



A Comprehensive Study on Agricultural Residue Management by Vermicomposting

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Abstract

The green revolution as well as improved seed-based fertilizers and water management have increased food grain production. The planned crop has led to an increase in food grains and biodiversity. Rice farming, wheat production as well as sugarcane crops have also increased the yield and crop waste. This farm waste has also increased the cost of farm management. Many farmers' burn and dispose of this waste, which causes air pollution. For example, the burning of waste from paddy and wheat farms in Punjab has led to an increase in air pollution in and around New Delhi. Also, the burning of farm waste is causing the loss of organic matter. Therefore, the vermicomposting project is the right way to use all such agricultural waste in the same field. This will enable proper drainage of field waste and enable the concerned farmer to produce vermicomposting containing the maximum amount of Nitrogen, Phosphorus, and Potash in less space. Therefore, while maintaining the balance of the environment, natural air, and water remain clean. Varieties of earthworm species are utilized for making vermicompost, which is useful for the rapid growth of a crop. This reduces the use of chemical fertilizers in the field and enables the farmers to do properly planned farming at a low cost. It takes less time to do vermicomposting. They also make the seedlings grow faster, Increases soil water holding capacity, and Reduce soil BOD. Also, vermicomposting is a boon for the nursery. Stakeholders would be truly intelligent consumers.



Article History

Received: 01 March 2023

Accepted: 16 June 2023

Keywords

Agricultural Waste;
Ecological Balance;
Organic Matter;
Waste Incineration;
Water Holding Capacity.

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Doi: <https://dx.doi.org/10.12944/CARJ.11.2.20>

Introduction

With the exception of sugarcane, paddy, and wheat, a large amount of solid waste is often generated in the field. Crop solid waste leaves, mulch, farm by-products (Cow dung), etc. are termed as agricultural waste. India produces about 620 to 680 metric tons of solid waste per year.³ 1/3rd of that agricultural waste is not used. Also, sugarcane husk, solid waste of wheat crop and paddy, and solid waste of pigeon pea crop is about 30%.⁶ In horticulture, such as banana production and coconut production, this crop produces solid waste. After harvesting and threshing cereals, pulses like pigeon pea, green gram, Black gram, millet, sorghum, a large amount of solid waste is generated in the field. Depending on the cropping pattern, crop growth, frequency, multi-cropping pattern, and crop production, the production of this crop depends on it. After cereals and pulses, solid waste is generated from the sugarcane crop. Uttar Pradesh is the largest producer of solid waste from sugarcane, pulses, and cereals.

The fibrous cropping system produces more solid waste from the state of Gujarat and more solid waste from the state of Rajasthan from oilseed crops. About 70 percent of the farmland solid waste in the fertile silt area is incinerated in the fields and the remaining 30 percent is generated from non-agricultural groups.¹¹ About 85 percent of paddy, wheat, and sugarcane crops and about 15 percent of the remaining crop produce solid waste. The burning of solid waste in the fields causes pollution in the environment and causes physical ailments to human health and animal life. It reduces organic carbon. Burning of one tonne of crop residue releases 1,515 kg CO₂, 92 kg CO, 3.83 kg NO₂, 0.4 kg SO₂, 2.7 kg CH₄, and 15.7 kg non-methane volatile organic compounds. The residue of paddy crops contains 15 to 20 percent phosphorous similarly it contains the same amount of potassium, these were hampered due to field waste burning.⁷

Material and Methods

Related Work

It can be used in the field by other means than burning solid waste in the field, such as mulching, electric current generation, and mixing raw materials in brick making. It can also be made into organic manure by picking fruits and vegetables or, most importantly, by decomposing it. The solid waste from

the field can be used with processed compost, which has less C / N. So vermicomposting is a good way to compost organic waste in less time as compared to other composting methods.

Lim and *et.al*¹ noted the following observations. Vermicomposting is a process in which earthworms are used to convert organic materials into humus-like material known as vermicompost. The nutrient profile in vermicompost is higher than in traditional compost. The soil used with Vermicompost gives good permeability parameters. High concentrations of soluble salts are available in vermicompost.

