**VERMICOMPOSTING**

 Vermicomposting is the technique of speeding up the process of composting by the use of earthworms. That is earthworms are utilized to decompose organic wastes. They eat the organic waste and convert it into worm castings or vermicompost. The process of vermicomposting allows safe conversion of noxious wastes into valuable vermicompost, thus reducing pollution problems. Vermicompost is more productive, ecologically safe and non-toxic when compared to chemical fertilizers. It is odourless, clean and increases useful bacteria in the soil. With the rich content of nutrients for plants, the vermicompost is a highly valued superior quality natural fertilizer.

The composting worms are usually voracious feeders that feed on almost all types of organic materials. Once ingested by the worms, these organic materials undergo physical and chemical breakdown in the gut. The worms secrete the enzymes, proteases, lipases, amylases, cellulases and chitinases, which bring about rapid biochemical conversion of the cellulosic and the proteinaceous materials in the variety of organic wastes including farmyard manure, municipal solid waste, household garbage, etc. Thus, by the feeding and the casting activity, the earthworms convert organic wastes into vermicompost.

The art, science and technology of breeding earthworms and maintaining them in a healthy condition is called vermiculture. vermiculture is done to obtain the required amount of worms for agriculture, animal feed or vermicompost.

Vermicomposting is the use of earthworms in breaking down organic waste into manure, which can be utilized productively. It is one of the most efficient methods of converting organic waste, crop residues into a rich plant nutrient mixture. In the vermitechnology several biological organisms are involved to degrade the organic waste into vermicompost, a dynamic soil amendment indeed for the excellent growth of the plant.

There are about 500 spp. Of earthworms in our country and based on the ecological niche they are broadly classified into 3 groups, the epigeics, endogeics and anecics. For best results, all the 3 groups should work together.

It is a necessity to pre-digest the raw material using cow-dung slurry from biogas plant and should be moistened frequently with water sprays. About 3-4 weeks incubation period is required with frequent turning of the waste. The temperature of the heap raises to 600c and would help to eliminate pathogen spores, microorganisms, buds and weeds.

Another method of pre-digesting the garbage, farm waste will be spreading the garbage material layer by layer and adding the cow dung slurry to each layer. The lower layers are raised using wooden framework to ensure aeration from the bottom. The entire heat should be covered with thick black polythene sheet to hasten the decomposition and vermicompost will be ready by 3 to 4 weeks time.

**Common Species of Earthworms Used For Vermicomposting**

Three ecological groups of earthworms have been recognized- epigeics, anecics and endogenics. Epigeic worms live above the mineral soil surface, typically in the litter layers of soil. They do not form permanent burrows. Anecic worms live in permanent vertical burrows in the mineral soil layers. They come out occasionally for feeding on litter mixed with soil. Endogenic worms inhabit in mineral soil, making horizontal burrows, non- permanent burrows. They are feed on soil rich in organic matter and hence often called geophagous.

Earthworms are good biodegraders. However, not all species are useful in vermicomposting. Only selected species are employed for this purpose. Many Epigeic worms and some Anecic worms are suitable for vermicomposting. Some of the commonly used species in vermicomposting are *Perionyx excavatus, Eisenia foetida, Eudrilus euginae etc.*

**Process of Vermicomposting**

Vermicomposting can be done in pits, concrete tanks, well rings etc. The composting bed site should be preferably under a shade in an area of an upland or an elevated level to prevent water stagnation.

**Step 1:** Broken bricks or pebbles are placed as a basal layer in the pit/tank.

**Step 2:** Coarse sand is topped on it at about 6-7.5 cm thickness to ensure proper drainage.

**Step 3:** After moistening a layer of loamy soil up to a height of not less than 15 cm. is placed.

**Step 4:** About 100 epigeic and anecic earthworms are introduced into this loamy soil.

**Step 5:** Small lumps of cow dung are scattered over the soil.

**Step 6:** Then it is covered with a layer of hay upto 10 cm in height.

**Step 7:** Water is sprayed liberally till the entire set up is moist, but not wet.

**Step 8:** The unit is finally covered with broad leaves like that of coconut palm or so. This is to prevent birds from disturbing the vermibed.

**Step 9:** The unit is covered with a net.

**Step 10:** Watering and monitoring of the unit should be done for 30 days. Water management is very important. Too little water kills the worms and too much chases them away. Juvenile earthworms should appear by this time which is a healthy sign.

**Step 11:** Solids wastes are added on the thirsty first day, after the leaves / jute bags are removed. The spread of wastes should not exceed 5 cm thickness for each application. Replace the covering.

**Step 12:** Watering is continued according to requirement. After a few applications of refuse, only the refuse may be turned over taking care not to disturb the vermibed underneath. When the refuse just fills the unit, watering is continued with occasional turning over of the refuse. On the forty fifth day of application of refuse, the compost is ready for harvest.

**Harvest:** The solid waste has not turned into a soft spongy dark brown vermicompost. Adding water should be stopped on the forty second day. This compels the worm to move into the lower end of the vermibed, so that compost could be collected without disturbing the worms. The harvested compost is placed in the form of a cone in bright sunlight. This is to compel the worms, if any present, to move to the lowest layers, which could later be removed to new units of vermicomposting. The vermicompost is then sun dried served and packed prudently in polythene bags to retain moisture.

