# Vermicomposting: A promising technology to turn kitchen waste to organic compost

Technical Brief

## Background:

In recent years, the world is experiencing rapid population growth which has resulted in large-scale expansion of urban areas, massive loss of cultivable land and increased agricultural land use intensity. With increased land use intensity, use of agro-chemicals to increase food production from limited agricultural land is also increasing. However, rising agro-chemicals use has contributed to a range of environmental problems including greenhouse gas emissions, water-borne pollution, degradation of soil and water quality, and loss of biodiversity and ecosystem services[i].

Owing to above mentioned situation, this technical brief describes one of the best ways to utilise kitchen and urban organic waste to reduce agrochemical use in agricultural production. This technique of converting organic waste into compost manure not only boosts organic production but also helps to effectively manage household and urban organic waste.

**Picture: Composting worm Red wigglers (*Eisenia fetida*)**

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**Vermicomposting:** A process of composting that uses earthworm to convert organic waste into humus like high quality compost is called vermicompost. Earthworm feeding nature has ability to promote microbial activity that accelerates the breakdown of organic matter and stabilisation of soil aggregates. Vermicompost is a nutrient-rich, microbiologically active organic amendment that results from the interactions between earthworms and microorganisms during the breakdown of the organic matter. It is a stabilised, finely divided peat-like material with a low carbon-nitrogen (C:N) ratio, high porosity, and high water-holding capacity, in which most nutrients are present in forms that are readily taken up by plants[ii]. Vermicompost can be produced in small scale at household level using household organic waste as well as in industrial level using urban organic waste. Only the size of composting chamber matters for scale of production. If it is for household purpose, a small wooden or thermocol ice box with variable size depending upon amount of daily household waste can be used as composting chamber. However, if it is for commercial purpose, a large compost chamber should be constructed. Depth of the composting bin/box/chamber should not be more than 1 metre.

Benefits of vermicompost:

- Improves soil aeration and water holding capacity.
- The worm castings are rich in humic acids, which condition the soil and help balance pH.
- Microbial activity in worm castings is 10 to 20 times higher than in the soil and organic matter that the worm ingests.
- Provides plants with essential nutrients and aids in the suppression of plant diseases.
- Worm castings contain five times more nitrogen, seven times more phosphorus, and 11 times more potassium than ordinary soil, the main minerals needed for plant growth.

## Steps of vermicomposting:

Before starting vermicomposting, one should clearly understand about important earthworm species for vermicomposting, amount of available organic waste and necessary management steps.

- **Selection of earthworm species:**

Almost all earthworm species have natural ability to transform organic materials into useful compost. However, the best types of worms for vermicomposting are red wigglers (*Eisenia fetida*) and red worms (*Lumbricus rubellus*). These species are rather fast and perform best in compost environment than other plain soil dwelling earthworms.

It will be difficult to identify suitable species in natural habitat. So, one should buy it from local suppliers. If local supplier is not available, one should contact the nearby agriculture service centre.

- **Compost bin construction:**

Size of compost bin depends upon the purpose and availability of organic waste. If one wants to construct a compost bin with the purpose of selling vermicompost, he or she should follow procedure of large scale vermicomposting. Management and production techniques are almost same for both large and small scale vermicomposting. Small scale vermicomposting can be done in any type and any size of container ranging from a flower pot to wooden/thermocole/metal/plasctic boxes. But the size of the container should be based on available organic waste.

While selecting materials for construction of bin, one should be aware of negative effects of these materials, like metal containers often conduct heat too readily, are prone to rusting, and may release heavy metals into the vermicompost. Similarly, styrofoam containers may release chemicals into the organic material[iii] and some cedars, Yellow cedar, and Redwood contain resinous oils that may harm worms[iv].

Bins need holes or mesh for aeration. Some people add a spout or holes in the bottom for excess liquid to drain into a tray for collection.[v] The most common materials used are plastic: recycled polyethylene and polypropylene and wood[vi]. Worm compost bins made from plastic are ideal, but require more drainage than wooden ones because they are non-absorbent. However, wooden bins will eventually decay and need to be replaced[vii].

- **Bedding materials**

Different materials like shredded papers, cartons, moss, straw, etc., can be used as bedding materials[viii]. However, these materials must be able to hold moisture, allow air exchange, and provide a safe medium uncontaminated by harmful chemicals. Decaying leaves can provide natural habitat for worms. Peat moss along with bedding materials helps retaining moisture, but should not be used alone as it creates acidic environment for the worms. Bedding material should be piled up to at least 3 inches in thickness.

