

# SUSTAINABLE VERMICOMPOSTING: AN ECO-FRIENDLY APPROACH TO BOOST CROP PRODUCTIVITY

## Abstract

Vermicomposting is a highly cost-effective and environmentally beneficial method for decomposing organic waste. In India, the agro-industrial sector generates significant amounts of plant materials that can be efficiently transformed into compost through vermicomposting. A recent study compared the effects of 50% vermin-compost with plant growth enhancers on the exomorphological aspects of *Capsicum annum* (bell pepper). The results demonstrated that plants treated with vermicomposting exhibited remarkable growth and development. This ongoing research aims to showcase the advantages of using organic amendments instead of synthetic fertilizers to enhance soil health and promote plant growth. Vermi-compost is a rich source of macro- and micronutrients, and its application leads to improved plant nutrition, enhanced growth, increased photosynthesis, and higher chlorophyll content in the leaves. By reframing these findings, we shed light on the potential of vermin-compost to revolutionize sustainable agriculture practices.

**Key words:** Vermicomposting, Cost-effective, Photosynthesis, Chlorophyll, Sustainable

## Authors

### **Dr. Kamalkant Yadav**

Assistant Professor  
Galgotias University  
Greater Noida, Uttar Pradesh, India.

### **Nandini Singh**

MSc. Agronomy  
Galgotias University  
Greater Noida, Uttar Pradesh, India.

### **Dr. Somnath Nayak**

Assistant Professor  
Galgotias University  
Greater Noida, Uttar Pradesh, India.

### **Sonu Kumar**

Lab technician  
Noida International University  
Greater Noida, Uttar Pradesh, India.

## I. INTRODUCTION

In recent years, earthworms have emerged as a crucial tool for processing biodegradable organic materials. Vermicompost, the end product of this process, is a nutrient-rich organic fertilizer with a high concentration of humus, nitrogen (2-3%), phosphorous (1.55-2.25%), potassium (1.85-2.25%), as well as essential micronutrients and beneficial soil microbes like 'nitrogen-fixing bacteria' and mycorrhizal fungi. Scientific studies have unequivocally demonstrated the remarkable benefits of vermicompost as a plant growth supplement. The management process involves the utilization of earthworms, as described by Satchell in 1967.

Vermiculture, the process of using earthworms to improve soil, has gained popularity in organic farming. Vermicompost acts as a humus biofertilizer, soil fertility booster, activator, and conditioner, owing to its rich content of vital plant nutrients, vitamins, enzymes, growth hormones, and beneficial microbes, such as nitrogen-fixing, phosphate-solubilizing, denitrifying, and decomposing bacteria.

With a growing focus on innovative technologies, particularly those based on biological processes, recycling and efficiently utilizing organic residues have become a prominent trend. These practices not only conserve available resources but also facilitate the recovery of natural products, and in some cases, offer solutions to waste disposal problems while minimizing pollution effects. Vermicomposting stands out as an exemplary biotechnology for transforming agroindustrial wastes into value-added products, which, in turn, enhance soil structure and fertility in organic farming, as highlighted by Garg and Gupta in 2009. This approach, known as "parafreshing," plays a vital role in sustainable agriculture and contributes to environmental conservation

### **What is Vermicomposting?**

Vermicomposting is a natural process that involves the decomposition of organic waste materials by earthworms and beneficial microorganisms. The word "vermicomposting" is derived from "vermi," which means worm, and "composting," which refers to the decomposition of organic matter.

In this method, specific species of earthworms, such as *Eisenia fetida* (red wigglers) or *Lumbricus rubellus* (red earthworms), are used to break down organic waste into nutrient-rich compost known as vermicompost or worm castings. These worms consume the organic materials, such as kitchen scraps, garden waste, paper, and cardboard, and then excrete the waste in the form of nutrient-dense castings.

