Lesson 2

Vermicomposting types and methods

Learning outcomes

- The trainee knows the scale-dependent method types/alternatives in vermicompost production.
- The trainee explains the batch/static system requirements.
- The trainee explains **c**ontinuous-flow system requirements.
- The trainee knows the advantages and disadvantages of batch/static systems and continuous flow systems.
- The trainee analyzes the superiority of the batch/static system and the continuous flow system over each other.
- The trainee customizes the application requirements for the bed/pile method.
- The trainee customizes the application requirements for the pit method.
- The trainee customizes the application requirements for the bin method.
- The trainee analyzes the superiority of the bed, pit, and bin over each other.
- The trainee analyzes application methods in terms of production times.
- The trainee designs the vermicompost production process that is suitable for physical conditions, climatic properties and cost.

Instructions for the trainer

- The trainer conveys technical information about vermicompost production types and methods to the trainees with a teaching approach through presentation (narrative technique).
- The trainer explains the types of vermicompost, namely batch system and continuous flow system, using appropriate visuals.
- Trainer explains vermicompost production methods, namely pile, pit and bin methods, using appropriate visuals.

Basic requirements: Computer, projector

2. Vermicomposting types and methods

2.1. Vermicomposting Types

The type of system to be used in vermicompost production is classified under two main headings depending on whether the production is large or small scale, production of worms for vermicompost sale, manure harvesting time, availability of materials to be used as susbtrate, labor force and needs and environmental conditions. These are batch-static systems and continuous-flow systems (Table 1).

2.1.1. Batch-Static Systems

The batch system follows an application procedure where everything (worms, food and fertilizer) is added to the container/pile at once. The system is covered and left alone for 30 days. At the end of these days you can harvest the worms, liquid fertilizer (if waterproof) and vermicompost. The system provides low material investment costs, space optimization as batches can be stored vertically if made in boxes. The batch system can be disadvantageous as it is labor-intensive. All batches need to be changed every month, including the collection of worms from the system into another batch. The system is usually used to obtain liquid fertilizer in a waterproof box (IBC container) and to multiply the worms. However, some vermicompost can also be produced [11].

2.1.2. Continuous-Flow System

The continuous-flow systems are one of the systems used in the processing of biomass waste to produce vermicompost. The continuous-flow systems are characterized by dynamic operating conditions. It results in a simultaneous in-flow of fresh waste into the reactor and an out-flow of processed waste and vermicompost from the reactor. The system can be designed with metal or plastic material. It is of two main types: reactors with continuous substrate feed and reactors with continuous worm and substrate feed.

In the Continuous-Flow system, food is constantly added to the heap and the worms are always active and moving towards the new food added. This can be open air heaps or open raised beds built on stilts, which both supply air from the top and are called bottoms as harvesting takes place from the bottom. The raw material is added from the "grid" on top after two months. Continuous process, can be harvested continuously. Investment costs are generally higher than for other systems. Also, since feeding and harvesting are continuous, more inputs (feed) and labour are required.

Table 1. **The general summary of batch vermicomposting, continuous substrate and/or earthworms feed reactors and composite frame systems for continuous substrate feeding [11].**

	Windrow vermicomposting or traditional vermicomposting	Vermicomposting with continuous substrate and earthworms addition	Composite frame structured system for continuous substrate feed
Advantages	It treats large quantity of waste	It also treat large quantity of waste	It treat large quantity of waste but in a consistent small quantities
	–	It require small area of land when composted in a container	It require very small area of land for its operation
	–	–	Its substrate treatment duration is short
	–	May not be affected by cold if carried out in a wooden container	Cold weather does not affect the system since it could be installed in door
	It has low capital requirement	Low capital is required	The cost of installation is relatively low
	–	–	Vermicompost is easily harvested since the worms migrate out of the mature vermicompost into the freshly added substrate in the upper compartment
	–	–	Operating conditions could easily be maintained via mechanical aeration, watering to maintain humidity and regulate the temperature
Disadvantages	It require large area of land	It may require large area of land if using the windrow method	–

	Its operation is labour intensive	Its operation is equally labour intensive	–
	Waste processing is slow	Waste processing is relatively slow but faster than windrow vermicomposting without regular earthworms addition	–
	Environmental conditions like cold slow down the treatment process and accelerate the time	Cold weather also affect the efficiency of the process if the vermireactor is material other than wooden container	–
	There is tendency to loose nutrients through leaching	Nutrients loss is inevitable	–
	Vermicompost harvesting is difficult since it requires earthworms separation	Earthworms separation makes this process tedious	–
	It could develop anaerobiosis if covered with plastic sheets	–	–
	Maintaining a constant operating condition is difficult	Here it is difficult to also maintain a uniform operating condition	–

2.2. Vermicomposting Methods

Vermicomposting can be done in several ways (drum system, vegetable handle system, tree base), but bed, pit, and bin operations are the most popular, of which three are the main methods.

