Vermiculture Technology

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Introduction: Vermiculture and Vermicomposting

- **Vermiculture** is the culture of earthworms. The goal is to continually increase the number of worms in order to obtain a sustainable harvest. The worms are either used to expand a vermicomposting operation or sold to customers who use them for the same or other purposes.
- **Vermicomposting** is the process by which worms are used to convert organic materials (usually wastes) into a humus-like material known as vermicompost. The goal is to process the material as quickly and efficiently as possible.
- These two processes are similar but different. If your goal is to produce vermicompost, you will want to have your maximum worm population density all of the time. If your goal is to produce worms, you will want to keep the population density low enough that reproductive rates are optimized.

Suitable Earthworms for Vermiculture

- Earthworms are burrowing animals and their gut and the intestine act as a bioreactor where worms secrete enzymes like proteases, lipases, amylases, cellulases and chitinases for biochemical conversion of the cellulosic and the proteinaceous materials in the organic wastes.
- Various species of earthworms like *Megascolex mauritii*, *Eisenia fetida*, *Eudrilus eugeniae*, *Perionnyx excavatus*, *Lampito mauritii*, *Eisenia andrei*, *Lampito rubellus* and *Drawida willis* are used by degradation of waste products.
- However, *Eisenia fetida* is most appropriate earthworm for vermicomposting because it is easily adaptable for changing conditions and has lower chances of compromising on the vermicompost process.
- *Eudrilus eugenae* is used for vermiculture due to its rapid multiplication.

Suitable Earthworms for Vermiculture

- Life cycle is almost one year.
- It casts/lays 2 eggs or cocoons/ worm once a month within its life cycle.
- Its cocoon content at least 2 worms.
- The physical properties of earthworms such as weight, length, reproduction rate and population density play an important role in vermicomposting.

Suitable Earthworms for Vermiculture

Eisenia fetida

Eudrilus eugenae

Lumbricus rubellus

Perionnyx excavatus

Physical Conditions for Vermicomposting

- The organic waste is degraded to a biofertilizer in a vermireactor by continues action of earthworms over a particular time period ranging from 28-120 days.
- In addition, the process conditions are properly examined so they will not disturb the earthworm activities. The physical conditions monitored include temperature, moisture content, pH and electrical conductivity.
- Various feedstock including animal, plant, pharmaceutical, food and sewage wastes can be effectively used in vermicomposting.
- The optimum temperature for effective vermicompost process ranged from 18-67°C, pH 5.9-8.3, moisture content 10.6-80% and electrical conductivity ranged from 0.70-80 μScm^{-1}

Vermicompost Production Technology

- **Selection of suitable earthworm:** The Red worms (*Eisenia fetida*) and African earthworm (*Eudrilus engeniae*) are promising worms used for vermicompost production. Both kinds of worms can be mixed together for vermicompost production.
- **Selection of site:** Vermicompost can be produced in any place with shade, high humidity and cool. If it is to be produced in open area, shady place is selected. A thatched roof may be provided to protect the process from direct sunlight and rain. The waste heaped for vermicompost production should be covered with moist gunny bags.
- **Structure of vermicompost production:** A cement tub may be constructed to a height of 2.0- 2.5 feet and a breadth of 3 feet. The length may be fixed to any level. The bottom of the tub is made to slope like structure to drain the excess water. A small tank is necessary to collect the drain liquid. Vermicompost can also be prepared in wooden boxes, plastic bin or in any containers (except metal) with a drain hole at the bottom.

