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Vermicomposting: A Better Option for Organic Solid Waste Management

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ABSTRACT An innovative discipline of vermiculture biotechnology, the breeding and propagation of earthworms and the use of its castings has become an important tool of waste recycling the world over. Epigeics like *Eisenia foetida* and *Eudrilus euginiae* have been used in converting organic wastes (agro waste and domestic refuse) into vermicompost. In FRI, the division of Ecology and Environment has started a project on vermitechnology using the earthworm species *Eisenia foetida*.

INTRODUCTION

Management of solid waste has become one of the biggest problems we are facing today. The rapid increase in the volume of waste is one aspect of the environmental crisis, accompanying recent *global development* (Rapid urbanization. encroachment of fertile area and booming population is leading to generation of massive amount of waste).

Solid waste is defined as the organic and inorganic waste materials produced by different sources and have lost value in the eye of their owner. It has been estimated that India, as a whole, generates as much as 25 million tones of urban solid waste of diverse composition per year. But per capita waste production in India is minisculous compared to the per capita production of wastes in the industrialized countries. It is estimated that the per capita waste generated in India is about 0.4 kg/day with the compostable matter approximately 50-60%. Most common practices of waste processing are uncontrolled dumping which causes mainly water and soil pollution. Besides dumping or sanitary land filling, the final disposal of solid waste can be carried out by other methods like incineration and composting. Earthworm farming (vermiculture) is another bio-technique for converting the solid organic waste into compost (Ghosh, 2004).

An innovative discipline of vermiculture biotechnology, the breeding and propagation of earthworms and the use of its castings has become an important tool of waste recycling the world over. Essentially, the vermiculture provides for the use of earthworms as natural bioreactors for cost-effective and environmentally sound waste management.

Now there is an all-round recognition that adoption and exploitation of vermiculture biotechnology besides arresting ecological degradation could go a long way towards meeting the nutrient needs of the agricultural sector in a big way. On another front, widespread use of vermicultural biotechnology could result an increased employment opportunity and rapid development of the rural areas. It is high time that the scientific community of the country gave a serious attention to standardizing and popularizing vermiculture technology on a countrywide basis.

Role of earthworms in the breakdown of organic debris on soil surface and soil turn over process was first highlighted by Darwin (1881). Since then it has taken almost a century to appreciate their important contribution in curbing organic pollution and providing topsoil to impoverished lands. Although this realization has awakened the global population to give a serious thought to utilize them for the benefit of mankind, by the turn of this century (Kale, 1998).

Vermicomposting facilities have already entered domestic and industrial marketing in countries like Canada, USA, Italy and Japan.

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Vermicomposting was started in Ontario (Canada) in 1970 and is now processing about 75 tones of refuse per week. American Earthworm Company (AEC) began a farm in 1978-79 with about 500 tones capacity per month. Aoka Sangyo Co. Ltd., Japan has three 1000 tones per month plants processing wastes from pulp and food industries. Besides these, there are about 3000 other vermicomposting plants in Japan with 5-50 tones capacity per month. It has also started in Italy and in the Philippines. It is now time for India to think about vermitechnology commercially (Palaniappan et.al., 2005).

VERMITECHNOLOGY

The use of organic amendment, such as traditional thermophilic composts, has long been recognized as an effective means of improving soil structure, enhancing soil fertility (Follet et al., 1981), increasing microbial diversity and populations (Barakan et al., 1995), improving the moisture-holding capacity of soils and increasing crop yields. Effects on microorganisms have also been associated with their capability to suppress soil-borne plant diseases (Hoitink and Fahy, 1986), plant parasitic nematode populations and increased crop yields (Johnston et al., 1995).

