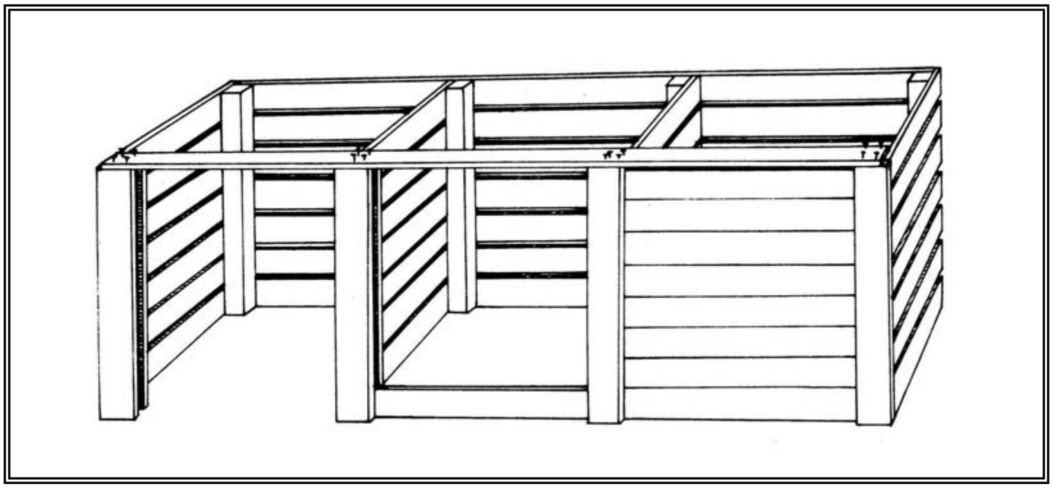


Figure 1 A Wooden Bin Unit, with Three Compartments

Materials to be composted should be added to bins in layers, rather than in small amounts over time. Materials should be stockpiled until enough accumulates to add approximately one cubic metre or yard in a bin.

Operation and management of poultry, and pork mortality compost systems are explained in ***Managing Poultry Mortality Composting Systems***, Factsheet No. 382.500-8, and ***Managing Pork Mortality Composting Systems***, Factsheet No. 382.500-9. A detailed design of a mortality composting bin is shown in ***Mortality Compost Bin Design***, Factsheet No. 382.500-10.

PASSIVE WINDROW

Passive windrow composting is a very low-cost approach requiring more land, but less labour and capital than other composting methods. Generally, material to be composted is collected and promptly piled into windrows which remain untouched. The materials may be wetted before they are initially formed into windrows, but this is not essential.

A windrow is simply an elongated pile of material with a more or less triangular cross-section. As illustrated in Figure 2, a windrow should measure about 3 metres (10 feet) wide and 1.5 metres (5 feet) high; its length will vary depending upon the amount of materials used. Aeration occurs naturally. As hot air rises, fresh air is drawn into the pile. Materials can be added as they become available, or stockpiled until sufficient amounts are available to make a good sized pile or windrow. Two windrows should be used. When the first one is large enough, it should be allowed to decompose undisturbed. Additional waste should then be added to the second windrow. Covering the windrow with a layer of finished compost will help prevent moisture loss, reduce odour problems, and produce a more uniform compost. Composting in these windrows can take from six months to two years.

Large passive windrows can be as wide as 7 metres (24 feet), and as high as 4 metres (12 feet) and of any length. The centre of a windrow this size will quickly become anaerobic and only by turning can it receive a new oxygen supply. An unpleasant odour will develop in the anaerobic region and may begin to emanate from the composting material; hence, a large land area is necessary to buffer residents and businesses from the odour. Since rapid composting can take place only in the presence of oxygen, the compost normally will require three years to stabilize.

With both the small and large windrows used in passive windrow composting, there is no ability for process control. Therefore only medium product quality is produced.

TURNED WINDROW

Aeration of the windrow can be achieved through mechanical turning. Turning can also be done manually, but is considered impractical with volumes larger than one or two cubic metres. Uniform