- **Inoculation of worm**

Earthworms are very critical in decomposition of organic matters as it can significantly accelerate decomposition rates and nutrient turnover[ix]. Type of microorganisms present in the gut of earthworm helps decomposition of organic matter, as it passes through the earthworm's guts, which are then released via

casting[x]. If composition of gut's microorganisms alters, it can hamper decomposition rates. So, at the beginning, one should apply earthworm along with earthworm-worked material (vermicompost) into unworked material. Stocking density depends upon the size of bin. Use "X *gram of worms per sq ft*" approach – the idea here is that you stock a certain quantity of worms per square feet of your bin's upper surface area. Recommendation is 500 gram of worms for every 4 sq ft of bin space. So a bin that's 2×2 ft surface area would be stocked with 500 gram of worms.

- **Worm food**

Earthworm loves variety of food, in fact, they are voracious eater. Under ideal conditions, they are able to consume in excess of their body weight each day. However, care should be taken as some of food varieties can hamper normal lifecycle of earthworm. Important food varieties that are ideal for composting worms include[xi]:

**Suitable:**

- Vegetable scraps: apple cores, peels, carrot tops and wilted lettuce or trimmings. Any vegetable that's not spicy or really gaseous will make them happy.
- Non-citrus fruit work best, such as watermelon rind, strawberry tops, old blueberries, etc. Drastically limit citrus or eliminate all together to avoid fruit flies and to keep the bin clean smelling and easy to work with.
- Used tea. We like to rip up the bags before dropping in but it's not necessary to break them up.
- Coffee grounds and filters. Don't add too much coffee all at once. Mix with other foods. Test your worms' preferences.
- Dried leaves. If you want to add more bedding, leaves are awesome!
- Used napkins and paper towels are ok as long as they are not greasy.
- Shredded cardboard and paper bags are easy to find and recycle. Shred up the paper bags to make the bedding fluffy. I like to moisten the bedding before adding to the bin. I dip in a big bowl of water or spray.
- Crushed egg shells. We've been reading that reproduction increases when worms live among egg shells! It helps adding a little grit to the bin. Otherwise, use a small amount of garden dirt that has not been treated with chemicals. A small handful of eggshells or dirt is enough.

**Limit:**

- Citrus peels and fruit – to avoid fruit flies.
- Starchy foods like pasta, bread and rice – too much for worms to handle with all that bedding already in there. It will take longer for the bin to compost.

**Avoid:**

- Onions, spicy peppers. Twigs, meat, oily foods, plastic, metal, glass, animal feces

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- **Harvesting casting/compost**

Harvesting procedure also depends upon type of container/bin used.

- If a small bucket like bin with smaller surface area less than 1 sq. ft is being used, get another container and a plastic bag with holes cut into it. Place the bag over the top of the new container, and make sure it is over the opening. Put the new container in the sun, and start putting the contents of your worm bin onto the top of the bag. The worms will burrow through the holes and into the new container because they don't want to be out in the sun.

  This way you can separate the castings from the worms. When you are done with harvesting, put the worms back into their compost bin.

- If the surface area is more than 4 sq. ft, cover half of the surface with black plastic and expose other half to sunlight. Earthworm from the exposed part will move to covered part as they do not like light. Then harvest the casting in this part. After harvesting of compost, cover exposed part and expose previously covered part and harvest remaining compost. This procedure of harvesting can also be followed for large/industrial scale vermicompost harvesting.

## Compost bin care and management

- **Bedding moisture**

A worm's body consists of 75% to 90% water, and its surface *must* be damp for smooth breathing. If the moisture content is less than 50%, survival of earthworm is affected. So, moisture content of bedding materials should be maintained approximately the same moisture content as the worm's body. This not only helps proper breathing but also alleviates any stress caused by a too-cold or too-hot environment.

- **Aeration**

Earthworms need sufficient amount of oxygen for respiration. Condition like excessive moisture and presence of greasy food stuffs combined with poor aeration favours anaerobic environment and hampers normal supply of oxygen. This will kill the worms very quickly. Anaerobic environment also favours growth of microorganisms that produce toxic substances (e.g., ammonia) which can kill earthworm. Hence, proper aeration should be maintained by adding sand into bedding material to make bedding material relatively porous and avoiding use of materials that favours anaerobic environment.

- **pH**

Most earthworms can survive pH range of 5-9. However, earthworms can best perform at neutral pH, i.e., 7 or slightly higher. In general, pH seems to drop with time and if the food source is acidic, pH will gradually drop down. Acidic

environment increases incidence of pest like mites and other diseases. In such condition, one should add calcium carbonate to adjust pH.

## Things to remember:

- The bedding materials must be able to absorb and retain water fairly well if the worms are to thrive.
- Meat and other greasy food stuffs with high fat content should not be used as food for earthworm, such food can boost anaerobic environment and attract rodents.
- Darkness should be maintained as earthworm prefers dark environment by covering bin with black plastic. However, ventilation should be allowed for proper aeration.
- Avoid over feeding bin.

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