Pathma and *et.al*² noted the following observations. The vermicomposting process is done with the help of earthworms and microbes. The final product has a good texture with excellent permeable parameters. It has excellent porosity, excellent air circulation, and good ability to discharge water, improve water retention ability, the activity of microbes of soil, and better nutrient condition. It is helpful for soil fertility and plant growth.

Yadav and *et.al*⁸ noted the following observation. In agriculture biological inputs instead of intensive use of chemical fertilizers and pesticides. Organic farming does not harm the health of the soil or the environment. Blouin and *et.al*⁴ noted the following observation. Vermicomposting is a process whereby earthworms transform organic residues into compost that can be used as a substrate for plant growth. The best original material to be used for vermicompost production is cattle manure.

The following remark was made by Adhikary.⁵ Vermicompost has piqued the interest of scientists all around the world in recent decades. A sustainable society requires solid waste planning. Vermicomposting, rather than landfilling, should be used for solid waste disposal. Earthworm excreta (Vermicast) is a nutritive organic fertilizer that is high in humus, NPK, micronutrients, beneficial soil microbes, nitrogen-fixing, phosphate-solubilizing bacteria, actinomycete, and growth hormones like auxins, gibberellins, and cytokinins. Both vermicompost and Vermicast have been shown to help crop plants develop, promote, and protect themselves.

Arancon *et al.*⁶ noted the following observations. Organic matter available in the field provides essential nutrients to fruit trees and other crops. It also mixes with soil and improves soil texture. Increases soil fertility. Organic matter decomposes by earthworms and decreases the carbon-to-nitrogen proportion in the soil. The soil cavity grows, and crop yields increase. The nutritional value of the soil increases. The use of organic matter in the field increases the water-holding capacity of the soil. Ramnarain and *et al.*⁷ noted the following observations. Vermicompost fertilizers In comparison with chemical fertilizers, produce low-cost, highly nutrient vermicompost. The nutritional content of the obtained vermicompost was excellent. Lazcano and *et al.*⁸ noted the following observations. Vermicomposting is a low-tech, environmentally benign method of dealing with organic waste. Vermicomposting requires organic waste, so the conversion of farm solid waste into good natural organic manure in less time and less money. Those fertilizers contain earthworm droppings and decomposed organic matter. It is useful for orchards and for vigorous cultivation of crops. Vermicomposting helps in maintaining the balance of a sustainable agricultural environment. This paper sheds light on the following.

Results

The Role of Earthworms in Vermicomposting

Moist soil compost is converted into organic manure by rotting soil due to earthworms. In this, earthworms use decomposed semi-field waste as food. It goes through their digestion and comes out in the form of feces, which is known as their final product, vermicomposting. These organic fertilizers contain humus, nitrogen, phosphorus, potash, micronutrients, beneficial bacteria in soil, fungus, etc. This fertilizer is a boon to farmers and is a supplement to the chemical fertilizer, which stimulates the growth of plants and enhances the physical, chemical, and biological properties of the soil. Vermi culture means the scientific breeding of earthworms under controlled conditions. Also, vermicomposting and vermiculture are called vermin technology. Vermicomposting causes the decomposition of farm waste and the production of vermicomposting through its excrement. Earthworms increase the surface area of solid waste. As a result, it degrades quickly. The following are the advantages of using earthworms.

- Barren land (barren) is converted to arable land.
- Drainage is good for air circulation.
- Organic manure is produced.

Types of Earthworms

The animal grooves of the earthworm Phylum Annelida. Earthworms come in around 3,000 different species. India is home to 300 of these species. Clitellum turns into hard capsules called cocoons when the earthworm lays its eggs. The number of cocoons varies from one to five. In suitable habitat, earthworms can live anywhere from one to ten years. Vermicomposting relies heavily on worms that dwell and work on the soil's surface. *Eudrilus eugeniae* and *Eisenia foetida*, as well as *Perionix excavates*, are examples of exotic worms. They make compost from organic degraded debris. This kind of earthworm thrives in temperatures ranging from 0 to 400 C.

