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## **A SUSTAINABLE SYSTEM FOR SOLID WASTE TREATMENT - VERMICULTURE**

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### ***Abstract***

*Vermiculture appears to be an innovative sustainable technology for waste treatment, which holds a promising future in the field of solid waste management. Vermiculture is the process of culturing worms to decompose organic food waste, turning the waste into a nutrient-rich material capable of supplying necessary nutrients to help plant growth.*

*This method is simple, effective, convenient and noiseless. It saves water, energy, landfills, and helps to rebuild the soil. The worms have the ability to convert organic waste into nutrient-rich material which reduces the need for synthetic fertilizers.*

*Vermicompost improves soil structure and aeration as well as increasing its water-holding capacity. Worms help the environment by decomposing organic material (food and yard waste) turning it into a natural rich organic soil amendment. The end result is called vermicompost, wormpoop or worm castings. Vermicompost provides a tremendous source of nutrients for plants that dramatically improve the texture and fertility of soil. This replaces valuable nutrients taken out of the soil when fruit and vegetables are harvested. Vermicomposting adds beneficial organisms to the soil. These microorganisms and soil fauna help to break down organic materials and convert nutrients into a more available food form for plants.*

*Vermiculture composting is nature’s way of completing the recycling loop. Being born, living, dying, and being reborn again. Adding compost to soil aids in erosion control, promotes soil fertility, and stimulates healthy root development in plants.*

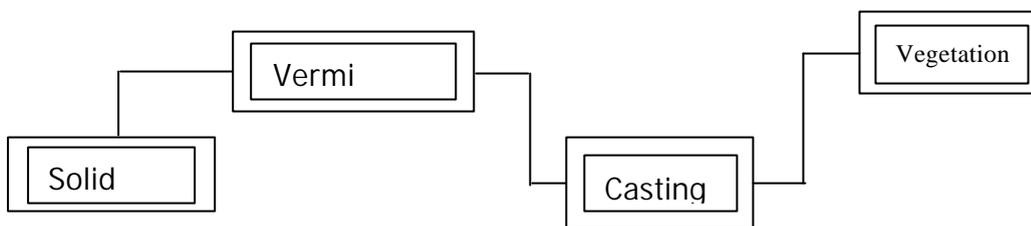
### **INTRODUCTION**

Solid wastes are the waste arising from human activity, which are discarded as useless or unwanted. Solid waste management comprises of purposeful and systematic control of the generation, storage, collection, transport, separation, processing, recycling, recovery and disposal of waste. Nowadays the focus of solid waste management is towards ecofriendly disposal and reuse of by-products.

The foremost option in conversion of the biodegradable waste is vermiculture biotechnology. Vermiculture helps in bioconversion and the end product obtained is a rich manure.

### **VERMICULTURE:**

Vermiculture is used for conversion of solid wastes into a nutrient-rich material. 'Vermi' means worms (earthworms) and 'culture' means farming; thus, vermiculture is a farming of earthworms. In this process, earthworms are harnessed as versatile natural bioreactors, which convert the organic solid waste into a valuable by-product.



*Fig. 1 Schematic representation of vermi composting*

### **VERMI ITS TYPES:**

◆ Based on lifestyle and burrowing habit of earthworms:

#### ***1. Eisenia Foetida.***

Red Worms or (*Eisenia foetida*) are the best type of worm for eating food waste. These worms are surface worms and stay in the top 18 inches of the soil.

#### ***2. Lumbricus Rebellus.***

This variety will adapt to the worm box environment, but they are really a soil earthworm. Their natural habitat is in soils, which contain a lot of organic matter.



#### ***3. Epiges.***

These type of worms are surface dwellers, tolerant to disturbances and have a shorter life span.



#### **4. Endoges.**

They live in upper 30-50mm of soil layer and have a longer life span.

◆ Based on basis of feeding habits:

##### **1. Detrivores**

They feed on plant litter or dead roots and other plant debris.

