Vermi Composting

Vermicomposting is a modified and specialised method of composting - the process uses earthworms to eat and digest farm wastes and turn out a high quality compost in two months or less. Vermicompost is not a biofertiliser as is touted by some, merely an improved compost.

Vermicompost can also be used to make compost tea. Vermicompost tea is useful as a prophylactic against pests and diseases, for pest repelling and as a foliar spray. A by-product of vermicomposting called vermiwash (which can be collected if there is a tap at the base of the vermicompost tank) also serves the same purpose.

An important point to note in case of vermicomposting but widely ignored, is to carry out proper sieving of the compost before applying it in the fields. The most efficient and widely-used earthworms in vermicomposting are not indigenous and if the worms and casts find their way to the fields, they will quickly colonise and dominate the local species. Farmers can also use indigenous earthworm species, collecting them from their fields using collection baits and introducing the earthworms into heaps.

In the usual way vermicomposting is practiced in India and most other places around the world, it is both labour-intensive and requires some infrastructure. As a result, while a small farm can use this method to compost most of its wastes, a larger farm often finds it expensive and difficult to compost most of its wastes through vermicomposting. We have after some experimentation developed a methodology through which these issues are resolved - labour, time, managerial inputs, infrastructure and the usage of exotic worms.

Get Started:

You Need 5 Basic Ingredients to Start Vermicomposting:

1. a container
2. bedding
3. water
4. worms
5. nonfatty kitchen scraps.

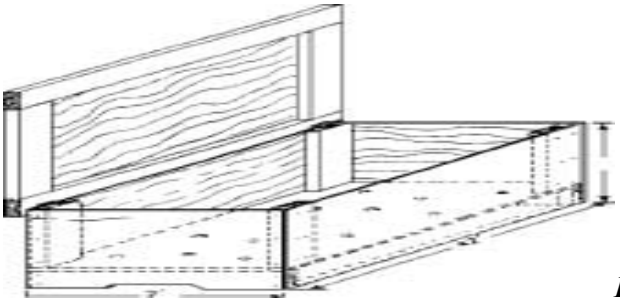
Containers:

It is suggested that weighing your household food waste for one week (in pounds), and then provide one square foot of surface area per pound. The container depth should be between eight and twelve inches. Bins need to be shallow because the worms feed in the top layers of the bedding. A bin that is too deep is not as efficient and could potentially become an odor problem.

Worm boxes can be purchased or made. Plastic storage containers are convenient and come in a variety of sizes. These containers are easily transported and are a nice alternative to heavier wood bins. Many people choose to have several small bins as opposed to one heavier, large wood bin. Small bins work best in homes, apartments and school classrooms. They are easy to tuck under desks, place below kitchen sinks and keep out of the way in laundry rooms.

TIP: If you make a worm bin out of a plastic storage container, never snap the lid shut tight. The lid should lay loosely on the bin.
The large worm bin below (figure 1) is heavier, but is desirable in situations where a bin is going to be outdoors part of the year or in a heated garage. Wood bins allow for a better air movement and a bin this size (figure 1) will take care of food scraps from a family of four.

TIP: If you are truly going to make this an "environmental experience", try making your bin out of an old dresser drawer.



Portable Worm Bin

Depending on the size of the container, drill 8 to 12 holes (1/4 - l/2 inches) in the bottom for aeration and drainage. A plastic bin may need more drainage -- if contents get too wet, drill more holes. Raise the bin on bricks or wooden blocks, and place a tray underneath to capture excess liquid which can be used as liquid plant fertilizer.

The bin needs a cover to conserve moisture and provide darkness for the worms. If the bin is indoors, a sheet of dark plastic or burlap sacking placed loosely on top of the bedding is sufficient as a cover. For outdoor bins, a solid lid is preferable, to keep out unwanted scavengers and rain. Like us, worms need air to live, so be sure to have your bin sufficiently ventilated.

1-2-3 Portable Worm Bin (1' deep, 2- wide and 3 long). This bin has a bottom so it can be moved and used in a heated garage or basement during cold weather. When a worm box is used outside, it does not need to have a bottom. You may want to line the bottom with rocks or boards to keep rodents and other worm-loving creatures from tunneling in. Wooden boxes will typically last for 2 or 3 years.

Bedding:
The bedding for vermi composting systems must be able to retain both moisture and air while providing a place for the worms to live. Bedding does not have to be purchased and most of us have plenty of bedding resources in our home, office or school. Here are some suitable sources of bedding.

