UPSCALE

mssrf

NIBIO
NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

ASSAM AGRICULTURAL UNIVERSITY
विज्ञानं लोकसेवारतम्

ORISSA UNIVERSITY OF AGRICULTURE & TECHNOLOGY

CRRI
Estd. 1946

Training Manual:
Vermicomposting Technique

Norway
Norwegian Embassy
New Delhi

This project has received funding from the Ministry of Foreign Affairs, Norway/ the Norwegian Embassy, New Delhi, under Grant Agreement No. IND-15/0010

Comprehensive Extension Handout: Vermicomposting Technique

A Practical Guide for Agricultural Extension Officers, Trainers, and Progressive Farmers

1. Introduction

Vermicomposting is a scientifically proven, eco-friendly biotechnology that utilizes specific species of earthworms to convert biodegradable organic waste into a nutrient-rich, humus-like organic fertilizer known as vermicompost. The term originates from the Latin word *vermis*, meaning worm. In this process, earthworms act as biological bioreactors. They consume partially decomposed organic matter, digest it, and excrete it as granular casts.

For farmers, vermicomposting is not just a waste management practice; it is a vital step toward sustainable agriculture, reducing dependency on expensive synthetic fertilizers, and creating a closed-loop nutrient cycle on the farm.

2. Importance of Vermicomposting

In modern agriculture, the continuous use of chemical fertilizers has led to soil degradation, loss of native microflora, and declining crop yields. Vermicomposting addresses these challenges by:

- **Recycling Farm Waste:** Converting crop residues, animal manure, and weed biomass into valuable fertilizer.
- **Enhancing Rural Livelihoods:** Providing an additional income stream for farmers and rural youth through the sale of compost and live earthworms.
- **Promoting Circular Economy:** Ensuring that farm outputs (waste) become inputs (fertilizer) for the next crop cycle.
- **Mitigating Climate Change:** Preventing the anaerobic decomposition of organic waste, thereby reducing methane emissions.

3. Benefits to Soil Health

The application of vermicompost fundamentally improves the physical, chemical, and biological properties of the soil:

- **Physical Benefits:** Improves soil structure, reduces bulk density, increases soil porosity, and significantly enhances water holding capacity. It prevents soil crusting and erosion.
- **Chemical Benefits:** Buffers soil pH, increases cation exchange capacity (CEC), and reduces the toxicity of heavy metals. It acts as a slow-release fertilizer, ensuring nutrients are available to plants throughout their growth cycle.
- **Biological Benefits:** Introduces a massive population of beneficial microbes (actinomycetes, nitrogen-fixing bacteria, and phosphate-solubilizing bacteria). It also contains plant growth-promoting hormones like auxins and gibberellins.

4. Advantages over Conventional Compost

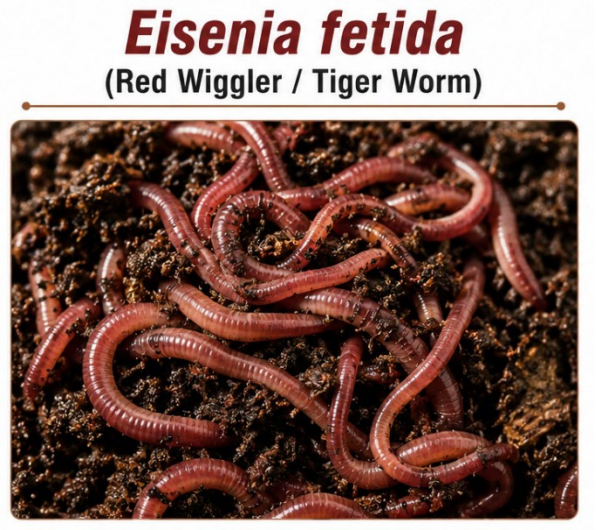
While traditional composting relies solely on microbial action and takes longer, vermicomposting offers distinct advantages:

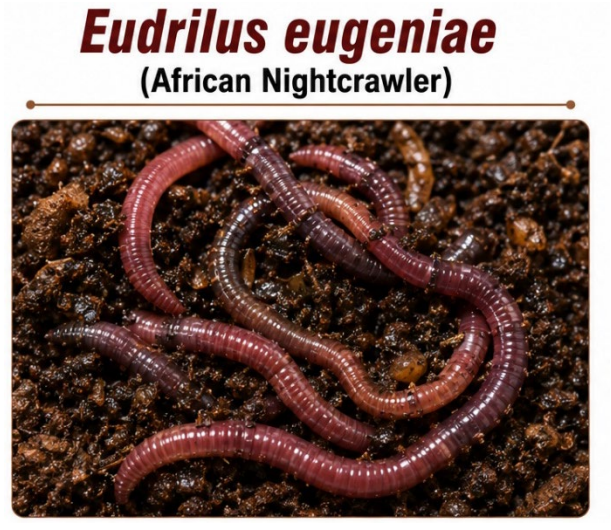
Parameter	Conventional Compost	Vermicompost
Time taken	3 to 6 months	45 to 60 days (after pre-digestion)
Nutrient status	Moderate (Nitrogen ~0.5-1.0%)	High (Nitrogen ~1.5-2.5%)
Microbial load	Moderate	Extremely high
Enzyme content	Low	High (contains amylase, lipase, cellulase)
Odour	Often emits foul odours if not turned	Odourless, pleasant earthy smell
Granulation	Clumpy and non-uniform	Uniform, granular, highly porous

5. Suitable Earthworm Species

Not all earthworms are suitable for composting. Deep-burrowing (anecic) and soil-dwelling (endogeic) worms are less effective. Vermicomposting requires **epigeic** species—surface dwellers that thrive in high organic matter.

	***Eisenia fetida* (Red Wiggler / Tiger Worm)**	***Eudrilus eugeniae* (African Nightcrawler)**	***Perionyx excavatus* (Indian Blue Worm)**
Identification	Reddish-purple with distinct yellow stripes.	Large, purplish-grey, iridescent sheen.	Thin, bluish-purple, very active and fast-moving.
Characteristics	Highly robust, tolerates a wide range of temperatures (0°C to 35°C), and has a rapid reproduction rate. It is the most universally recommended species for commercial units.	Voracious eater and produces large granular casts. However, it is highly sensitive to extreme temperatures and handles cold poorly. Ideal for tropical climates.	Indigenous to India, excellent for tropical conditions, rapid breeder, but tends to escape the bins if conditions (like moisture or pH) fluctuate even slightly.

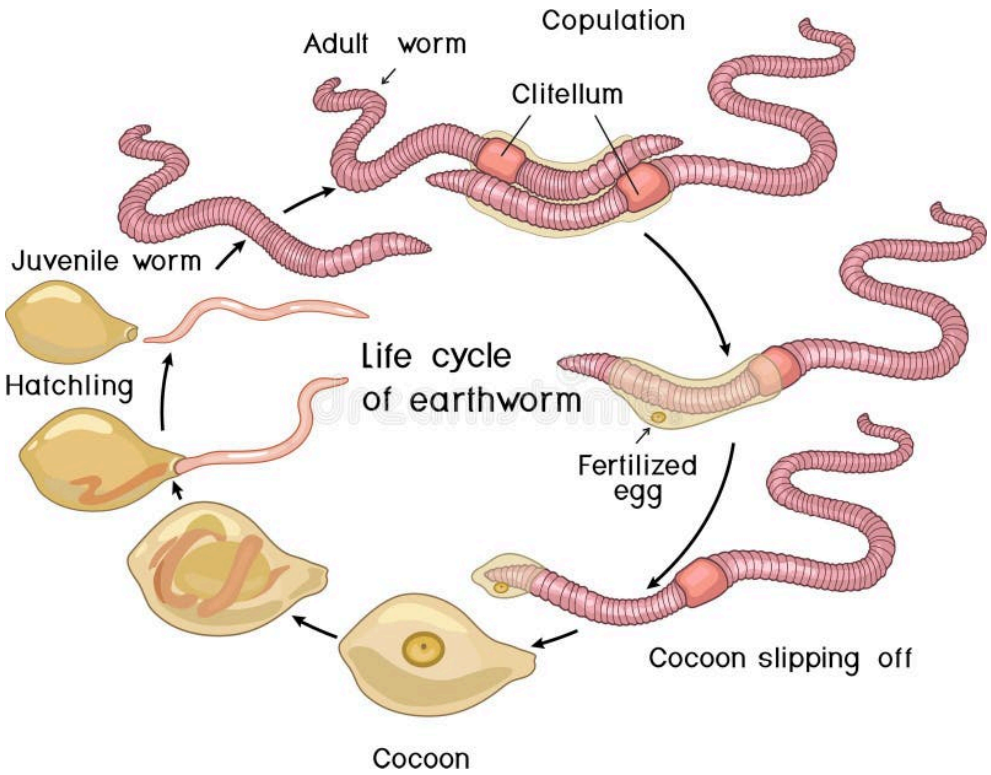




6. Biology of Composting Earthworms

Understanding the earthworm's life cycle is crucial for unit maintenance:

- **Hermaphroditic Nature:** Earthworms possess both male and female reproductive organs but require a partner to mate.
- **Cocoon Production:** After mating, they produce lemon-shaped capsules called cocoons. *Eisenia fetida* produces 2-3 cocoons per week.
- **Incubation:** Cocoons hatch in 20-30 days, releasing 2-5 juvenile worms per cocoon.
- **Maturation:** Juveniles become reproductive adults in 45-60 days. Under optimal conditions (moisture, temperature, food), an earthworm population can double every 60 days.



7. Materials Required

To set up a successful vermicomposting unit, the following materials are required:

- **Base Material:** Cow dung (7-15 days old is ideal; fresh dung produces lethal heat and methane).
- **Carbon Source (Browns):** Dry leaves, paddy straw, wheat straw, coir pith, chopped sugarcane trash.
- **Nitrogen Source (Greens):** Vegetable market waste, green grass clippings, leguminous crop residues, water hyacinth.
- **Inoculum:** Healthy culture of epigeic earthworms (approx. 1 kg or 1000 worms per square meter).
- **Shed Material:** Bamboo, thatch, shade net, or permanent structure to protect from sun and rain.
- **Tools:** Watering cans/hose, hand fork, spade, sieving mesh (2-3 mm).

8. Selection of Site

- **Shade:** The site must be heavily shaded. Direct sunlight elevates bed temperatures and kills earthworms.
- **Elevation:** Select elevated land to prevent waterlogging during monsoons.
- **Water Access:** Continuous availability of a fresh water source is mandatory.
- **Proximity:** Should be close to the cattle shed or farm waste generation point to reduce transportation labor.

9. Methods of Vermicomposting

There are two primary methods used globally:

Bed Method (Windrow System)

Organic matter is placed on the surface of the ground in elongated mounds or within brick/concrete enclosures above ground.

- *Advantage:* Excellent aeration, easy to harvest, easy to monitor moisture, prevents waterlogging. **This is the recommended method for extension.**

Pit Method

Organic matter is dumped into cemented or earthen pits dug into the ground.

- *Disadvantage:* Poor aeration, high risk of waterlogging, difficult to harvest, and prone to heat buildup. Generally discouraged unless carefully managed in dry, arid regions.

10. Step-by-Step Preparation Procedure

Flowchart of Vermicomposting Process

Collection of Waste → Chopping (2-3 cm) → Pre-digestion (15-20 days) → Bed Preparation → Earthworm Inoculation → Regular Watering & Maintenance → Harvesting Castings → Sieving & Packaging.

Procedure for Bed Method:

1. **Pre-digestion:** Mix farm waste and old cow dung (ratio of 3:1). Sprinkle water and keep it in a heap for 15-20 days. This initiates initial decomposition and dissipates toxic heat.
2. **Bed Sizing:** Create a bed on a raised platform. Ideal dimensions: 1 m wide, 0.5 m high, and length as per availability (usually 3 to 5 m).
3. **Basal Layer:** Place a 5 cm layer of chopped crop residues or coconut coir at the bottom to ensure drainage and aeration.
4. **Feeding Layers:** Alternate layers of pre-digested cow dung and organic waste until the bed reaches 0.5 m in height.
5. **Inoculation:** Release 1 kg of earthworms (*Eisenia fetida*) evenly over the top of the bed. They will naturally burrow downward.
6. **Covering:** Cover the bed with wet gunny bags or a layer of paddy straw to maintain darkness and moisture. Do not use plastic sheets.

11. Moisture Management

Earthworms breathe through their moist skin. If the bed dries out, they suffocate and die.

- **Optimal Moisture:** Maintain between 60% and 70%.
- **The Squeeze Test:** Take a handful of compost and squeeze it. If a few drops of water emerge, moisture is perfect. If water streams out, it's too wet. If it crumbles and falls apart, it's too dry.
- **Watering:** Sprinkle water daily in summer, and every 2-3 days in winter. Avoid flooding the bed.

12. Temperature Management

Earthworms are highly sensitive to temperature fluctuations.