Vermicompost Production Technology

- **Waste selection:** Cattle dung (except pig, poultry and goat), farm wastes, crop residues, vegetable waste, agro-industrial waste, fruit market waste and all other bio degradable waste are suitable for vermicompost production. The cattle dung should be decomposed before used for vermicompost production. All other waste should be pre-digested with cow dung for twenty days before put into vermibed for composting. Heavy spices and metallic products are not used in this process.
- **Materials required:** 1. Vermi bin/cemented tank; 2. Thatch roof; 3. Polythene sheet (black); 4. Waste materials; 5. Cow dung; 6. Water; 7. Gunny bags; 8. Plastic net (Happa); 9. Vermi worm

Procedure for Vermicomposting

1. The compost can be prepared in concrete tank (size is depending upon the availability of raw materials) could be used.
2. Collect and heap the weed biomass under sun for about 7-10 days or until well decomposed. Chop the hard materials required.
3. Sprinkle cow dung slurry on the heap for quick decompose.
4. Place a thin layer of surface soil/ sand (1-2 inch) at the bottom of the tank.
5. Place fine bedding material such as partially decomposed cow dung/dried leaves etc. over the soil or sand layer.
6. Place the chopped agro-waste and partially decomposed cow dung (in 1:1 to 3:1 ratio) layer-wise in the tank up to a depth of 0.5-1.0 ft.

Procedure for Vermicomposting

7. Release about 1000-2000 worms/m^2 of any of the above earthworm species over the mixture.
8. Cover the compost mixture with dry straw or thatch or gunny bag.
9. Sprinkle water as and when necessary to maintain 70-80% moisture content.
10. Provide shade over the compost mixture to protect from rain water and direct sunshine.
11. Stop sprinkling of water when 80-98% bio waste is decomposed. Maturity could be judged visually by observing the formation of granular structure of the compost at the surface of the tank.
12. Collect the vermicompost by scrapping layer-wise from the top of the tank and keep it under shade.

Procedure for Vermicomposting

Agri wastes and cow dung in 1:1 ratio

Tank for vermicompost production

Create adequate no. of holes (about 8 holes of 5 cm. diameter at the bottom) to facilitate drainage of excess water

Procedure for Vermicomposting

Earthworms are released on bedding comprise of broken bricks, stone pieces, saw dust, sand and soil.

Pre-decomposed material are added in layers but its depth should not be more than 1.5 to 2 feet.

Tank is covered with thatched roof to maintain the moisture of the tank feed.

Procedure for Vermicomposting

- **Conversion:** One kilogram of worms numbering about 600 to 1000 can convert 25 to 45 kg of wet waste per week. The compost recovery would be around 25 kg per week under well managed conditions.
- **Harvest:** The total decomposition may take about 75 – 100 days depending on various factors. Therefore one tank may be used to 4 to 5 times in a year for vermicompost. A few days before the harvest watering of the tank are discontinued to allow migration of worms towards the bottom of the bed. The compost is then transferred outside without disturbing the bed and heaped on a plain open surface. The compost is sieved through a 3 mm mesh and then packed in gunnies.

Conventional sieve

Hand operated sieve

Harvesting the Compost and Worms

1. **Manual methods:** Manual harvesting involves hand-sorting, or picking the worms directly from the compost by hand. This process can be facilitated by taking advantage of the fact that worms avoid light. If material containing worms is dumped in a pile on a flat surface with a light above, the worms will quickly dive below the surface. The harvester can then remove a layer of compost, stopping when worms become visible again. This process is repeated several times until there is nothing left on the table except a huddled mass of worms under a thin covering of compost. These worms can then be quickly scooped into a container.

Harvesting the Compost and Worms

2. **Self-harvesting (migration) method:** This method is based on the worms tendency to migrate to new regions, either to find new food or to avoid undesirable conditions, such as dryness or light. We often make use of simple mechanisms, such as screens or onion bags in this method. A box is constructed with a screen bottom. The mesh is usually ¼”, although 1/8” can be used as well. The worms are forced downward by strong light. The difference with the screen system is that the worms go down through the screen into a prepared, pre-weighed container of moist peat moss. Once the worms have all gone through, the compost in the box is removed and a new batch of worm-rich compost is put in. The process is repeated until the box with the peat moss has reached the desired weight.