#### **BIO REACTOR SET UP:**

- A Worm-bed is started by shredding 1-inch strips of newspaper, enough to fill the container.
- Soak the shredded strips of newspapers with water and the excess water is squeezed out and is fluffed-up. The fluffed-up, wet newspaper is placed into the container. The container should be one-half to three-fourths full.
- In a well lighted area or outside on a sunny day the worms are emptied on top of the shredded newspaper (making sure the light or sun is shining down on the box). The worms will quickly go down into the bedding material because they don't like the light. Once they go into the bedding they will start making their new home in the bedding. The bedding is kept moist.
- Little soil is added over the bedding material. Worms need soil or sand to digest their food. After 7 days other food materials are added to the worm bed. The worms need to become acclimated to their new environment for the first week.



#### **REACTOR:**

- Almost any type of container can be used for housing worms. A medium sized worm box can process more than 2.267 Kg. of food waste each week.
- An old wooden crate, a sturdy wooden box, a plastic storage container with a top, even a wash basin or an old toilet bowl will serve as a worm box. Worm box should be shallow preferably. Red worms like to live near the surface where they can breathe.
- A Container that is 12 to 18 inches in depth can work well, depending on the number of worms. To Start with, two to three square feet of surface area is best.
- Usually one Kilogram of worms is enough to get started. One Kilogram is between 800-1200 worms.
- Worm bed should also have a tight fitting lid and holes drilled in the bottom for ventilation and drainage.



### **SUBSTRATE FOR WORMS:**

- Food scraps from the kitchen like fruit and vegetable trimmings, lettuce leaves, carrot tops, ground eggshells, orange peelings, banana peelings.
- Yard trimmings, grass clippings, leaves, and mulch are great for vermiculture.
- Peelings or rinds from apples, avocado skins and pits, banana peelings, berries, cantaloupe rinds, carrots, (worms don't like citrus as much as other fruits), cucumbers, grapes, green beans, greens of any kind, lettuce leaves, melons and melon rinds, onions, pears, pineapple, potatoes, tomatoes, or, strawberries, etc.

### **ADDITION OF SUBSTRATE:**

Any kind of scraps can be added after one week. Brown and green leaves, small amounts of grass clippings, straw, hay, yard trimmings, cow and horse manure, rabbit droppings, peat moss, and even sawdust and wood chips are great for Vermiculture.

The worm bed should never smell sour. If it smells sour then calcium carbonate can be added. This will reduce the sour smell of the bed. Usually the bed smells sour if it is too wet.

### **HARVESTING WORM CASTINGS AND METHODS:**

Usually about three to six months after starting a new bin, the worms will have digested not only the food you gave them, but most of their bedding also. What is left is primarily black worm castings or vermicompost. This is a soil-like material that makes a very good additive to house plants or flower beds. The castings must be harvested periodically in order to maintain a healthy environment for worms.

There are three different methods to harvest worm castings.

#### Harvesting Worm Casting Methods



#### ◆ **The Side to Side Method:**

- Finished compost is moved to one side of the bin and the empty side is filled with fresh bedding.
- For the next six weeks or so food waste is filled only in the newly bedded side of the bin.
- The worms will eventually seek out the fresh food and migrate over to the new bedding and "fresh" food.
- After their migration the castings are scooped out.

#### ◆ **The Bright Light & Scoop Method:**

- Bright light is focussed on the worms. They will avoid the light and burrow down through the vermicompost.
- Top layer of vermicompost is scooped off until the worms are seen again.
- This process is repeated periodically.

◆ **The Sun Dried Method:**

- This is a fairly fast, easy way of harvesting the worms but it requires a second bin and some plastic mesh.
- Fresh moistened bedding is filled in a second bin and is covered with plastic mesh.
- The castings and worms are dumped from the first bin on top of the plastic mesh and the new bin is put out in the sun.
- The sun will dry the castings. As it does, the worms will move down through the mesh into the moist bedding below.
- The worm casting on top of the mesh is now ready for use.

**VERMICULTURE SYSTEMS:**

◆ **CAN-O-WORMS**

- It is a multi-level, 5-legged, circular system which automatically sorts pre-digested scraps from finished compost
- It is a mess-free and fly-proof concept
- It is an odour-free unit and works indoors (and outside)
- It can produce year-round nutritious worm castings.
- The liquid plant food can be easily collected via built-in spigot.



◆ **DOWN UNDER WORM FORM**

- This affordable Worm Farm uses top feeding redworms to consume organic wastes derived from your food scraps.
- The castings can be used in garden as a soil conditioner.
- The worms live and breed in the top layer.