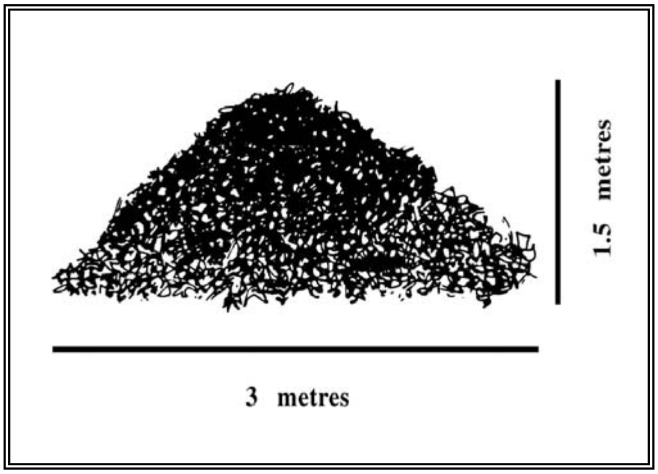


Figure 2 The Width and Height of a Pile

decomposition, as well as pathogen destruction, is best achieved by turning the outer edges into the centre of the pile at each turn. However, if this cannot be accomplished, the frequency of turning can be increased. Turning should also be more frequent than under a regular schedule when the moisture content of the pile is too high so as to minimize the development of anaerobic conditions. In areas that receive heavy rainfall, it may be necessary to cover the windrows so they do not become too wet; however, the cost of this may be prohibitive for certain operations. Alternatively, maintaining a triangular or dome shaped windrow is effective for shedding excess rain or preventing excess accumulation of snow in the winter. In windrow composting, the raw material is mixed and placed in rows, either directly on the ground or on paved or concrete surfaces. During the active compost period, the size of the windrow decreases. Following the active period, windrows at the same level of maturity can be combined into larger rows, making additional space for more raw materials or compost.

The equipment used for turning the windrow, varies from front-end loaders or bulldozers to specially designed turning machines. Loaders, although inexpensive compared to turners, have a tendency to compact the composting material, are comparatively inefficient, and can result in longer composting periods and less consistent quality. Figure 3 shows a pull-type, tractor driven power takeoff, compost turner.

There are two basic types of windrow turners. The most commonly used have a series of heavy tines that are placed along a rotating horizontal drum which, turns, mixes, aerates and reforms the windrow as the machine moves forward. A second type uses a moving, elevator table chain equipped with sharp teeth. These windrow turners are either self-contained units that straddle the row, or are powered by a tractor driven power takeoff.

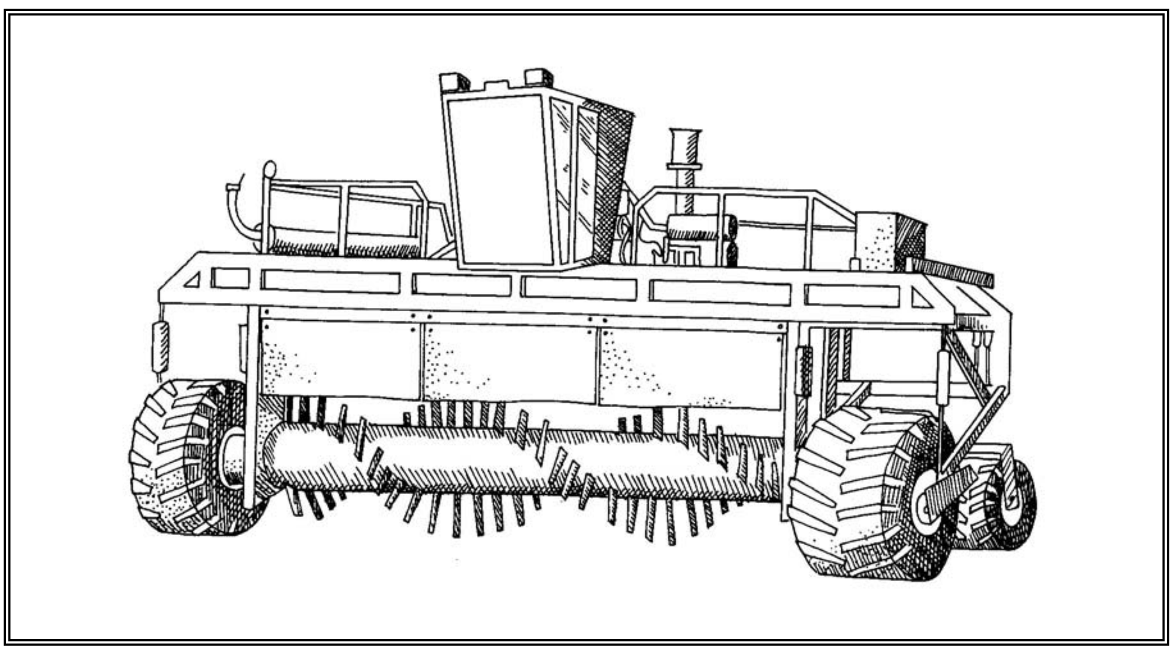


Figure 3 Pull-Type Compost Turner

Windrows should be turned frequently at first and then at longer intervals by the end of the first month. A recommended turning frequency is:

1st Week	3	Turnings
2nd Week	2-3	Turnings
3rd Week	2	Turnings
4th and 5th Week	1	Turning each week
6th and above	1	Turning every 2 weeks if heating still occurs

Temperature measurements inside the windrow should be used to gauge the need for turning to stimulate or control heat production.