Figure 1 shows the species of *Eisenia foetida*. Figure 2 shows the species of *Eudrilus eugeniae*. Figure3 shows the *Eisenia foetida* cocoons. Figure 4 shows *Foetida* 4 worms/cocoons.



Fig. 1: *Eisenia foetida*



Fig. 2: *Eudrilus eugeniae*



Fig. 3: Eisenia foetida cocoons



Fig. 4: Foetida 4 worms/cocoon

Vermicomposting Operating System

The partially decomposed field waste decomposes into the earthworm's digestive system and is converted into feces. It is known as vermicomposting. Five to ten percent of this consumed material is used for earthworm growth and the rest of the material is converted into excrement to form vermicomposting.⁹

Vermicomposting Preparation

Varied wastes in the field have different C/N ratios. As a result, the C/N ratio affects the breakdown of such waste. Microbes with a high C/N ratio need nitrogen to grow the soil. This lowers nitrogen levels in the soil at first. The C/N ratio in Vermicompost is less than 20:1. Organic garbage decomposes swiftly at that time. Vermicompost is made with the following components. Sawdust, dried leaves, weed biomass, dirt, kitchen garbage, cow dung, biomass slurry, animal urine, and other organic waste generated in the field. The C/N ratios of various agricultural wastes are shown in Table 1. The C/N ratio of sugarcane waste residue has reached its maximum value. 0 C

Table 1: Crop residue C/N ratio (source: nracs.usda.gov).²⁹

Sr.No.	C/N Ratio	Crop
1	82:1	Rye Straw
2	86:1	Paddy Straw
3	80-100:1	Sugarcane Straw
4	80:1	Wheat Straw
5	70:1	Oat Straw
6	57:1	Corn Stover
7	37:1	Rye as cover crop
8	29:1	Pea Straw
9	26:1	Rye Cover Crop (Vegetative)

Steps Involved in Vermicompost Preparation

- Flour, bed or mound is used for composting. The size of the pit is 10 feet * 4 feet * 2 feet. It does not grow to more than two feet in height, as the earthworm works properly up to a height of two feet. Make vermicompost in fallow soil.
- In the form of cow dung and powder the leaves of the tree (dried) should be taken in the ratio of 3: 1.
- When making the bed, make a thin layer of 15-20 cm of field waste.
- 0.5 to 1 quintal of raw material in each bed in which cereals and cereals should be used.
- After spreading the material on the bed, sprinkle water on the first and second layer and apply a layer of 2 inches moist dung. Make a bed two feet high. The waste should be rotated periodically to keep humidity and temperature in it.
- Keep the waste for twenty to twenty five days for low decomposition.
- After 24 days, earthworms should be maintained on the bed at the capacity of 2000 nos. Or peat capacity.
- If an earthworm is left on the bed, sprinkle water on it so that moisture, temperature and humidity remain in the bed. Get down on the bed once in about 30 days.
- In 45 to 50 days, the compost gate will be ready to harvest. It is dependent on the circumstances. In two to three months, vermicompost is ready to utilize.
- Worm manure production is 75% efficient. This means that if 1000 kg of raw material is used

for making vermicompost, it produces 750 kg of manure.¹⁰

Complementary circumstances and factors affecting the dispersion of the earthworm. The PH, EC, Organic matter, temperature, and moisture all influence the dispersion of earthworms in beds.

- Temperature- 18°C to 35°C temperature is favourable for the growth of an earthworm since the respiratory system and metabolism of an earthworm depend upon temperature.
- PH and electrical conductivity- The pH and raw material affect the distribution and number of earthworms. The pH level should be neutral. The loss of weight of organic matter owing to decomposition and the release of salts in a new form enhances electrical conductivity. Moisture Content.
- Moisture holding capacity is an important part. Almost 75% to 90% body weight of earthworms is covered by water, the mortality rate of worms depends upon moisture contained in beds.
- Aeration and soil texture it is maintained by pore space in the soil. If it is less than 50% of earthworms' death occurs due to suffocation. Soil texture influences earthworm population, moisture-holding capacity, nutrient content, etc.
- Compost harvest from the pit: Stop watering the bed one week before harvesting. A pail of water is used to separate the worms from the pit. Collect the top compost, then sieve the dipper layer using a 2 mm sieve to separate the worms and compost. The remaining uncomposed debris is moved to a new Pit to be composted. Collect the compost after sieving and store it in a shaded area. And keep their moisture level up. Vermicompost is the name given to the end product. For selling, place the compost in plastic or gunny bags.

