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Handbook on Vermicomposting

Requirements, Methods, Advantages and Applications

Anchor Academic Publishing

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PREFACE

The earth is constantly being loaded with waste materials. They pose danger to the world by polluting the land, air as well as water resources. Some alternatives need to be developed to extract the best out of waste. Vermicomposting presents such an alternative. It utilizes the zero valued waste materials to yield valuable biofertilizers from them. It can be used to increase the production of crops as well as improving the structure of soil, that too without damaging the environment.

*"There is a place in the heart where thoughts become wishes and wishes become dreams." We express our sincere gratitude to our beloved father Shri S. N. Singh and mother Smt. Ranju Singh, who bore the weight of sacrifice with patience, whose selfless love, affection, sacrifices and blessing made my path easier and helped us to make our dreams come true. Their blessings have always been the most vital source of inspiration and motivation in our life. Our most cordial thanks go to our younger sister Namrata who inspired us constantly and moulded us into the present position. How can we express our thanks to "**God**" because there is no word to express it. So, my lord, please realize and accept our feelings.*

Dedicated

To

My

Parents

CHAPTER I

INTRODUCTION

The population of the world is exploding ! This is attributed to the advancement made by science in various fields. The entire population needs to be fed. This feed is derived from the land. The process of agricultural modernization has been an important contributing factor towards this. Modern agriculture utilizes necessary inputs of fertilizers, pesticides and labour. Production has been improved through these modern technologies. This has led to adverse environmental impacts. Some of them are enlisted below :

Overuse of natural resources: It leads to

- depletion of groundwater,
- loss of forests and wild habitats,
- decline in the capacity to absorb water,
- waterlogging and increased salinity.

Contamination of the atmosphere:

- by ammonia, nitrous oxide, methane and the products of burning or
- by the spraying of pesticides and insecticides

It leads to

- ozone depletion,
- global warming and
- atmospheric pollution

Contamination of food and fodder: by residues of pesticides and antibiotics.

Contamination of water: It is caused by pesticides, nitrates, etc. and leads to

- wildlife damage,
- disruption of ecosystems and
- possible health problems in drinking water.

Resistance to pesticides: in pests and diseases including herbicide resistance in weeds.

Loss of genetic diversity: causing the displacement of traditional varieties and breeds.

One needs to use some better alternatives to sort out this situation. Vermicomposting seems to be an excellent replacement of these chemical fertilizers. Vermicompost is an odorless and clean organic material containing adequate quantities of N, P, K and several essential micronutrients. It is eco-friendly, non-toxic, consumes low energy input for composting and is a recycled biological product. The left over organic matter are decomposed to yield the precious vermicompost.

Vermicompost is an organic manure (bio-fertilizer) produced as the vermicast by earth worm feeding on biological waste material.

Vermicomposting is a process in which worms are used to convert organic materials usually wastes into a humus-like material known as vermicompost. The main purpose is to process the material as quickly and efficiently as possible.

Vermiculture is the culture of earthworms to continually increase the number of worms in order to obtain a sustainable harvest. These worms are used

- to expand a vermicomposting operation or
- to sell it to the customers.

DEFINITION OF VERMICOMPOSTING

Vermicomposting can be defined as an aerobic non-thermophilic bio-oxidation process of organic waste decomposition which depends on earthworms.

FEATURES OF VERMICOMPOSTING

- Natural
- Free from chemicals
- Eco-friendly
- Non-toxic
- Utilizes garbage
- Low energy input
- Easy to maintain

- Little or no odour
- Rich in nutrients
- Excellent for the growth of plants

Used In :

- Farms
- Agriculture
- Gardens

HISTORY

Composting has been used by farmers and gardeners since prehistoric times to recycle wastes into products that are capable of boosting plant growth. The word composting originated from Latin words com = together and post = to bring. Decomposting or vermicomposting has been known from the very beginning. The Egyptians were one of the first cultures to recognize the soil amending properties of the earthworm. Worms have been observed by such scholars as Aristotle and Charles Darwin as organisms that decompose organic matter into rich humus or compost.

Charles Darwin, the English naturalist conducted a comprehensive study of burrowing earthworms. In 1881, he published his last book “The Formation of Vegetable Mould, Through the Action of Worms, With Observations of their Habits”. This book reports the feeding behaviour of these organisms and conversion of the organic matter castings which favor plant growth.

Vermiculture was started in the 1950s in the United States for the production of fish baits. Vermicompost was produced in United States and United Kingdom from organic wastes by using earthworms in the 1980s. The publication of the “Proceedings of a Workshop on the Role of Earthworms in the Stabilization of Organic Residues” in 1981, 100 years after Darwin's study, is responsible for increasing vermicomposting within and outside of the United States. The research on vermiculture was carried out by Roy Hartenstein in the US and and Clive A. Edwards in the U.K. 1980s. Commercial vermicomposting projects have been developed in many countries such as England, France, the Netherlands, Germany, Italy, Spain, Poland, the United States, Cuba, Mexico, the Bahamas, China, Japan, Philippines, India and elsewhere in Southeast Asia, as well as Australia, New Zealand, American Samoa, Hawaii, and many countries in South America.