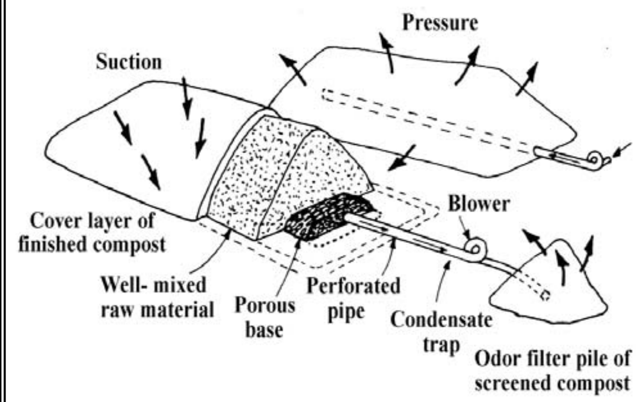
With efficient turning by using a windrow turner, a minimum composting time is one month, followed by at least two months in a curing pile. The compost may be ready to apply to land or be marketed.

Windrow composting can produce excellent compost, using a variety of diverse materials. Wastes such as manure solids, fish waste and poultry mortalities can be composted with bulking agents such as sawdust, straw and recycled paper products. Windrow composting efficiency and product quality are dependent primarily upon two major factors: 1. the initial compost mix, and 2. management practices.

AERATED STATIC PILE

The aerated static pile composting method was developed by the United States Department of Agriculture and can be a very efficient system. During recent years, this method has become popular at the municipal level in composting sewage sludge**,** but **has not yet become popular on the farm**.

The aerated static pile method does **not** mechanically agitate compost material to achieve the desired level of aeration. The pile is constructed above an air source such as, perforated plastic pipes, aeration cones or a perforated floor; and aeration is accomplished either by forcing or drawing air through the compost pile. This system of aeration requires electricity at the site and appropriate ventilation fans, ducts and monitoring equipment. The monitoring equipment determines the timing, duration and direction of air flow. The pile should be placed after the floors are first covered with a layer of bulking agent, such as wood chips or finished



Source: NRAES-54 On-Farm Composting Handbook

Figure 4 An aerated Static Pile with a Bio.Filter

compost. The material to be composted is then added, and a topping layer of finished compost applied to provide insulation. The optimum size of pile is related to the materials composted, air flow capabilities and the type of handling equipment. In some facilities, the initial mix is piled between temporary fencing or movable highway dividers. This allows considerable flexibility with respect to the size and location of the pile within the working area or building. In aerated static pile operations, the timing, duration and uniform movement of air are important. Air flow requirements change depending upon the materials composted, the size of the pile, and age of the compost.

A major difficulty with the static pile system is the efficient diffusion of air through out the entire pile, especially with wastes characterized by a large particle size distribution, high moisture content, or a tendency to clump. Other problems include the formation of channels in the pile which allow forced air to short-circuit. This causes excessive drying due to evaporation of moisture near the channels. These situations may require more frequent turns of piles.

Aerated static piles can produce excellent compost, provided that two basic operating conditions are met:

- The initial material has adequate porosity; and
- The air flow system works properly and provides adequate air flows uniformly during the active compost period to all areas of the pile.

In comparison to windrow composting, aerated static piles require a different level of management and monitoring. Windrow composting is often regarded as a "normal" extension of an existing manure-handling system, since some or all of the existing farm machinery can be used for windrow composting. Aerated static piles require additional equipment and infrastructure investment, and these assets are dedicated solely to the compost operation. In addition, **pre-compost product mixing** is a very important step in aerated static pile systems. In contrast, the mixing and blending is done throughout the active composting stage in windrow composting.

Odour is an operation problem that can affect any type of compost system; however, odour problems are often inherent within a windrowing system. In contrast, if odour problems develop in an aerated static pile system, they can be easily identified and corrective measures taken such as for example, changing air flows; improving air flow capacities; dispersion and filters; and increasing the insulative cover. With negative air pressure delivery, air is drawn through the pile and can be cleaned using a bio-filter before releasing it to the atmosphere; with positive air pressure, air is pushed through the pile and the exterior insulative cover of mature compost cleans the exhaust air. Figure 4 shows an aerated static pile set-up using bio-filters.