Precautions

- The vermicompost pit should not be covered with plastic material so that heat is absorbed and gas is produced during decomposition. Cover with coconut leaves or paddy straw instead.
- Take the height of a heap of organic waste of more than 2 feet to avoid the generation of heat which affects the population of an earthworm because more height decreases aeration in the pit.

- Do not keep the pit dry since worms will migrate from a dry location to a damp area.
- Excessive water causes waterlogging, which causes death. Watering should be done every day in the summer and every three days in the winter and rainy seasons.
- Tomato and citrus waste are rich in acidity hence they reduce worm density so they do not utilize.
- During rainy days drainage channels are necessary to avoid water stagnation.
- Non-biodegradable goods such as glass, plastic, stone, hazardous materials, ceramics, and other non-biodegradable items must be removed from organic waste.
- Transportation of live worms is done in a cardboard or plastic container that should be well aerated and contain worm feeding material.
- Natural enemies in the pit include ants, centipedes, termites, pigs, rats, birds, and snakes. Apply a 4 percent neem cake at the time of pit filling to minimize the number of natural enemies.

Advantages of Wormy Compost

- Wormy compost develops disease resistance in plants, it is rich in all essential plant nutrients. It is also used as a valuable soil amendment.
- It is not produced any odor.
- It improves soil's physical properties.
- Enzymes found in the worm gut aid in the microbial integration of crop residue degradation and speed up the decomposition process.
- It increases the number of earthworms in the soil and their activity.
- It promotes plant stress tolerance.
- It is used in nurseries to raise seedlings as a rooting medium.
- It boosts plant immunity, retains the plants' lush green color, and ensures a high-quality product.

Discussion

The main issue is the burning and disposal of farm waste. The burning of waste destroys the nutrients in the soil, as well as pollutes the environment, creates health problems for human beings, and raises the temperature of the soil. This disturbs the soil ecosystem. In India, paddy, wheat, and sugarcane produce more solid waste. Small and medium farmers cannot afford to transport the waste and destroy it, so they burn it in the field and drain it. So if farmers can afford to collect it and make

vermicompost from it. Earthworm manure contains NPK, micronutrients, and growth nutrients. They are useful for plant growth. It also improves soil texture. Vermi wash is also a product produced at the time of vermicompost preparation. So that there is no need to spray pesticides in the field. If farmers use chemical fertilizers regularly, the soil becomes infertile and fertile, groundwater becomes polluted, and chemical fertilizers affect human health, increase farm costs and reduce yields. They are harmful to the ecological chain. Therefore, making vermicompost is a boon to farmers and farms. Also, high-quality manure is produced from farm waste organic waste in less time and it is easier to do sustainable farming.

Acknowledgment

The authors are grateful to the Management of Karmayogi Engineering College, Shelve, Pandharpur for providing an Environmental Engineering Lab to install an Experimental setup, and other required facilities for the experimentation. We are also very grateful to Dr. Khadatare S. V., Zonal Agriculture

Research Station, Solapur under Mahatma Phule Krushi Vidhyapeeth, Rahuri. We are also helpful to Dr. Patil S. P., Principal of Karmayogi Engineering College Shelve for guiding us.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest

- The following mentioned information is true.
- All authors contributed in (a) idea and design, or data analysis and interpretation; (b) drafting the article or critically editing it for vital intellectual content, and final approval of the final version.
- This work has not been submitted to or is currently being reviewed by any other journal or publishing venue.
- The writers are not affiliated with any entity that has a direct or indirect financial interest in the subject matter covered in the paper.

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