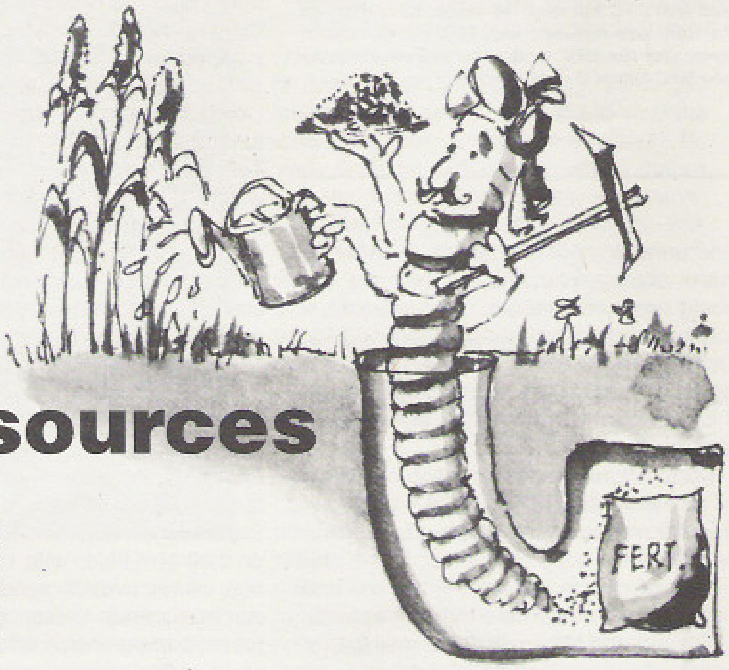
vermiculture biotechnology

Converting wastes into resources



Vermiculture, as propagated by the Bhawalkar Earthwor Institute (BERI), is a form of appropriate biotechnology f of organic wastes into valuable humus and plant nutrien agriculture, vermiculture also enhances soil formation a tion and hence creates optimal benefits for plant growth

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India alone produces about 750 million tonnes of organic wastes every year. Although an important part of these wastes are recycled in agriculture, conversion is, however, not very efficient and high losses of valuable nutrients occur. Organic wastes from cities and agricultural processing are often dumped, causing serious pollution. Though poor in nitrogen, phosphorus, potassium and other plant nutrients, as compared to commercial mineral fertiliser, organic wastes consist for 50% of biocarbon, which feeds the soil processes that make nutrients available to plants. They can also be applied as mulch which feeds as well as protects the living soil from sun and rain. Therefore, organic wastes are too valuable to be wasted.

Earthworms farm bacteria

There are about 3,000 different earthworm species known to man which can be divided into two main classes: "compost worms" and "earthworms". Compost worms thrive in decomposting organic matter above the soil surface. They do not process the soil and do not survive in harsh field conditions. It is somewhat inaccurate to call them "earthworms". The real earthworms burrow inside the soil. They consume organic matter as well as a large proportion of soil. The vermiculture technology developed by BERI over the past 12 years is based on one such species of burrowing earthworms called *Pheretima elongata*, which has been found to be especially efficient in breaking down the toughest of organic wastes like sugarcane trash.

Earthworms take organic litter from the soil surface into the soil. They grind organic matter together with soil particles and leave their castings throughout the soil profile. Through their burrowing activities earthworms not only increase the water holding capacity of the soil but also provide ideal aerobic growth conditions for bacteria as well as plant roots. Fortunately, both bacteria and plant roots thrive under similar conditions of moisture, temperature and pH. Earthworms enhance the growth of beneficial soil bacteria, the most diverse and speediest agents for decomposting organic wastes. Earthworms, on their turn, graze selectively on microorganisms and soil pathogens. By reducing their population density earthworms stimulate bacteria to continue their growth.

Earthworms maintain their population in spite of predators. They do not run away and have no diseases reported so far. Hence one can sustain one's earthworm population with just feeding. Absence of feed and moisture for a period forces them to go underground and hibernate. They become active soon when conditions improve.

Bacteria build humus

Bacteria are the smallest creatures in the soil. They are mostly beneficial and use organic waste as food to produce plant nutrients, vitamins, hormones and antibiotics. Without earthworms, however, bacteria may be restricted to the thin top soil and may operate at a low speed due to improper conditions of moisture, air, pH, temperature and nutrients. Healthy soil is teeming with bacteria and earthworms. Under low moisture or acidic conditions fungi and soil insects replace bacteria and earthworms. These organisms carry out the decomposting processes at a lower speed.