The first Vermitechnology Unlimited worm farm was constructed on a five acre parcel with very large oaks and some pines scattered in. It was built to utilize the natural shade rather than clear cut and then put up artificial shade or a green house operation. This farm has a total of 3,000 linear feet of worm beds which averaged 3100 lbs. of worms being produced each month.

The production of vermicompost and vermimeal started in 1979 in Philippines. The International Symposium-Workshop on Vermi Technologies for Developing Countries was held in the Philippines in 2005.

In 1972, Mary Appelhof, Michigan biology teacher first started home vermicomposting. She is also known as the mother of modern day vermiculture. A 2009 article in the New York Times, "Urban Composting: A New Can of Worms," made many more American readers aware of the potential for even apartment dwellers to try vermicomposting.

- Vermicomposting centers are numerous in Cuba. When the Soviet Union fell, it became impossible for them to import commercial fertilizer. Vermicompost has been the largest single replacement for commercial fertilizer by Cuba. In 2004, an estimated 1 million tons of vermicompost were produced on the island.
- In India, and estimated 200,000 farmers practice vermicomposting and one network of 10,000 farmers produce 50,000 metric tons of vermicompost every month.
- Farmers in Australia and the West Coast of the U.S. are starting to use vermicompost in greater quantities, fuelling the development of vermicomposting industries there.

- Scientists at several Universities in the U.S., Canada, India, Australia, and South Africa are documenting the benefits of vermicompost, providing facts and figures that support the observations of those who have used it.

TYPES OF COMPOSTING

Composting is biological conversion of organic matter into humus-like material called compost by heterotrophic microorganisms such as bacteria, fungi, actinomycetes and protozoa. The process occurs naturally. Right organisms, feed material, moisture, aerobic conditions and nutrients are needed for microbial growth. At optimum conditions, the composting process can occur at a much faster rate.

According To Its Nature

Aerobic composting: - It stands for composting in the presence of air. Organic waste are broken down quickly and is not prone to smell. It requires high maintenance as it needs to be turned on a regular basis to keep air in the system and temperatures up. It is also likely to require accurate moisture monitoring. This type of compost is good for large volumes of compost.

Anaerobic composting: - It stands for composting in the absence of air. Anaerobic composting requires low maintenance as waste is simply throw in a pile. It is a slow process. It may take years to break down. Anaerobic composting produces awful smell. The bacteria break down the organic materials into harmful compounds like ammonia and methane.

Vermicomposting: - Composting is carried out by red worms including bacteria, fungi, insects and other bugs. The broken organic materials are utilized by the others to eat. Red worms eat the bacteria, fungi and the food waste and then deposit their castings. Oxygen and moisture are required for healthy composting. It requires medium level maintenance. One needs to feed the red worms and monitor the conditions.

According To Its Use

Industrial systems: - Industrial composting systems are popularising these days as an alternative to landfills. Untreated waste breaks down anaerobically in a landfill, producing methane gas and adds to greenhouse effect. It aims at treating biodegradable waste before it enters a landfill to harm.

***Agriculture**: - W*indrow composting is used in agriculture. It is the production of compost by piling organic matter or biodegradable waste such as animal manure and crop residues, in long rows (*windrows*). This method is appropriate for producing larger volumes of compost. These rows are generally turned to improve porosity and oxygen content, mix in or remove moisture and redistribute cooler and hotter portions of the pile. Windrow composting is commonly used for farm scale composting.

***Home**:* - Home composting is the simplest way to compost. At home, composting is generally done by using composting bins or in the form of pile composting. Other methods include trench composting and sheet composting. It is a small scale process and requires less outlay of capital and labour.

The World is Catching On

Vermicomposting is being adapted globally, especially in the warmer climates. India and Cuba are among the leaders.

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  About 200,000 farmers practice vermicomposting and a network of 10,000 farmers produce 50,000 metric tons of vermicompost every month.
- Farmers in Australia and the West Coast of the U.S. are also starting to use vermicompost in greater quantities.

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VERMICOMPOST PRODUCTION AND ITS ECONOMICS

Mitchell and Edwards (1997) studied production *Eosinea fetida* of vermicompost from feed-lot cattle manure. Significant reductions in total mass of cattle manure were obtained by the activity of earthworms. The process yielded two products: residual vermicompost, and an increase in earthworm biomass. The most successful mode of manure application was found to be surface (vertical) application which resulted in a reduction of 30% of the initial manure (dry) mass and the production of live earthworms to 4.9% of the initial manure mass (dry weight). The increase in earthworm biomass represented extraction of 7, 18, 7 and 2% of initial total C, N, S and P respectively from the manure.