****Shredded corrugated cardboard** is an excellent bedding, but is difficult to find.
****Shredded paper** like newspaper and computer paper is easy to find, but may dry out quicker than corrugated cardboard. There is not a problem with the ink from the paper.
****Peat moss** has a low pH level that may cause a problem for the worms and it is more expensive.
****Commercial worm bedding** is available in sporting goods stores, but it is also more expensive.
The amount of bedding depends on the size of the box. A 2-by-2 foot box will need between 4 and 6 pounds of dry bedding, a 2-by-3 foot box will take 9 to 14 pounds. No matter what the size, the bin

should be 2/3 filled with "fluffed" prepared bedding (see below). For smaller bins, experiment--if you prepare excess bedding, it can be dried, stored and used another time.

Prepare the Bedding:
Water is needed to moisten the bedding. Place the dry, shredded bedding in a large container and add water until it covers the bedding. Allow the bedding to absorb as much water as possible before putting it in the worm bin. This could take from two to 24 hours, depending on the bedding used.
Before putting the bedding in your bin, squeeze the water out from the bedding as much as possible. The bedding should feel like a well-wrung washcloth. Place the bedding in the bin and fluff.

Your bedding needs to remain moist. If it is drying out, mist the paper with water from a spray bottle and dampen the bedding again.

The Worms:
The worms used in vermicomposting are called redworms (*Eisenia foetida*), also known as red wigglers, manure worms, red hybrid or tiger worms.

- You can order them through lawn and garden catalogs
- You may be able to find them in a bait store
- If you know someone who has an established supply, they may be willing to sell you some of their worms.

An example of a garden catalog source that sells red worms is Gardens Alive! (ph. 812-537-8650). There are many others. The internet is a good place to start looking.

What About Nightcrawlers? Do not try to use nightcrawlers or other worms native to Nebraska to stock your worm bin. These worms depend on cooler temperatures and an extensive tunneling system to survive. They will die in your worm bin

Why Redworms? Redworms prefer temperatures between 55 and 77 degrees Fahrenheit and are suited to living in a worm bin. The temperature of the bedding should not be allowed to get below freezing or above 84 degrees.

How Many Worms Do I Need? The amount of worms needed will depend on the amount of kitchen waste generated per day. One pound of redworms will easily take care of each half-pound of garbage. To add worms to the bin, simply scatter them over the top. The skin on the worm reacts to light and they will immediately work their way down into the bedding to get away from the light.

Kitchen Waste:

The kitchen waste fed to worms can come from a variety of sources, including all vegetable and fruit waste (don't be surprised that some seeds may germinate and potato peels with eyes sprout), pasta leftovers, coffee grounds (with filter) and tea bags. Worms may have a problem with garlic and onion skins. Worms have a gizzard like chickens so fine grit should be added to help the worms digest food. This gritty material includes cornmeal, coffee grounds and/or finely crushed egg shells (dry the shells and then crush). Avoid large amounts of fat, meat scraps or bone. Some sources feel that a small amount of meat and eggs will provide protein to the worms, but be careful you don't overdo it and know that you may attract rodents.

Adding Kitchen Scraps:
First, and foremost, **START SLOWLY**. It will take time for bacteria to form and your bin can quickly become very smelly if you add too much food, too fast. In the beginning, add a very small amount of gritty material (see above) and a small amount of vegetable matter. Don't worry about the worms starving because they will be eating bedding as well. You can gradually increase the amount of food as the bin becomes established.

The easiest method is to spread the scraps in a thin layer on top of the bedding. If the bin is kept in a dark place or covered, the worms will come to the surface to eat. You can also pull back a small amount of bedding in the bin and dump in the scraps. Cover the scraps with an inch of bedding. Start at one corner of the bin and bury garbage in a pattern to fill in all the spaces. By the time you get back to the first burying spot, the worms will have composted most of the waste.

If you notice odors, cut back on the amount of food or try chopping the food up into smaller pieces. Note: citrus does have a strong odor and the peelings seem to last a long time in the bin. Bins seem to be more manageable when there is less fruit and citrus and more of the leafy vegetables.

Harvesting the Compost:

Given the right environment, the worms will go to work to digest the kitchen scraps and bedding faster than any other compost method. The material will pass through the worms' bodies and become "castings." In about 3-4 months, the worms will have digested nearly all the garbage and bedding and the bin will be filled with a rich, black natural fertilizer and soil amendment. Compared to ordinary soil, the worm castings contain five times more nitrogen, seven times more phosphorus and 11 times more potassium. They are rich in humic acids and improve the structure of the soil.

