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5. Application of Vermitechnology in Agriculture and Aquaculture

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5.1 Introduction:

Now a day's agriculture is distinguished by excessive use of inorganic fertilisers, herbicides and pesticides, and insufficient use of organic fertilisers (Li et al. 2007; Gill and Garg. 2014).

As well as to increase crop production, excessive use of inorganic fertilisers was practised widely worldwide. This chemical farming will affect both terrestrial and aquatic compartments. To address such issues, urgent action is required to maintain agriculture production to feed the human should be produced sustainably.

Animal manure is a beneficial soil fertiliser because it contains a high concentration of macro-and micronutrients for crop growth and is a low-cost, ecologically acceptable alternative to mineral fertilisers. The non-thermophilic biodegradation of organic materials accomplishes vermicomposting by earthworms and microorganisms.

Earthworm plays a primary role in the process of vermicomposting. But actual decomposition of organic matter accomplishes by the microorganisms. Firstly, earthworms

act on the organic matter; it consumes organic waste it generates fragmented matter, by the action of beneficial microorganisms, numerous enzymes such as cellulase, amylase, lipase, protease, urease and chitinase and finally excreted in the form of "casts" (Munnoli et al. 2010; Dominguez and Edwards 2004), next step is maturation like a phase in which microbes degrade earthworm-processed materials.

Earthworm secretes the substance known as a coelomic fluid into the organic waste, which is helpful to destroy the pathogenic microorganisms such as Salmonella, Serratia marcesens and Escherichia coli and enhance the growth of plants (Prabha 2009).

Nutrients move from one system component to another system by the typical process called biodegradation. It is enhanced by the earthworm, releases macronutrients, and available phosphorus is more accessible to plants.

Vermicompost has been shown to have a positive effect on a wide variety of crops such as ornamental plants; a medicinal plant, forestry species promoted seed germination, helps in root growth, and stimulates flowering and fruit yield. In addition to this, several studies of previous research stated that vermicompost had a positive role in aquaculture.

5.2 Earthworm Distribution:

Earthworms have a significant role in soil health profile both in temperate and tropical countries, and this is commonly regarded as intestine of earth, farmer's friends and natural ploughmen, by this way it impacts on the physical (soil texture, porosity and resistivity), chemical (Cation exchange capacity and buffering capacity) and biological properties of soil (Singh et al., 2016a).

Abiotic factor (pH, moisture, soil texture and organic carbon) affects the distribution of earthworm species in different region of habitat in the soil. It showed a positive correlation between abiotic factors *vs* earthworm distribution, mostly this prefer to show higher diversity near to both gardens and nurseries (consists of high organic matter) compared to the chemical farming area (Singh et al., 2016b), besides it also depends on the different array of food source available and reproduction potential of species.

Earthworms are classified into three types based on ecological life form a)epigeics, b)anecics, c)endogeics

Epigeics exhibit higher respiration capacity, maturation, fecundity, mobility, and a smaller body than other earthworms (anecics and endogeics).

Endogeics are larger than epigeics, pigmentation usually absent, higher burrowing capacity; they show strong sensitivity to light, and primarily they are associated with organic matter.

Aneceics are anterior- dorsally pigmented, medium reproductive rate, hooked chetae. They are phytogeophagous worms, live in strongly developed vertical burrows.

Table: 1 Classification of Earthworms

Epigeics	**Endogeics**	**Aneceics**
Eisenia foetida	*Aporrectodea caliginosa*	*Lumbricus terrestris*
Lumbricus rubellus,	*A. trapezoids*	*L. polyphemus*
L. castaneus	*A. rosea*	*Aporrectodea longa*
L. festivus	*Millsonia anomala*	*L.mauritii*
Eiseniella tetraedra	*Octolasion cyaneum*	*D. willsi*
Dendrodrilus rubidus	*O. lacteum*	
D. octaedra	*Pontoscolex corethrurus*	

Table: 2 Raw Materials and Earthworm Species Used in Vermicomposting (From Gupta et al., 2019)

Bagasse	*Eisenia foetida*
Banana	*Eudrilus eugeniae,*
wastewater of a palm oil mill	*Eudrilus eugeniae*
Domestic waste + cow-dung	*Perionyx excavates, Perionyx sansibaricus*
Cattle manure	*Eudrilus eugeniae*
Wooden or plastic	*Eisenia foetida, Eudrilus eugeniae, Perionyx excavates*
Vegetable waste + floral waste	*Eudrilus eugeniae, Eisenia foetida, Perionyx excavates*

5.2.1 Benefit of Vermicompost in Agriculture:

Dominant crops such as cereals and root vegetables are considered leading crops, routinely taken as higher amounts beside it supply good fraction nutrients, high-calorie content, and energy. Wheat, Rice (*Oryza sativa L.*) and maize are the chief cultivated crops (staple crops), combined supply nearly 42% of calories to human population consumption.