The vermicomposting process is carried out in a controlled environment, typically in containers or bins, to provide suitable conditions for the earthworms' activity. The worms require a well-balanced diet, adequate moisture, and proper aeration to thrive and efficiently decompose the organic matter.

Vermicompost is an excellent soil amendment that enhances soil fertility, improves soil structure, retains moisture, and promotes healthier plant growth. It is a valuable

alternative to traditional compost and synthetic fertilizers, as it is environmentally friendly, cost-effective, and supports sustainable agricultural practices.

Overall, vermicomposting is an eco-friendly and efficient method for recycling organic waste, producing nutrient-rich compost, and contributing to more sustainable waste management and agriculture

## II. TYPES OF EARTHWORMS BENEFICIAL FOR VERMICOMPOSTING

Red wigglers and redworms are the best worms for vermiculture. These two earthworm species play a significant role in the vermicomposting process. The nicest thing about these worms is that they are simple to keep. They can be fed vegetable waste and can live on simple soil; not all worms have this advantage. Let's talk about the various varieties of worms and how they contribute to vermiculture and environmental conservation.

**There are mainly 5 types of worms that are mainly used for the Vermin-Culture:**

1. **Eisenia Fetida:** Red wigglers are known as Eisenia Fetida, and you will not find them in the garden soil. They may appear bulky, but they are ideally suited to the job of earthworm in the vermicomposting concept. They are excellent at making your life easier by consuming your household rubbish. You can use them for your basic compost bin, and they will decompose all of your garbage. Remember that you don't have to hurl everything at once; instead, allow some space.



**Figure 1**

2. **Lumbricus Rubellus:** Redworms are called Lumbricus rubellus. You can find redworms easily on the garden soil. The problem with redworms is that you may not be able to find the difference between them and other worms. They are best at eating the waste vegetables.



**Figure 2**

- 3. Epigeic:** These worms can be found under the soil and that soil is inside leaf litter. They are known to live but not burrow anything and they will feed themselves through the leaf litter. They are not striped but they can be red and red-brown.



**Figure 3**

- 4. Anecic:** These worms live within 180cm of the ground. They burrow deep and leave a lasting deep tunnel in the ground. Check the excrement pile on the surface, often known as a midden, for identification. The Anecic's purpose as an earthworm in vermicomposting is straightforward: eat dying leaves and grass and turn them into humus.



**Figure 4**

- 5. Endogeic:** Endogeic also comes in the role of earthworm in the vermicomposting process. They dwell in the soil and they feed on the soil as well. They help in mixing up minerals with air inside the soil. The only way to see or capture them is when there is heavy rainfall. They are always inside the soil, this is why they have the name Endogeic which means within the earth according to the Greek dictionary.



Figure 5

### III. MOST SUITABLE METHOD OF ADOPTING VERMICOMPOSTING

The types of Vermicomposting Processes are

1. **Vermicomposting in the Bin:** Vermicomposting in a bin is a popular and practical method of converting organic waste into nutrient-rich compost using earthworms. The process is simple and can be done at home, making it accessible to individuals and small-scale composting enthusiasts. Here's how vermicomposting in a bin typically works:

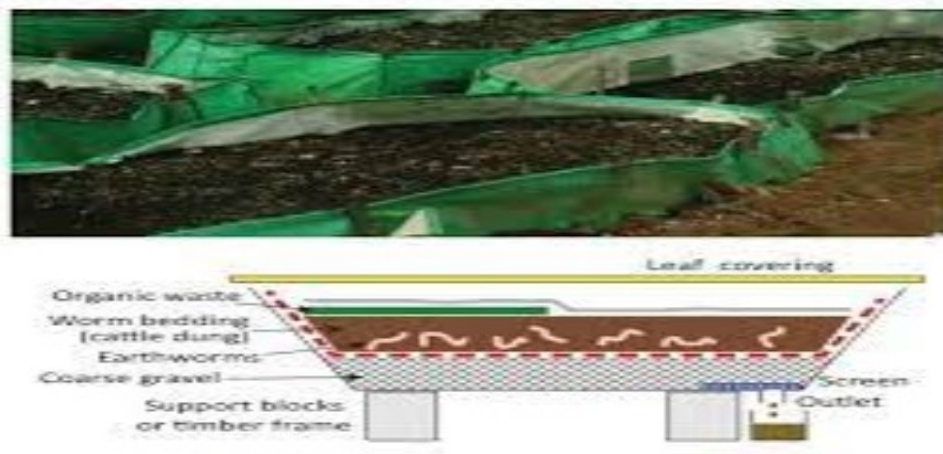


Figure 6: Vermicomposting Bin

**Choosing the Bin:** Select a suitable container or bin for vermicomposting. It can be a specially designed worm composting bin or even a simple DIY setup. The bin should have drainage holes to prevent waterlogging and a lid to cover the top.

- **Adding Bedding Material:** Create a comfortable bedding layer for the worms by adding shredded newspaper, cardboard, coconut coir, or a mix of these materials to the bin. The bedding provides a cosy environment for the worms and helps maintain moisture levels.

- **Introducing Earthworms:** Add a suitable species of earthworms to the bin. Red wigglers (*Eisenia fetida*) are the most commonly used worms for vermicomposting. You can purchase them from a local nursery or online supplier. Start with a small number of worms and let them acclimate to their new environment.
- **Feeding the Worms:** Begin feeding the worms with organic waste. Suitable kitchen scraps include fruit and vegetable peels, coffee grounds, tea bags, eggshells, and crushed nutshells. Avoid adding meat, dairy, oily foods, and pet waste, as they can attract pests and produce foul odour. Bury the food waste under the bedding to prevent fruit flies and other unwanted pests.
- **Maintaining the Bin:** Regularly check the moisture level in the bin. It should be moist like a wrung-out sponge, not too wet or too dry. Add water as needed to keep the bedding moist but not waterlogged.
- **Harvesting the Vermi-compost:** Over time, the worms will convert the organic waste into nutrient-rich vermin-compost. When the compost is ready for harvest, stop adding new food scraps to one side of the bin. The worms will migrate to the other side in search of fresh food. You can then remove the finished compost from the side without worms and use it to fertilize your plants or garden.
- **Continual Process:** Vermicomposting is a continuous process. As you harvest the finished compost, keep adding new bedding and organic waste to the bin to provide a constant food source for the worms.

Vermicomposting in a bin is a sustainable and efficient way to manage organic waste, reduce landfill contributions, and create valuable compost for enriching the soil and promoting plant growth. With proper care and attention, the bin can be a productive home composting system that benefits both the environment and your gardening efforts.

2. **Vermicomposting in Vermin-Compost Pile:** Vermicomposting in a vermin-compost pile is another effective method of utilizing earthworms to decompose organic waste and create nutrient-rich compost. Instead of using a bin, the vermicomposting process takes place in a designated compost pile or heap. Here's how vermicomposting in a vermin-compost pile is typically done:

- **Selecting the Site:** Choose a suitable location for the vermin-compost pile. It should be well-drained and preferably situated in a shaded area to prevent the pile from drying out quickly. The spot should also be easily accessible for adding organic waste and harvesting the vermin-compost.
- **Creating the Pile:** Start the vermin-compost pile by laying down a base layer of organic materials, such as straw, leaves, or small sticks. This base layer helps with aeration and drainage. On top of the base layer, add a mixture of kitchen scraps, garden waste, and other organic materials.