Vermicomposts are finely-divided mature peat-like materials with a high porosity, aeration, drainage and water-holding capacity and microbial activity which are stabilized by interactions between earthworms and microorganisms in a non-thermophilic process (Edwards and Burrows, 1988). Vermicompost contains most nutrients in plant available form such as nitrates, phosphates and exchangeable calcium and soluble potassium (Edwards, 1998; Orozco et al., 1996). Vermicompost have large particulate surface areas that provide many micro sites for microbial activity and for the strong retention of nutrients (Shi-wei and Fu-Zhen, 1991). Vermicomposts are rich in microbial populations and diversity, particularly fungi, bacteria and actinomycetes (Edwards, 1998; Tomati et al., 1987). Vermicomposts consistently promote biological activity which can cause plants to germinate, flower and grow and yield better than in commercial container media, independent of nutrient availability (Arancon et al., 2004; Atiyeh et al., 2000 a, b). For instance, substitution of small amounts of vermicomposts into soil-less bedding plant potting mixture has resulted in significant increase in the germination and growth of marigolds tomatoes and peppers, in greenhouse trials, when all necessary nutrients are available, even at substitution rates as low as 5-30% into the medium (Atiyeh et al., 2000a,b, 2002 a). Vermicompost contains plant growth regulators and other plant growth influencing materials produced by microorganisms (Grappelli et al., 1987; Tomati et al., 1988, 1990) including humates (Atiyeh et al., 2002 b). Krishnamoorthy and Vajrabhiah (1986) reported the production of cytokinins and auxins in organic wastes that were processed by earthworms. Vermicompost also contains large amounts of humic substances (Masciandaro et al., 1997; Senesi et al., 1992) and some of the effects of these substances on plant growth regulators or hormones (Muscolo et al., 1999). However, most research on the use of vermicomposts has been in the greenhouse, and few workers have reported on the use and effects of vermicomposts in the field.

The technology to use surface and sub-surface local varieties of earthworms in composting and soil management is called vermitech. Regular inputs of feed materials for the earthworms can be in the form of agro wastes, kitchen wastes, and nitrogen rich materials like cattle dung, goat manure and pig manure. Poultry manure should however be handled carefully due to the presence of toxic components (Senapati, 1993). By processing these wastes into organic fertilizers we also get rid of organic solid wastes. Vermicomposting therefore is also solid waste management, where organic wastes are considered as resources. Vermitechnology comprises three main processes:

1. Vermiculture - rearing of earthworms.
2. Vermicomposting - biodegradation of waste biomass in earthwormic way.
3. Vermiconvertion - mass maintenance of sustainability of waste lands through earthworms.

Utilizable products and benefits of vermitechnology are waste biomass management, animal protein production, and organic pollution abatement, waste land conservation, land reclamation, production of worm-worked manure, soil fertility and enhancement in plant production.

WORMS FOR CULTURE (VERMICULTURE)

Nature has created and differentiated earthworms into epigeic, anecic and endogeic species based on definite ecological and trophic functions in the respective soils. Of the three ecological varieties, the epigeics in particular and the aneceic in general, have largely been harnessed for use in the vermicomposting process.

Epigeics like *Eisenia foetida* (Hartenstein et.al., 1979 a, b) and *Eudrilus euginiae* (Kale and Bano, 1988) have been used in converting organic wastes (agro waste and domestic refuse) into vermicompost. Though these surface dwellers are capable of working hard on the litter layer and can convert all the organic waste into manure they are of no significant value in modifying the structure of the soil. The anecics however are capable of both organic waste consumption as well as in modifying the structure of the soil. Such burrowing species that are widely used in soil management like the earthworms, *Lampito mauritii* (Ismail, 1993) also effectively create a drilosphere apart from helping in compost production.

Worm-worked soils are conspicuously different from soil devoid of earthworms. Importantly, the tunnel formed by the worms (Rahuman, 1984) aid in the passage of water, which also washes the nutrients from the drilosphere to the roots that extend quite rapidly along these channels. This principle is also applied in the preparation of vermiwash. Vermiwash functions as a good foliar spray, as it contains the requisite nutrients in it (Ismail, 1997).

VERMICOMPOSTING

Composting can be done either in pits or concrete tanks or well rings or in wooden or plastic crates appropriate in a given situation. It is preferable to select a composting site under shade, in the upland or an elevated level, to prevent water stagnation in pits during rains.