Products Obtained from Vermiculture Technology

❑Vermicompost

- Vermicompost is an odourless, dark brown biofertilizer which is rich in potential microbes, micro and macronutrients obtained from the process of vermiculture technology.
- Various types of organic wastes have been reported to produce vermicompost containing a range of macro and micronutrients.
- Vermicompost is an excellent soil additive and act as effective biofertilizer made up of digested compost.

Table: Nutrient composition of vermicompost and vermiwash.

Nutrients	Vermicompost	Vermiwash
pH	6.9	6.8
Organic carbon (%)	14.1	-
N (%)	1.5	0.005
P (%)	0.98	0.0025
K (%)	1.1	0.063
Ca (mg/kg)	2760	786
Mg (mg/kg)	4100	328
S (mg/kg)	600	-
Fe (mg/kg)	11200	0.151
Mn (mg/kg)	1290	213
Zn (mg/kg)	180	0.132
Cu (mg/kg)	38	0.117

Products Obtained from Vermiculture Technology

❑ Vermiwash

- Vermiwash is a brown colored leachate that is produced during the vermicomposting process by the action of earthworms.
- It is a rich source of macronutrients and micronutrients important in maintaining soil health and increasing crop production.
- Vermiwash also contains many plant microbes beneficial for growth and development of plants.
- It is a commercial product and used as foliar application.

Critical Factors Affecting Vermiculture Technology

- Bio-wastes free from ants/termites/flies, etc. are to be used for vermi-compost preparation.
- Cover the bin or tank with a plastic to protect from rat/mouse.
- Kerosene oil could be used (if necessary) on the brim of the tank.
- Frequent check the vermi- bin/tank to avoid from over heat and moist inside the compost.
- Green undecomposed materials damages the compost.
- Avoid use of heavy spices from kitchen waste and un-consumable things in the composting.
- Direct sunlight and rain to the vermi-composting is avoided.

Critical Factors Affecting Vermiculture Technology

- The worms that are used in composting systems prefer temperatures between 12-21 ^{0}C and temperature of the bedding should not get below freezing or above 29 ^{0}C.

- Optimum amount of moisture should be maintained during vermiculture process because excess of water or lack of moisture could affect population of the earthworms.

Importance of Vermiculture Technology

- Vermiproducts (vermicomost and vermiwash) have been used and applied as biofertilizers on different crops as foliar spray or as soil treatment.
- Studies suggests that protein content of some food grains also increased by the presence of earthworms in the soil.
- Application of vermiproducts increases the soil organic matter (SOM) which acts as a ‘glue’ to bind ‘soil particles’ into aggregates and improve the soil structure, infiltration, air porosity, nutrient and water holding capacity.
- Application of vermiproducts compensates the loss of soil carbon thus maximize production of crop over time.
- The SOM decomposes over time results in the accumulation of more stable carbon compound called humus which improves mineral breakdown and provide continues supply of nutrient to plants.

Importance of Vermiculture Technology

- Vermiproducts are rich in microbial diversity which includes beneficial phosphate solubilizers, nitrogen fixers, plant growth hormone producers and enzyme producers etc.
- Earthworms further propagate the population of these useful microbes in soil. Soil organic matter (SOM) acts as a healthy food source for these beneficial soil microbes and helps in improving their growth in soil.
- Microbes are responsible for transforming, releasing and cycling of macro-micronutrients so as to make them available for plants.
- Vermiproducts specially vermicompost maintain the optimal pH level of soil.
- Earthworms restores disease suppressive soil. Earthworms act as vehicle for carrying those kinds of microbes which also have antimicrobial activity against various fungal and bacterial pathogens in soils.

Problems in Vermicomposting

- Putting overabundance of "greens" in the bin, which is actually too much nitrogen combining with hydrogen and forms the ammonia. To neutralize the odours, add some sources of carbon like, paper and dried leaves etc.

- Bad odour can attract pests such as rodents and flies. Fix plastic nets around the bins.

- *Eisenia foetida* worms can attack native worms in natural areas. Don’t allow to go out natural places.

- Rain and bright light drastically affect the worms.


Thank You