While sugar, protein, starch, cellulose, chitin and other substances are biodegraded by bacteria, lignins are only partially modified by soil bacteria to form humus. Humus gives structure to the soil by keeping soil particles together. This enhances the ability of the soil to hold water and nutrients. A good humus reservoir is essential for producing fertile top soil which can boost plant productivity. This humus reservoir can be mined with excessive soil cultivation, exposing the soil surface to sun and use of excessive chemical fertiliser. This may produce bumper yields on a short term, but these practices are not sustainable.

Nutrient magnification

Organic farming often involves feeding tonnes of compost as source of plant nutrients. If a typical commercial crop needs per ha about 250 kg nutrients available to plants, this may require feeding about 10 tonnes of compost produced from nearly 30 tonnes of farm residues. These amounts are unlikely to be available and such organic farming may be achieved only by a few farmers at the cost of others. However, our experience is that under favourable conditions, by in-situ application of farm residues, vermiculture produces 10-20 times more available plant nutrients than would be available in the organic residues themselves.

Organic wastes are often burnt because they are not valued much because they have a low NPK content. However, organic matter is still valuable for its high bicarbon content (about 50%). Bicarbon feeds the soil microorganisms which, in turn, can get nitrogen from the air and other nutrients from the mineralisation of soil and rock particles. Earthworms not only enhance the activities of soil microorganisms but, by grinding tonnes of soil they also speed up the mineralisation process by which nutrients are released. In this way "nutrient magnification" can take place.

Starting vermiculture

Earthworms are thus ideal managers whom man can employ to maximise growth of aerobic bacteria for waste processing. To achieve this, all farmers need to do is rear earthworms by providing them with proper living conditions and then feeding them with organic wastes. Where earthworms disappeared, due to application of chemical fertiliser or erosion of the land, farmers can start vermiculture by applying vermicastings on their land to add life into their soils. These vermicastings contain cocoons with worm eggs. Farm residues are then applied directly as mulch. These are in-situ processed by the beneficial soil bacteria which are "farmed" by the earthworms hatched from the cocoons in the vermicastings. Where the original earthworms are still present in sufficient quantities this inoculation process is not necessary.

The box on this page compares the results of two ways of vegetable production, conventional farming and vermiculture. The results explain why so many farmers are interested in the many benefits of vermiculture.

Agro-industrial and city wastes

An other important application of BERI's vermiculture technology is in the large-scale processing of agro-industrial waste and city refuse. A unique example of this can be found at Venkateshwara Hatcheries, where a vermiculture facility has successfully begun processing poultry residues. The feathers, claws and other residues of ten thousand birds, amounting to over four tonnes daily, are converted by earthworms to produce vermicastings. This not only provided a tidy solution to the problem of waste disposal, but the resulting vermicastings are now being marketed by the company as a biofertiliser.

Why farmers are interested in vermiculture

A successful vegetable farmer planted tondali (*Coccinia cordifolia*) on saline soil and irrigated his crop with saline groundwater. His experiments with vermiculture had quite some results on the soil. Its pH improved from 8.2 to 7.3 in one year, its water holding capacity increased, the soil structure improved and salt-crustation on the surface disappeared. The produce was of better quality, fetching a 30% higher price. Although he had to pay Rs 4000 for 1 m3 of vermicastings, which is the amount BERI advises to use on 1 acre, profits where higher. The comparison of performance of a chemical plot (3 years) and a vermiculture plot (2 years) can be summarised as follows:

Chemical plot inputs for 1 acre	Rs/year	Vermiculture plot inputs for 1 acre	Rs/year
chemical fertiliser	2,700	vermicastings (divided over 5 years)	800
organic fertiliser	2,340	FYM, 15 cartloads	450
		organic fertiliser	980
		mulching	500
pesticide sprays (18 Nos. x 100)	1,800	pesticide sprays (6 Nos x 100)	600
weeding (6 times 250)	1,500	weeding	--
cultivation (3 times 300)	900	cultivation	--
irrigation (33 times 15)	495	irrigation (23 times 15)	345
total inputs	9,735	total inputs	3,675
soil depreciates	+1,000	soil appreciates	-1,000
real expenditure	10,735	real expenditure	2,675
average yield: 23,800 kg		yield: 22,710 kg	
returns (at Rs 2/kg)	47,600	returns (at Rs 2.6/kg)	59,046
expenditure	10,735	expenditure	2,675
profit	36,865	profit	56,371

Experiments

On an experimental scale, vermiculture is being harnessed to set up organic wastes bioconversion facilities in the cities and food industries. Individual gardeners and farmers are using vermiculture for swift changeover to low-external-input or organic farming without loss of yield. Also Redworms (*Eisenia foetida*) are used to produce vermicompost from organic waste. But as Redworms are "compost worms" they do not have the same benefits of nutrient magnification and feedback from the roots as with "earthworms". Redworms do not survive in harsh field conditions. Hence they are not useful for inoculation of farm land.

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