Sunitha *et al.* (1997) attempted evaluation of methods of vermicomposting under open field conditions. It was aimed to evaluate methods of vermicomposting under open field conditions. The heap system was found to be better than the pit method for biodegradation of wastes. The heap recorded higher population growth with a 20.37 - 20.86 fold increase in *Eudrilus eugeniae*.

Atiyeh *et al.* (2000) studied the effects of vermicomposts and composts on plant growth in horticultural container media and soil. The results showed that vermicomposts have the potential for improving plant growth when added to greenhouse container media or soil. However, there seem to be distinct differences between specific vermicomposts and composts in terms of their nutrient contents, the nature of their microbial communities, and their effects on plant growth.

Biradar *et al.* (2000) analysed the influence of seasons on the biomass of *Eudrilus eugeniae* and vermicompost production at the Regional Research Station, Bijapur, Karnataka, during 1995-98. The results of the study showed that the rainy season was more congenial for earthworm multiplication and vermicompost production than either winter or summer.

Giraddi (2000) studied the influence of vermicomposting methods and season on the biodegradation of organic wastes. An experiment was conducted during 1997-98 at Dharwad, to study the effect of vermicomposting and season on the biodegradation of organic wastes. The biodegradation was quite efficient during rainy and winter composting as compared to summer composting. This is indicated by higher vermicompost production and lower amounts of undegraded wastes in rainy and winter composting than in summer composting.

Jeyabal and Kuppuswamy (2001) investigated on the recycling of agricultural and agro-industrial wastes for the production of vermicompost. Its response was studied in a rice-legume (black gram) cropping system during 1994-96 in Tamil Nadu, India. The study showed that bio-digested slurry and weeds was found to be an ideal combination for vermicomposting considering the nutrient content and compost maturity period. The integrated application of vermicompost, fertilizer N and bio-fertilizers increased rice yield by 15.9% over application with fertilizer N alone.

Anonymous (2004) studied the market driven eco-enterprises for livelihood security. Based on the economic viability, these enterprises included production of a biological control agent, bio-fungicide, vermicompost, bio-fertilizers, food processing, mushroom culture, ornamental fish breeding, production of handmade paper and boards from crop wastes.

Garcia-Gil *et al.* (2000) and Bulluck *et al.* (2002) reported that compost produces significantly greater increases in soil organic carbon and some plant nutrients as compared to comparison with mineral fertilizers.

Dominguez (2004) stated that vermicompost is a stabilized, finely divided peat-like material with a low C:N ratio, high porosity and high water-holding capacity, in which most nutrients are present in forms that are readily taken up by plants.

Barik *et al.* (2005) studied the effect of different farm wastes on vermicomposting. Various crop residues such as paddy straw, vegetable waste, gliricidia leaves, rice bran, wheat bran, green gram haul, and gober gas slurry and groundnut haulm were mixed with cow dung and were used as substrates for vermicomposting. The production of vermicompost was maximum with the groundnut haulm treatment (2.5kgs). This was at par with having gliricidia leaves and green gram halum.

Costa *et al.* (2005) evaluated composting process through diary temperature monitoring of piles composed of wastes from the cotton carding industry and with 3 kinds of inoculums. The results showed that the rumen as inoculum presented high temperature values in the initial phase and low values in the final phase although the stabilization occurred at the same time. The system with aeration allowed faster material stabilization as compared to the system without aeration. The intensification of turnings in the second phase decreased the composting time and reduced the final volume by 46%. The vermicomposts showed higher nutrient content as compared to the other composts produced.

Reddy *et al.* (2006) conducted a study in Tiptur taluk of Tumkur district, Karnataka to workout economics of vermicompost use in coconut with a sample size of 40 vermicompost (VC) user farmers and 20 non-vermicompost user farmers. In general, VC users incurred lower expenditure on inputs especially on fertilizer and plant protection chemicals. The variable vermicompost, though not statistically significant, had positive association with the copra output. The application of VC to coconut farms resulted in many environmental benefits such as reduction in fertilizer use, plant protection chemicals and number of irrigations given to the crop.

Chinnappa Reddy *et al.* (2007) analyzed economics of vermicompost production and economic gains from its application to the crops like, banana, coconut, coffee, and pepper. The study was carried out in Coorg, Mysore, Hassan, Kolar, Mandya, Tumkur and Bangalore districts. The study focused on two types of vermicompost production, viz., vat method and heap method with regard to the vermicompost production.

Ramamurthy *et al.* (2007) in their study conducted near Nagpur in Maharashtra reported that vermicompost application would improve the yield of citrus by 21 %, with B: C ratio of 3.21. The adoption of vermicompost application increased from 3 per cent to 28 per cent over five years. The rate of return of vermicompost worked out to be 2.92.

Weber *et al.* (2007) reported that the results of several long-term studies have shown that the addition of compost improves soil physical properties by decreasing bulk density and increasing the soil water holding capacity. Long-term beneficial effects of composted materials are also observed in soil humic substances (due to an increase in the complexity of their molecular structure, which increases the humic/fulvic acid ratio) as well as in soil sorption properties.