Vermicomposting is set up by first placing a basal layer of vermibed comprising broken bricks or pebbles (3-4 cms.) followed by a layer of coarse sand to a total thickness of 6-7 cms. To ensure proper drainage, a 15 cms moist layer of loamy soil follows. Into this soil 100 earthworms are inoculated. Small lumps of cattledung (fresh or dry) are then scattered over the soil and covered with a 10cm layer of hay. Water is sprayed till the entire set up is moist but not wet. Less water kills the worms and too much water chases them away. Watering the unit is continued and the unit is monitored for 30 days. The appearance of juvenile earthworms by this time is a healthy sign.

Organic refuse is added from the 31st day as a spread on the bed. Addition of refuse can be done twice a week, watering to requirement. After a few applications, the refuse is turned over without disturbing the bed. The day enough refuse has been added into the unit, watering is continued and 45 days later the compost is ready for harvest.

The organic refuse changes into a soft, spongy, sweet smelling, dark brown compost (Ismail, 1997).

VERMICOMPOSTING AT FRI

Vermicomposting is essentially an environment friendly technology generating wealth from waste. As Uttaranchal is mostly covered with forest and the main occupation of the people is agriculture and cattle breeding, raw materials like solid waste, cattle dung are available in abundance. This abundance is causing major problems in the disposal of the waste. Natural degradation takes a long time. Thus, composting and vermicomposting are ideal technologies. These are cheap and non-time consuming as well.

At FRI, the division of Ecology and Environment has started a project on vermitechnology. The project “Income generation for women in rural areas of Uttaranchal through vermicomposting of organic solid waste into manure” is sponsored by the Department of Biotechnology, Government of India. The main objective of this project is to develop additional source of income for rural population especially women folk by using the solid waste as useful resource

Under this project we have planned to conduct awareness programmes in selected villages for the management of solid waste/organic waste to produce rich compost, which can help villagers to keep their surroundings clean and green besides developing a reasonable income. Farmers in general and women folk in particular would be the main targets.

Various programme and activities will be conducted for faster dissemination of the technology. The total activities will be divided into training (1000 women), field demonstrations and other extension activities. These activities have been designed for various purposes like on campus training to impart skills and improve the knowledge of different technologies involved in vermicomposting (Fig. 1, 2). Off campus training and field demonstrations will be conducted to

Fig. 1. On Camus training of the authors explaining the Four-pit vermicomposting system to the participants from the village Rajawala (Dehradun, Uttarakhand)

Fig. 2. On Campus training field assistant showing the earthworm species *Eisenia foefida* to the participants from the village Telpura (Dehradun, Uttarakhand).

show the results and also for the faster adoption and diffusion of the vermicomposting business (Fig. 3). For mass communication/group based transfer of technology, various extension activities will be conducted. A marketing support unit will also be developed to avoid the inclusion of a middle-man in the project, which generally reduces the desired income of the farmers. Women will be given special consideration as the project is mainly for their benefit.

Earthworm species like *Eisenia foetida*, is being cultured. This earthworm is highly productive and is suitable for this region. In 12 months time the earthworm quantity can triple. This increases the capacity of the farmers to produce more vermicompost with no additional investments for earthworms.

CONCLUSIONS

Vermicomposting technology is known throughout the world, although in limited areas. It may be considered a widely spread, though not necessarily popular technology. As a process for handling organic residuals, it represents an alternative approach in waste management, in as much as the material is neither landfilled nor burned but is considered a resource that may

Fig. 3. Off Campus training one of the authors having a discussion with the women folk of Bhagwanpur (Dehradun, Uttarakhand)

be recycled. In this sense, vermicomposting is compatible with sound environmental principles that value conservation of resources and sustainable practices.

Vermicomposting in developing countries could prove to be useful in many instances. Some aspects of the process may be labour intensive when mechanized equipment such as front-end loaders, trommel screens, tractors, etc., are not available to handle large volumes of material. In areas where creation of low or semi-skilled jobs is considered advantageous, vermicomposting may supply an opportunity for employment. Where accumulation of food waste, paper, cardboard, agriculture waste, manures, and biosolids are problematical, composting and vermicomposting offer good potential to turn waste material into a valuable soil amendment.

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