- **Optimal Range:** 20°C to 30°C.
- **Summer Care:** Increase watering frequency. Apply a thick layer of straw mulch. Ensure the shade net (preferably 75% green) is intact.
- **Winter Care:** Reduce watering. Cover the beds with thick gunny bags to retain the metabolic heat generated inside the bed.

13. Aeration

Earthworms require oxygen. Compaction of the bed leads to anaerobic conditions, producing foul-smelling gases (hydrogen sulfide) which are toxic to worms.

- **Action:** Once every 15 days, gently loosen the top 10-15 cm of the bed using a hand fork.
- **Caution:** Do not dig deep with sharp tools to avoid cutting the worms.

14. Feeding Schedule

Unlike batch feeding (filling the bed once and waiting), continuous feeding yields better results.

- Add a 5-10 cm layer of fresh pre-digested dung/waste every week as the bed shrinks.
- Stop feeding 15 days before the intended harvest time to allow worms to process all remaining material.

15. Maintenance Practices

- **Weed Control:** Pluck out any weed seeds that germinate on the bed immediately.
- **Predator Protection:** Draw a line of turmeric powder, wood ash, or chalk around the bed base to repel ants. Install wire mesh around the shed to keep out rats and birds.
- **pH Monitoring:** Maintain neutral pH (6.5 to 7.5). If the bed becomes too acidic (sour smell), sprinkle a light dusting of agricultural lime or crushed eggshells.

16. Harvesting of Vermicompost

The compost is ready in 45-60 days when the material turns dark brown, highly granular (like tea leaves), and has a pleasant forest-soil smell.

1. Stop watering 3-4 days before harvesting to allow the compost to dry slightly, making sieving easier.
2. Scrape the top layer of ready compost gently.
3. Pile the scraped compost in a cone-shaped heap under sunlight for 1-2 hours. Earthworms are photophobic (afraid of light) and will move to the bottom of the heap.
4. Collect the worm-free compost from the top and sides of the heap.

17. Harvesting Earthworms

To harvest worms for selling or starting new beds:

- Use the heap method described above to concentrate worms at the bottom.
- Alternatively, use a bait trap: Place fresh, sweet cow dung or mashed overripe fruits (like bananas) in a mesh bag on top of the bed. Within 48 hours, thousands of worms will congregate in the bag, which can then be lifted out.

18. Vermiwash Preparation

Vermiwash is a potent foliar spray containing worm coelomic fluid, enzymes, and micronutrients.

- **Setup:** Take a 20-litre plastic bucket with a tap at the bottom. Layer gravel, sand, and pre-digested cow dung. Release 200-300 earthworms.
- **Process:** Hang a pot with a small hole above the bucket, allowing water to drip slowly (1 drop per second) onto the compost.
- **Collection:** The water passes through the worm ecosystem and is collected from the bottom tap.
- **Application:** Dilute 1 litre of vermiwash in 10 litres of water and use as a foliar spray to boost plant immunity and yield.

19. Quality Parameters of Good Vermicompost

Farmers must know how to identify high-quality output:

- **Colour:** Dark brown to black.
- **Texture:** Fine, granular, non-sticky, free-flowing.
- **Odour:** Earthy (no ammonia or rotting smell).
- **Moisture:** 15% to 25% at the time of packing.
- **Particle Size:** 90% should pass through a 4 mm sieve.

20. Nutrient Composition Table

Note: Values vary based on the raw materials used.

Nutrient	Average Percentage/Amount
Organic Carbon	9.0% - 15.0%
Nitrogen (N)	1.0% - 2.5%
Phosphorus (P)	0.8% - 1.5%
Potassium (K)	0.8% - 1.5%
Calcium (Ca)	0.5% - 1.0%
Magnesium (Mg)	0.2% - 0.3%
Iron, Zinc, Copper	20 - 200 mg/kg (ppm)
C:N Ratio	15:1 to 20:1

21. Application Rates for Different Crops

Vermicompost should be applied near the root zone and mixed lightly with the topsoil, followed by irrigation.

Crop Type	Recommended Dose	Time of Application
Field Crops (Rice, Wheat)	2.5 to 3.0 tonnes/hectare	During basal dressing / final ploughing
Vegetables (Tomato, Brinjal)	100 to 200 g/plant	At transplanting and 30 days after
Fruit Trees (Mango, Citrus)	2 to 5 kg/tree	Annually before monsoon in the drip circle
Potted Plants / Nurseries	100 to 200 g/pot	Once every 30-45 days

22. Storage and Packaging

- **Packaging:** Store in breathable, laminated HDPE bags. Never use airtight plastic bags, as the microflora needs oxygen to survive.
- **Storage:** Keep bags in a cool, dry, and shaded place.
- **Shelf Life:** Properly stored vermicompost retains its microbial vitality for 6 to 9 months. After a year, nutrient values remain, but microbial counts drop significantly.