The first of these is the bed method. In this method, organic matter is arranged in the form of a bed. The second method is the pit method. As the name suggests, pits made of cement are made to collect organic matter. This method is less common since organic matter cannot get enough air and water can also accumulate [12]. The most common method for small scale composting is the bin composting method. The bin can be constructed of several materials such as wooden/plastic/recycled containers like bathtubs and barrels. These methods are explained in detail below.

2.2.1. Bed Method (Pile/Bed)

Composting is done by constructing a bed of organic mixture measuring 2 x 0.6 x 0.6m (~6 x 2 x 2 feet) in natural or raw ground (Figure 2 and 3). This technique is simple to maintain and use.

Figure 2. Vermicompost dual small beds [13]

Vermicomposting bed method is a composting method applied in open areas for the decomposition of organic waste using compost worms (species such as Eisenia fetida or Eisenia andrei). The method has some advantages and disadvantages:

Advantages:

- Natural Composting: The vermicompost bed made in the ground is used as a natural part of the garden soil and performs a natural composting process. This allows you to obtain a natural and environmentally friendly fertilizer for your plants.
- Affordable Cost: The vermicompost bed method is more cost-effective than other composting methods. No special equipment or closed systems are needed, and natural materials are used.

- Easy Applicability: The vermicompost bed made on the ground is a practical composting method and can be easily applied by everyone. It does not require special skills or knowledge.
- Utilisation of Organic Wastes: Organic waste decomposed in the bed becomes valuable vermicompost fertilizer and increases the productivity of your garden.
- Natural Worms: In an in-ground vermicompost bed, earthworms live in their natural environment and naturally decompose organic waste. Natural earthworm species are preferred in this method.

Figure 3. Vermicompost large bed [14]

Disadvantages:

- Weather Dependence: An outdoor vermicompost bed can be affected by weather conditions. Excessive rainfall or extreme heat can affect the efficient operation of the worms.
- Risk of Contamination: Beds made in the ground can be attractive to wild animals and pests and can threaten the earthworms or compost.

- Adequate Space Requirement: A vermicompost bed requires sufficient space to decompose the appropriate amount of organic waste. It can be difficult to implement in small gardens or limited spaces.
- Decomposition Time: Compared to some other composting methods, the vermicomposting bed method may carry out the decomposition process more slowly. It may take some time for full maturation and vermicompost to become ready.

As a result, the vermicomposting bed method is a natural and environmentally friendly composting option. It provides a natural decomposition of organic waste in the open field and allows you to obtain valuable fertilizer for your plants. However, some disadvantages must be taken into account, such as dependence on weather conditions and the risk of contamination. When choosing a composting method, it is important to consider your space, your needs, and your possibilities.

2.2.2. Pit Method

This technique is simple to maintain and use. Composting is done in pits measuring 1.5 x 1.5 x 1 m (~5x5x3 feet) and made of cement. Straw grass or other locally accessible material is used to cover the structure. For the best pit composting, the pit depth should be at least 12 inches (30 cm) and the top of the pit should be covered with at least 8 inches (20 cm) of soil after the organic materials have been added (Fig 4a and 4b).

Figure 4. a) Pit method application [15], b) Pit method example [16]

The vermicomposting pit method is the decomposition of organic waste within the pit using red composting earthworms (species such as Eisenia fetida or Eisenia andrei). The advantages and disadvantages of this method are given below:

Advantages:

- Natural Composting: In-pit vermicomposting encourages a natural composting process. Worms naturally decompose organic waste and create valuable vermicompost fertilizer.
- Low Space Requirement: The vermicomposting pit method requires less space than other composting methods. It can be applied in small gardens or limited areas.
- Low Cost: The pit method is a cost-effective composting option. It does not require special equipment or closed systems, just digging a pit is enough.
- Natural Worms: Natural earthworm species are used in the in-ground pit method. Earthworms live in a natural environment and decompose organic waste, providing valuable nutrients to the soil.

- Easy Applicability: Vermicompost pit is a practical and easy-to-use composting method. It requires no special knowledge or skills.