- **Introducing Earthworms:** Introduce earthworms to the pile by gently placing them on the surface of the organic materials. Red wigglers (*Eisenia fetida*) are commonly used for vermicomposting in piles, as they are efficient composters and thrive in organic-rich environments.
- **Covering the Pile:** Cover the vermin-compost pile with a layer of dampened burlap, cardboard, or a tarp. This cover helps to retain moisture and provides a dark environment preferred by the worms.
- **Adding Organic Waste:** Regularly add kitchen scraps, garden clippings, and other biodegradable materials to the pile. Bury the fresh waste under the existing compost to avoid attracting pests and to promote efficient decomposition by the worms.
- **Maintaining Moisture and Aeration:** Monitor the moisture level in the vermin-compost pile and add water as needed to keep it consistently damp but not waterlogged. Turning the pile occasionally with a pitchfork or shovel helps aerate the compost and aids in the breakdown process.
- **Harvesting the Vermi-compost:** After several months, the vermin-compost pile will have transformed the organic waste into rich, dark vermin-compost. To harvest the compost, move the top layer of unfinished compost and worms to one side of the pile. The finished vermin-compost will be at the bottom of the exposed area. Collect the compost and use it to nourish your plants or garden.

Vermicomposting in a vermin-compost pile is an excellent method for recycling organic waste and creating nutrient-dense compost on a larger scale than with a bin. It promotes soil health, reduces waste, and supports sustainable gardening and farming practices. With the help of earthworms, this process contributes to the overall improvement of soil fertility and plant growth in a natural and eco-friendly way.

#### IV. VERMI-COMPOST'S ROLE IN FARMING

Vermi-compost plays a crucial and multifaceted role in agriculture, offering numerous benefits that contribute to sustainable and efficient farming practices. Its impact extends to various aspects of agriculture, ranging from soil health to plant growth and environmental conservation. Here are some key roles of vermin-compost in agriculture:



**Figure 7**

- 1. Soil Enrichment:** Vermi-compost is a potent organic fertilizer that improves soil fertility by providing a rich source of essential nutrients, including nitrogen, phosphorus, potassium, and micronutrients. These nutrients are released slowly and are readily available to plants, promoting healthy root development and overall growth.
- 2. Soil Structure and Aeration:** Vermi-compost enhances soil structure by improving its aggregation and porosity. The presence of organic matter helps loosen compacted soil, allowing better water infiltration and air circulation. This leads to improved root penetration and nutrient uptake by plants.
- 3. Water Retention:** Vermi-compost increases the water-holding capacity of soil, reducing water loss through runoff and evaporation. It helps plants withstand drought conditions by maintaining moisture levels, ensuring consistent hydration for optimal growth.
- 4. Suppression of Plant Diseases:** Vermi-compost contains beneficial microorganisms, including antagonistic fungi and bacteria, which can help suppress harmful plant pathogens. These microbes contribute to a healthier soil microbiome, supporting disease resistance in plants.
- 5. Enhanced Plant Growth and Yield:** Studies have shown that vermin-compost significantly improves plant growth parameters such as shoot and root length, biomass, and flowering. Increased plant productivity and higher crop yields are often observed when using vermin-compost as a soil amendment.
- 6. Reduced Need for Chemical Fertilizers:** By supplying essential nutrients in a balanced and natural form, vermin-compost reduces the reliance on synthetic chemical fertilizers. This minimizes the risk of nutrient imbalances, soil degradation, and environmental pollution associated with excessive fertilizer use.
- 7. Waste Recycling and Pollution Reduction:** Vermicomposting provides an eco-friendly solution for recycling organic waste, such as kitchen scraps, agricultural residues, and livestock manure. By diverting organic materials from landfills, vermicomposting reduces methane emissions and decreases the environmental impact of waste disposal.
- 8. Carbon Sequestration:** The incorporation of vermin-compost into the soil enhances carbon sequestration, helping to mitigate climate change by capturing and storing carbon dioxide from the atmosphere in the form of stable organic matter.
- 9. Sustainable Agriculture:** Vermi-compost aligns with the principles of sustainable agriculture by promoting soil health, reducing environmental impacts, and ensuring long-term productivity and resilience of agricultural ecosystems.