23. Pest and Disease Problems in Vermicompost Units

- **Ants and Termites:** Consume earthworms and organic matter. *Control:* Neem oil spray on the periphery; ensure moisture is adequately high (ants hate wet beds).
- **Centipedes and Flatworms (Bipalium):** Voracious predators of earthworms. *Control:* Hand-picking; avoid introducing soil from unknown sources into the bed.
- **Rats, Frogs, and Birds:** Eat the worms. *Control:* Secure the shed with nylon nets or wire mesh.
- **Protein Poisoning (Sour Crop):** Occurs when too much protein/nitrogen (like raw food waste) is added. Bed becomes acidic, worms swell, turn pale, and die. *Control:* Remove uncomposted food, add crushed eggshells, and aerate.

24. Troubleshooting Guide

Symptom in the Bed	Probable Cause	Corrective Action
Foul, rotting smell	Anaerobic conditions / too wet	Stop watering, turn the bed, add dry straw.
Ammonia smell	Too much nitrogen / fresh dung	Remove fresh dung, add carbon (dry leaves).
Worms crawling out of bed	Acidic pH, heat, or excessive water	Check moisture, sprinkle lime, improve drainage.
Bed heating up	Un-composted waste continuing to ferment	Stop feeding, water heavily, aerate thoroughly.
Tiny red mites appear	Bed is too acidic and slightly dry	Moisten bed, add agricultural lime.

25. Economics of Small-scale Vermicomposting Unit

Estimates for a 10 m x 1 m x 0.5 m commercial bed per cycle (2 months).

Item / Activity	Estimated Cost / Revenue (INR / Local Currency context)
A. Capital/Fixed Costs	
Shed construction (Thatch/Bamboo)	3,000
Brick bed construction	2,000
Earthworms (10 kg @ 300/kg)	3,000
B. Recurring Costs (per cycle)	
Cow dung & biomass	1,500
Labour & Maintenance	1,000
Packaging bags	500
C. Revenue (per cycle)	
Sale of Vermicompost (2 tonnes @ 10/kg)	20,000
Sale of excess Earthworms (2 kg @ 300/kg)	600
Net Profit per cycle	**17,600** (minus initial capital recovery)

(Note: Returns multiply as the farmer scales up the number of beds).

26. Environmental Benefits

Beyond the farm, widespread adoption of vermicomposting yields profound environmental impacts:

- **Reduces Landfill Burden:** Diverts thousands of tonnes of municipal and agricultural organic waste from landfills.
- **Carbon Sequestration:** Locks organic carbon into the soil in the form of stable humus rather than releasing it as atmospheric CO2.
- **Prevents Eutrophication:** Unlike chemical fertilizers that leach into water bodies and cause algal blooms, vermicompost holds nutrients tightly in the soil matrix.

28. Do's and Don'ts

Do's	Don'ts
Do keep the bed moist at all times (60-70%).	**Don't** flood the beds or allow water to stagnate.
Do provide adequate shade and protection from rain.	**Don't** expose the vermibed to direct sunlight.
Do use a mixture of cow dung and plant residues.	**Don't** use plastics, glass, metals, or hazardous chemicals.
Do cover the bed with wet gunny bags or straw.	**Don't** cover the bed with plastic sheets (causes suffocation).
Do aerate the top layer every two weeks.	**Don't** use deep digging tools that cut the worms.

30. Summary

Vermicomposting is an essential, low-cost, and highly effective biotechnology for sustainable agriculture. By utilizing specific earthworm species like *Eisenia fetida*, farmers can rapidly convert agricultural residues and cow dung into high-quality organic fertilizer within 60 days. Regular attention to moisture, temperature, and aeration ensures a thriving earthworm population and a premium end-product. Adopting vermicomposting not only improves soil health and crop yields but also reduces dependency on chemical fertilizers, making farming economically viable and environmentally safe.

Interesting Facts

- Aristotle called earthworms the "intestines of the earth."
- An earthworm can consume organic matter equal to its own body weight every single day.
- Earthworm casts contain 5 times more nitrogen, 7 times more phosphorus, and 11 times more potassium than the surrounding soil.