**Essential Precautionary Steps in Vermicomposting**

Before going into the detailed steps involved in vermicomposting, it is essential to take note of certain precautionary steps involved in vermicomposting.

Most of the wastes containing organic matter, ranging from domestic (like vegetable matter, cardboard, paper, meat, food wastes etc.) to agro- industrial residues, can be treated using vermicomposting. But, when these wastes are fed directly to vermibins/vermipits (where earthworm population is maintained) the result seems to be doubly negative. Of the several reasons cited for such failure, the major one’s are that the worms cannot withstand the heat generated by fresh urban wastes and the presence of certain undesirable organisms like insects and weeds. Hence, a pre-treatment stage becomes inevitable where in such wastes are to be treated using vermicomposting technology.

Decomposition of pure cellulosic materials like cotton, paper, and straw, which have a low, or no content of nitrogen can be enhanced by mixing them with materials of high nitrogen content like sewage sludge, dung of domestic animals, night-soil etc.

The rate of decomposition can be estimated by parameters such as

* Percentage weight loss,
* Percentage decrease in C/N ratio,
* Oxygen consumption or carbon dioxide evolution by the decomposer organism,
* Individual chemical parameters like nitrate production, cations, soil enzymes, etc

Of these, the percentage weight loss is considered directly as a decomposition parameter. The decrease in carbon or nitrogen is also being used and shows a high correlation with loss in ignition.

**VERMIWASH**

The system consists of 100l plastic barrel in which a perforated plastic waste paper basket is placed at the centre, upside down and central 1m plastic tube 5cm wide with hole up to 7.5cm height is at the dipped end. Around the waste paper basket is placed broken bricks and packed sand- up to 7.5cm deep. The plastic pipe should pass through centre of the waste paper basket, so that the ends of the holes touch the base of the barrel. The whole assembly is kept inside a thatched shed or any cool corner of a farm shed. Above the mixed brick and sand, comes a layer of humus, along with about 5000 earthworms. Every day, 2-3 tablespoons of fresh cow dung slurry is spread over the humus layer and vegetable waste, fruit peels etc. as feed for the earthworms. Above 2l of water is poured from the top. The water percolates down and collects at the bottom barrel.

This water brings along with it part of the casts of earthworms as vermiwash, which can be siphoned from the barrel. The vermiwash can be excessive. The heating should be sufficient to make the activity of the earthworms at a high level of efficiency. Adding an inch of material, every day or two is usually enough, depending on the feedstock.

The processing of organic materials occurs most rapidly at temperatures between 150c and 250c and at moisture contents of 70-90%. Beyond these limits, the earthworm’s activity and productivity, and rate of waste processing fall drastically. For maximum efficiency, the feed stock should be maintained as close to these environmental limits as possible.

The other kind of constraints are due to the undesirable organisms like germs, insects, and weeds . This is contrary to common belief that worms do not have many serious natural enemies, diseases or predators. The presence of traces of certain inorganic compounds and salts also affect the processes negatively. In particular, earthworms are very sensitive to ammonia, salts and certain other chemicals. For instance they die rapidly if exposed to more than 0.5mg /gm of ammonia of waste and more than 0.5% salts.

Most of the constraints cited can be overcome by adopting certain pre-processing steps before subjecting the organic waste directly to vermicomposting. Few such pre-processing steps are given below:

* General pre-processing steps involve washing, pre-composting, macerating or mixing.
* Salts and ammonia can be washed out of the organics or dispersed by pre-composting.
* Another pre treatment process is bisanitation or accelerated aerobiosis.

**Benefits, Economics And Marketing**

Vermicomposting as described earlier can break down organic residuals into valuable, finely divided plant growth media with excellent porosity, aeration and water-holding capacity, rich in available nutrients with superior plant growth characteristics. In plant growth trials, vermicompost outperformed both traditional composts and commercial plant growth media is almost every experiment. Additionally, properly matured composts may exhibit favourable antipathogenic influences when applied to soils, assisting in counteracting root-rot and damping off problems with seedlings and plants .In addition, the shelf life of food products or the quality of resisting enzymatic-induced deterioration can be significantly increased with the use of properly made composts. Such properties have been observed in earthworm developed composts when all kinds of biodegradable wastes pass through the earthworm gut.

**Environment Friendly Technology**

**Water**

 The process uses up nearly 700l of water t-1 of compost produced, but, this is fully utilized (except a small fraction lost through evaporation), leaving no waste water.

**Gases**

Biological respiration is the only aspect of vermicomposting which involves gases. Oxygen is consumed and water vapour and carbon dioxide are released. The latter is released at a rate comparable to the natural process taking place in grasslands and forests. Hence, there is no additional contribution to the green house effect.

**Pollutants**

A substantial portion of organic pollutants as also some pathogens, is broken down into harmless or useful products.

**Aesthetics**

The aesthetic consideration depends on the type of industrial architecture chosen and the care taken of the surrounding area. The noise pollution levels are far lower than those caused by trucks bringing in the waste and taking away the products. There is no final waste.

**Economics**

The economics would depend on the scale of operation and the degree of mechanisation. A large and economically attractive market exists for compost products, particularly for all levels of farmers and horticulturists. This is especially prohibiting the giving of any kind of subsidies by government for chemical fertilizers and pesticides have been accepted.