Overall, vermin-compost serves as a valuable tool for farmers and gardeners seeking to improve soil quality, increase crop productivity, and adopt more sustainable and eco-friendly practices in agriculture. Its ability to nourish the soil, support plant growth, and recycle organic waste makes it an essential component of modern agricultural systems.



**Following are the Benefits of Vermicomposting in Soil:**

- Improves the soil structure, porosity, and density, thus creating a better plant root environment
- Increases infiltration and permeability of heavy soils, thus reducing erosion and runoff
- Improves water holding capacity, thus reducing water loss and leaching in sandy soils
- Supplies a variety of macro and micronutrients
- May control or suppress certain soil-borne plant pathogens
- Supplies significant quantities of organic matter
- Improves cation exchange capacity (CEC) of soils and growing media, thus improving their ability to hold nutrients for plant use
- Supplies beneficial microorganisms to soils and growing media
- Improves and stabilizes soil pH
- Can bind and degrade specific pollutants.

Although the most common way to produce compost is using microorganisms, compost can be also produced using worms. This is called worm compost or vermicompost. This kind of compost is a highly valued, and is often called black gold. This is because there are not many farmers involved in worm compost production and it takes time to produce.

**V. EFFECT OF VERMICOMPOST ON AGRICULTURAL CROP PERFORMANCE**

- 1. Yield:** Studies on the production of important vegetable crops like tomato (*Lycopersicon esculentum*), eggplant (*Solanum melongena*) have yielded very good results (Adhikary, 2012). Similarly the overall productivity of potato was significantly higher on vermicompost applied about 6 tons/ha as compared to control. Vermicast produced higher garden pea green pod plants, higher green grain weight per plant, and higher green pod yield as compared to chemical fertilizer Vermicompost increase in crop yield probably because of higher nutrient uptake.
- 2. Growth:** Worms and vermicompost promoted excellent growth in the vegetable crop with more flowers and fruits development (Adhikary, 2012). Vermicompost can have dramatic effects upon the germination, growth, flowering, fruiting and yields of crops. Differences in growth were attributed mainly to differences in nutrient content of the potting mixtures, but some changes in physical and biological properties of the substrate could also be responsible (Tringovska, Dintcheva, 2012)
- 3. Nutrient Content:** Application of Vermicompost increased chlorophyll content, pH of juice, total soluble solids of juice, micro and macronutrients, carbohydrate (%) and protein (%) content and improved the quality of the fruits and seeds. Studies suggested that treatments of humic acids, plant growth promoting bacteria and vermicomposts could be used for a sustainable agriculture discouraging the use of chemical fertilizers (Joshi *et al.*, 2015).
- 4. Plant Protection:** The most significant observation was drastically less incidence of diseases in worm and vermicompost applied plant (Adhikary, 2012). Accordingly,

vermicompost also protects plants against various pests and diseases either by suppressing or repelling them or by inducing biological resistance in plants (Sinha et al., 2009).

- 5. Human Health:** Organically grown fruits and vegetables especially on 'earthworms and vermicompost' have been found to be highly nutritious, rich in 'proteins, minerals and vitamins' and 'antioxidants' than their chemically grown counterparts and can be highly beneficial for human health. They have elevated antioxidants levels in about 85% of the cases studied. They have been found to be protective against several forms of 'cancers' and against 'cardiovascular diseases

## VI. CONCLUSIONS

In conclusion, sustainable vermicomposting is an eco-friendly and innovative approach that transforms organic waste into nutrient-rich vermin-compost. This method enhances soil health, nutrient uptake, and water retention, while reducing the reliance on synthetic fertilizers and waste disposal. By fostering a healthier soil microbiome and sequestering carbon, vermicomposting contributes to environmental conservation and climate change mitigation. Embracing this practice aligns with the principles of sustainable agriculture and holds promise for a greener and more productive future for agriculture.

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