◆ **LIVE COMPOSTING RED WORMS**

- This type of worm is capable of consuming up to its own weight daily in organic waste.
- The end result is referred to as worm castings or cow-free manure which is highly regarded as a soil amendment.
- During daylight hours, these worms continually tunnel in and feed on the food scraps, all the while aerating the bin.

- The finely ground digested matter is passed out of the worm's body in the form of rich, nutritious casts.
- Redworms tolerate a wide range of environmental conditions, which make them ideal for vermiculture.



#### ◆ *The Ultimate Home Vermiculture System*

- It is designed with the homeowner in mind who needs a larger capacity unit than the standard worm bins.
- It is a sturdy, stable construction with little fear of tipping by children or pets.
- It is a convenient process because of its height, which is easily accessible by all family members.
- Its angled harvesting tray allows for easy drainage and liquid separation.
- Its rubber legged bumpers protect floors from scratches.
- It is easy to operate harvesting mechanism.



#### ◆ **EXPANDABLE WORM TOWER**

- Worm composting is an incredibly efficient way to convert kitchen scraps into nutrient-rich compost for the garden.
- The Expandable Worm Tower automatically separates food scraps from finished compost.
- The bottom tray is simply filled with red wiggler, composting worms, bedding and food scraps.
- As the top feeding worms finish digesting, they will naturally seek more food and migrate upward into the tray above which there is the newly added scraps, leaving rich castings behind.
- By continually adding new food to trays at the top, and emptying the bottom tray we can have a constant supply of castings.
- The tower is made from high quality recycled plastic.
- It is also very simple to assemble.



◆ **PERPETUAL OUTDOOR WORM SHED**

- It has a durable construction because of superior craftsmanship.
- It has enormous capacity for businesses, campgrounds, restaurants, community gardens, city halls, fire stations, recycling centers, etc.
- It can hold upto 2 cubic feet.
- It has a very attractive and elegant apperance.
- It is very convenient as the hinged lid makes dumping of scraps quick and easy.



◆ **THE SWAG HANGING OUTDOOR WORM SYSTEM**

- This system is also known as “Off-The-Ground Vermiculture”.
- It can be hung from any shady spots like a porch, balcony, basement rafter, or tree branch.
- No rats, mice or cockroaches can reach it or get in.
- The continuous flow technology prevents liquid from pooling inside the unit.
- There is no small or moving parts to break or lose.
- It has less maintenance and is easy to harvest the finished redworm castings by just opening from bottom.
- This is highly durable.
- Velcro lined mesh cover can be used which can be opened easily for adding scraps.



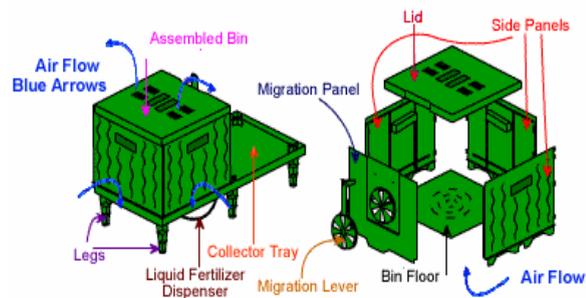
◆ **THE ORIGINAL VERMI-COMPOSTER**

- It has a Separate drainage tray and vented lid for continuous aeration.
- Screens are present in bottom to keep worms and bedding secure.
- There is no or minimal odor.
- The bedding is simple to acquire and to make.
- It can be derived from newspaper pulp and top soil.
- This is ideal for classroom education which teaches about the cycle of life and ecology.



◆ **WORM-A-ROO RECYCLING FACTORY**

- It can be used to recycle everyday organic household wastes.
- It has a dual bin with which the worms can separate by themselves from the finished compost to the new food in the alternate bin.
- This unique, double bin feature allows to maintain a never ending supply of nutrient rich compost from one bin, without disrupting the composting process in the other.



*Working principle*

- It has a good air flow which is accomplished by ventilation slots throughout the unit, maintaining maximum surface oxygenation for efficient, rapid, aerobic composting.
- A liquid collector tray with overflow safety valve is present which allows for simple and clean dispensing of nutrient-rich liquid fertilizer.
- These units are self-contained (worms can't escape), odorless, fly / vermin proof, and can be used indoors year round.