Split treatment of vermicompost prepared from six mixed organic waste inoculated with earthworms (*Eisenia fetida*) and applied to rice at a different stage of crop growth resulted in higher yield characteristics such as panicles (294 m2), full grains per panicle (138), total spikelets per panicle (142) and grain yield (3.91 t ha-1) (Bejbaruah et al., 2013).

Bread wheat (*Triticum aestivum L.*) contributes to nearly 30% of overall cereal production and more than 50% of total human calorie consumption (FAOSTAT, 2015). In another experiment, a combination of deep tillage system and vermicompost made up of various

crop organic waste (rice, cotton and maize straw) biodegraded by using the worms (*Eisenia fetida* and *Dendrobaena veneta*) applied to wheat crop in both seasons showed higher grain yield (kg ha− 1) Biomass yield (kg ha-1) compared to chemical amendment (sulfuric acid and gypsum) and control (Ding et al., 2021).

A research carried out in eastern China, an area mainly undergoes temperate, and monsoon climate, two different types of compost were taken to know the efficiency of vermicompost. Organic matter and nitrogen, available phosphorous, and potassium quantity showed higher in the cattle manure-vermicompost (added with Eisenia fetida)-maize system (VC system) than the traditional type of compost made of cow dung. During the breakdown of the organic compounds, pH significantly decreased, especially vermicomposting compost. In this system, maize absorbed a greater nutrient, ultimately increasing the yield in dry matter of total above-ground biomass and maize grain by 7.7% and 18.3%, respectively (L. Guo et al., 2015). Similarly, waste generated in aquaculture is mainly of aquaculture sludge or soil waste generated from aquaculture. It comprises uneaten feed settle on the bottom of the pond and becomes sludge, harming aquatic species. This nitrogenous organic waste is converted into valuable fertiliser by the vermitechnology process. This vermicompost is used in the agriculture field as fertiliser, which promotes the growth of crops (Birch et al., 2010).

5.2.2 Benefit of Vermicompost in Aquaculture:

Several studies reported that vermicompost could be utilised in an aquaculture farm differently.

Application of vermicompost to aquaculture pond as fertiliser showed the higher population of both Phytoplankton (3,034 L-1), Zooplankton (780 L-1) production compared to other inorganic fertiliser (Single superphosphate and Mixed fertiliser). Vermicompost may contribute higher nutrient content, enhance the plankton production, which eventually increases the fish yield of *Oreochromis mossambicus* (Cichlidae) (4,000.00 kg ha-1 90 days) as well as increases the overall productivity of the pond (Chakrabarty et al., 2010). Similar to that seen by (Chakrabarty et al., 2009), who noticed that the application of vermicompost might be contributed to increasing the phytoplankton population (2,759 nos l-1) and fish yield (3,970.56 kg ha-190 day-1) than diammonium phosphate and compost without earthworm. Vermicompost (prepared from cow dung) applied to fish pond as manure at the rate of 15,000 kg/ha/year contributed the better water quality parameters (mainly, Dissolved oxygen), Zooplankton population, enhanced fish yield/tank and Specific growth rate of Common carp, *Cyprinus carpio* compared to semi-digested cow dung (Kaur, V. I. and Ansal, M. D. (2010). The pond fertilised using vermicompost @10000kg/ha/yr revealed the most growth of *Catla catla* in weight gain, length gain, and growth increment (Kaur J and Gupta, 2016).

Organic acids, such as liquid vermicompost can assist shrimp farming by improving growth, feed utilisation, gastrointestinal health, and disease resistance in aquatic animals (Ng WK and Koh CB YC, 2017).

Notably, application of vermicompost @ 10,000 kg/ha/yr and 15,000 kg/ha/yr in fish rearing pond of two different treatments revealed that the absence of bacteria such as *E. aerogens, P. fluorescens, P. aeruginosa, Shigella sp., K. oxytoca,* and *Streptococcus sp*. were all found to be negative, both treatments showed a higher growth rate of Indian major carps in rearing ponds (Kumar, S., and Godara, S., 2019). Vermicomposting is recommended as a safe and long-term method of converting sludge from aquaculture into extremely valuable vermicompost and earthworm biomass. Stabilized vermicompost produced from sludge can be utilised in agriculture farming systems. Earthworms, high in protein, have been advocated as a feed for livestock, including fish (A. Kouba et al.,2017).

5.3 Conclusion:

Inorganic farming harms the ecosystem; it has altered microbial communities in the soil and decreased soil fertility. Alternatively, organic farming leads to less stress on the soil and water compartment. Vermicompost increased soil fertility, supported plant growth, a significant role in pest control, arthropod suppression, nematode control, and it has better management in medical waste and sewage water treatment. In addition, vermicompost plays a significant role in aquaculture; directly (Fish feed) or indirectly improves phytoplankton production, ultimately increasing the fish yield.

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