IN-VESSEL

In-Vessel compost systems are **high rate controlled aeration systems** which are designed to provide optimal composting conditions involving mechanical mixing of compost under controlled environmental conditions. Although various designs are available, the different systems are similar in that they are both **capital and management intensive**. In-vessel, or enclosed-vessel systems fall under three main categories:

- rotating drum
- horizontal (rectangular/cylindrical) or vertical silos
- channels

The main advantages of the in-vessel system over others (windrows, aerated static piles etc.) are the shortening of the mesophyllic and thermophilic stages, a higher process efficiency, and a decreased number of pathogens, resulting in a safer and more valuable end product. As well, space requirements are generally less than that of other methods. However, it is important to note that all systems require final stabilization of the compost. Disadvantages of the enclosed vessel method include high capital and operational costs due to the use of computerized equipment and skilled labour. In-vessel composters are generally more automated than windrow or static pile systems, and can produce a top quality finished product on a consistent basis. Common reasons for choosing in-vessel composting over other methods include:

- odour control
- space constraints at the site
- process and materials handling control
- better public acceptance due to the aesthetics/appearance of the composting site
- less manpower requirements
- more consistent product quality

Several existing in-vessel systems in British Columbia consist of a series of channels equipped with a turner mounted on wheels that move on tracks placed at the top of the channel. The turner serves as a mixing device. The channel contains a perforated bottom for continuous or intermittent forced aeration. Figure 5 shows a possible four channel in-vessel method of composting with under-floor aeration. Retention time is approximately three weeks before the composting material is cured. Capacities of operations range from a few tonnes to hundreds of tonnes per day.

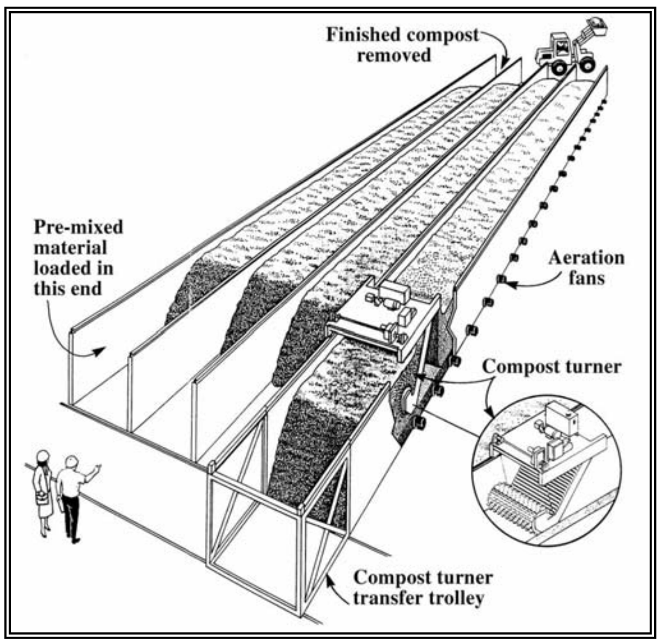


Figure 5 Four Channel In-Vessel Composting

SUMMARY OF THE FOUR MAIN MANURE COMPOSTING METHODS				
	1. Passive Windrow	**2. Turned Windrow**	**3. Aerated Static Pile**	**4. In-Vessel Channel**
General	Low technology Quality problems	Active systems most common on farms	Effective for farm and municipal use	Large-scale systems for commercial applications
Labour	Low labour required	Increases with aeration frequency and poor planning	System design and planning important. Monitoring needed.	Requires consistent level of management/product flow to be cost efficient.
Site	Requires large land areas	Can require large land areas	Less land required given faster rates and effective pile volumes	Very limited land, due to rapid rates and continuous operations
Bulking Agent	Less flexible, Must be porous	Flexible	Less flexible, Must be porous	Flexible
Active Period	Range: 6-24 Months	Range: 21-40 days	Range: 21-40 days	Range: 21-35 days
Curing	Not applicable	30+ days	30+ days	30+ days
Size: Height Width Length	1 - 4 metres 3 - 7 metres Variable	1 - 2.8 metres 3 - 6 metres Variable	3 - 4.5 metres Variable Variable	Dependent on bay design Variable Variable
Aeration System	Natural convection only	Mechanical turning and natural convection	Forced positive/negative air flow through pile	Extensive mechanical turning and aeration
Process Control	Initial mix only	Initial mix Turning	Initial mix. Aeration, temperature and/or time control	Initial mix. Aeration, temperature and/or time control. Turning.
Odour Factors	Odour from the windrow will occur. The larger the windrow the greater the odours.	From surface area of windrow. Turning can create odours during initial weeks.	Odour can occur, but controls can be used, such as pile insulation and filters on air system.	Odour can occur. Often due to equipment failure or system design limitations.

For further information on related topics, please visit our website
Resource Management Branch
www.agf.gov.bc.ca/resmgmt
Linking to our
Publications and Conceptual Plans

This is one of a series of Factsheets on Composting. A list of references used in producing this series is included in the Composting Factsheet "*Suggested Reading and References*."

COMPOSTING FACTSHEET SERIES PREPARED BY
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