◆ **WORM FRIENDLY HABITAT**

- These units are extensively used in municipalities, educational facilities, non-profit organizations and others.
- Each unit features a black snap on lid and built-in carrying handles for easy transport.
- Ventilation is accomplished through three vents, one on the top and two on the body (one at each end).



◆ **WORM WIGWAM**

- This has been designed to process large amounts of food & organic wastes
- It can be used in restaurants, farms, public gardens, dormitories & schools.
- This system requires no compost turning and requires no separating of worms.
- About 8 tons of waste can be composted per year by using this system.
- It has a raised floor design providing maximum aeration for faster worm feeding and shorter composting times.
- This system never needs to be emptied .



◆ **ADVANCED BIOSYSTEM-CLIMATE-CONTROLLED VERMICULTURE SYSTEM**

- This Advanced BioSystem is a perfect solution to small to mid volume, on-site, organic waste processing.
- It can be connected in series to other modules, as the need for additional capacity arises.
- This unit is ideal for processing not only food scraps, but also paper waste, and is developed for either indoor or outdoor operation.
- This system can be used anywhere because the climate inside the system can be controlled.
- The whole set-up can be transferred easily.
- It is a compact system.



### BY- PRODUCT CHARACTERISTICS:

Vermicompost is a 100% organic fertiliser that is made up of worm castings and partially decomposed organic matter. Worm castings are the richest natural fertilisers known to humans.

Vermicompost is packed with minerals that are essential for plant growth, such as concentrated nitrates, phosphorus, magnesium, potassium and calcium. It also contains manganese, copper, zinc, cobalt, borax, iron, carbon and nitrogen.

It contains a high percentage of humus. Humic acid, provides many binding sites for plant nutrients, such as calcium, iron, potassium, sulphur and phosphorus. These nutrients are stored readily in the compost. It contains 5 times the available nitrogen, 7 times the available potash and one and half times more calcium than that found in good topsoil.

### Using Vermicompost:

- *Mixing with potting soil* - 1 part vermicompost to 3 parts potting soil is used.
- *As top dressing* -  $\frac{1}{4}$  inch of castings is sprinkled on houseplants, every  $1\frac{1}{2}$  to 2 months.
- *As starter mix* – castings are sprinkled along bottom of seed row, or into the hole when transplanting are made.
- *Germination* - 20 to 30% Vermicompost with sand can added as an excellent germination mixture.
- *Soil Conditioner* –By adding a layer of vermicompost,farmers will get excellent results with pasture grasses if they use 100 kg per acre.
- *Fertiliser* – By adding vermicompost to the base of plants or by applying on large scale with phosphate spreader, farmers will benefit. Vermicompost can easily be mixed with water. This liquid mixture can be used as a leaf folient spray.
- *Deodoriser* - Vermicompost contains aerobic bacteria, a thin layer placed over a compost heap will neutralise the smell almost immediately.

Vermicompost is a much better product than the best artificial fertiliser on the market. Most potting soils have nutrient life of 2-5 days, where as vermi-compost can last up to 6 times as

long as other types of potting soil. Vermi compost acts as a barrier to help plants grow in soil where the pH levels are too high or too low.

Merits:

- It is a zero pollution ,environmental friendly technology.
- There is no gaseous emission or sludge formation.
- It has no major operating expenses such as electricity for aeration,mechanical equipment etc.,
- The process can be restarted after a gap.
- The process is simple to operate and maintain.
- It can replace artificial fertilizers.
- It can convert organic solid wastes into valuable products like vermicasting, used as manure.
- No need of any skilled labour.

Demerits:

- If there is excess water then it will lead to odour problems.
- Centipedes will eat the worms.
- Huge land requirements.

**CONCLUSION:**

Vermiculture provides an amicable solution in the field of solid waste management. Bioconversion and the by-products obtained do not disturb the ecological balance.

The manure obtained can replace the chemicals, which affects the soil as well as the water system. The pollutional load on the environment can be reduced considerably by adopting this Eco friendly method of bio conversion –Vermiculture.

**Think About It**  
PUT LIFE INTO YOUR SOIL THE WAY  
NATURE INTENDED...  
IT'S LIKE GOLD AT THE END OF THE RAINBOW...BLACK GOLD...  
VERMICOMPOST HAPPENS NATURALLY!

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