Disadvantages:

- Risk of Contamination: The pit method can lead to wild animals and pests attracting compost and threatening earthworms.
- Dependence on Environmental Conditions: Excessive rainfall or temperature changes can affect the efficiency of the earthworms and the decomposition process within the pit.
- Limited Capacity of the Worm Bed: The capacity of the worm bed within the pit may be limited. It may be necessary to create more than one pit to decompose large quantities of organic waste.
- Slow Decomposition Process: The pit method may have a slower decomposition process than some other composting methods.

As a result, the vermicomposting pit method is a convenient and cost-effective composting option for small gardens or limited spaces. It provides a natural decomposition of organic waste using natural earthworms and allows you to obtain valuable fertilizer for your plants. However, some disadvantages must be considered, such as the risk of contamination and dependence on environmental conditions. When choosing the composting method, you should choose the most suitable option according to the needs of your garden and your available space.

2.2.3. Bin Method

The most common method for small scale composting is bin composting method (Figure 5). The bin method is prepared to be used on a small scale such as home composting, in kitchen or garage and so on. The bin can be made of various materials, but wood and plastic ones are popular. Plastic bins, because of lightness, are more preferred in home composting. A vermicompost bin may be in different sizes and shapes, but its height must be more than 30 cm. bins with a height of 30-50 cm, and not so more than it, are perfect. Draining some holes in the bottom, sides and cap of the bin is so helpful to aeration and drainage. Around 10 holes with 1-1.5 cm in diameter

is a good choice. Before feeding the worms by wastes it's needed to apply a worm's bed. A height of 20-25 cm bedding is appropriate. It may be a mixture of shredded paper, mature compost, old cow or horse manure with some soil [17].

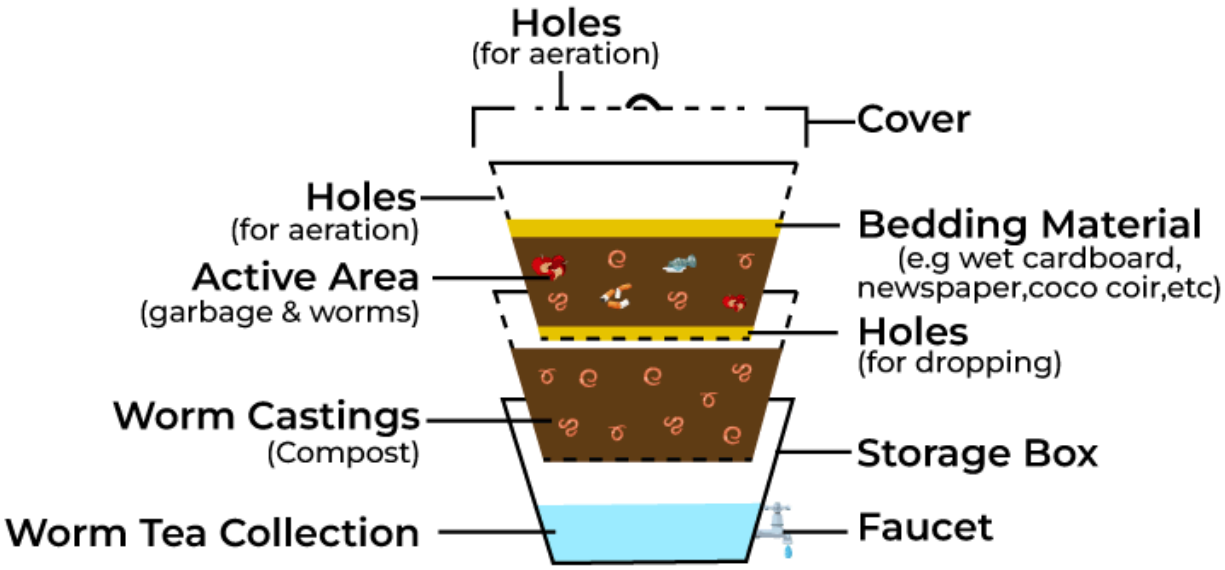

Figure 5. Bin method application [18]

Advantages:

- Low Space Requirement: The vermicomposting bin method requires less space than other composting methods.
- Low Cost: The bin method is a cost-effective composting option. It does not require special equipment or systems.
- Easy Applicability: Vermicompost bin is a practical and easy-to-use composting method. It requires no special knowledge or skills.
- Productivity: Bin system allows more airflow. It promotes a productive ecosystem.

Disadvantages:

- Limited Capacity of the Worm Bed: The capacity of the worm bed in the silo may be limited. It is not suitable for decomposing large amounts of organic waste.
- Bad smell: The leachate (extra moisture) leaks out the bottom holes in the bin and is messy to dump. If it is left to sit for a while it goes anaerobic and smells.
- Frequent Feeding: Since the space is small and limited, the worms require smaller amounts and frequent feeding.