To keep your bin going, you will need to remove the castings from time to time and there are several ways to go about it. One way to do this is to shine a bright light into the bin. The worms are sensitive to light and will move to the lower layers of the bin. Remove the top layer of casting by using your hands or a sieve. Each time you remove some bedding, the worms will be exposed to the light and they will keep migrating down to the bottom of the bin. Pick out any wigglers or worm eggs (small, opaque cocoons) and return them to the bin. Refill the bin with fresh layers of moist bedding and food.

Another method of harvesting composts is to push the black, decomposed material to one side of the bin, and fill the other side with new, moist bedding and kitchen scraps. Then wait several days. The worms will migrate to the freshly filled side of the bin and you can just scoop out the finished compost. Make sure you pick out any wigglers or worm eggs and return them to the bin.

Using the Compost:
For potted plants, add a thin layer to the top of the potting soil. You can also add the compost directly into your soil mix when repotting. In the garden, simply work it into the ground around the base of each plant. The compost is very mild and you won't have to worry about accidental burning or over fertilizing.

Some Don'ts:

**Don't put plastic bags, bottle caps, rubber bands, sponges, aluminum foil and glass in the bin. These materials will be there forever and make your worm bin look like trash.

**Don't let your cat use your worm bin as a litter box. First, cat urine would soon make the odor intolerable. Secondly, the ammonia in the urine could kill your worms. There is also a concern with toxoplasmosis, a disease that is of particular concern to a pregnant woman who may pass on the disease to her unborn child. If you have cats, provide a screen or other device to keep them from using the worm bin as a litter box.

**Don't use insecticides around your worm bin. You'll not only take care of a few pests, but also your worms.

**Don't use garden soil as bedding for the worms.

**Don't mix fresh cow, horse and especially chicken manure into your bedding. These manures will heat up the bedding and literally cook your worms.

Composting Process

Generally, the Composting methods are as follows: (a) aerated, (b) un-aerated, (c) covered & (d) uncovered. The composting methods include passive piles, windrow composting, static piles and in-vessel composting. It has been found that (after two decades of research) for Indian conditions, the Aerobic windrow composting with the help of microbes is the most effective and efficient method. Recently vermicomposting process has also been found to be effective and can be used. In this method the waste is partially decomposed microbiologically followed by feeding to earth worms to obtain vermicompost.

Aerobic composting

When the organic material is decomposed in the presence of oxygen, the process is called aerobic.

While selecting the location of the unit and accessing the raw material requirements, the following points may be looked into:-

- material source and type
- collection frequency
- condition of material as delivered (may be different when it was collected)
- amount of each material type
- daily delivery schedule
- regulatory constraints
- content of chemical, organic and physical contaminants
- compatibility with the composting technology
- impact of odour generation
- cost and availability
- C - N ratio, moisture content.

Flow Diagram Showing Various Steps in Compost Production

Receiving Fruit & Vegetable waste

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Segregation of non bio degradable materials

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Windrows

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Addition of Culture/Inoculants/Bulking agents

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Covering the windrows by polythene

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Turning

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Watering

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Repeat Turning & Watering

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Drying

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Segregation of non biodegradable materials

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Screening (4 stages)

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Mature compost

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Value addition

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Packing

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Storage

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Distribution

Process

The garbage received is subjected to segregation of non bio-degradable materials such as plastic, glass etc. before arranging in windrows.

Windrow

The windrow composting involves placing mixed materials in long narrow piles and turning or agitating them regularly. Windrows are typically 1m to 3.6 m. high, 3 m to 3.6 m wide and hundred meter long, formed by using front-end loader or auger and are turned with special equipments or specialized turning device. For accelerating the compositing process, special microbial cultures or inoculants such as cellulytic and lignolytic or cowdung slurry are added. However, the fruit & vegetable waste usually contains the micro flora necessary for decomposition, the addition of inoculants/culture is optional. Various useful microbes like Azotobacter, phosphate solubilizing bacteria/ fungi (PSM) etc are also added for enriching the compost.

Turning & Watering

The turning operation mixes the compositing materials and enhances the aeration. The frequency of turning depends upon the rate of decomposition, moisture contentetc. Greater the frequency of turning, quicker is the process of conversion in to compost. During decomposition process, the temperature rises and reaches around 65-70 degree C, which creates optimum conditions for certain microorganisms and kills all unwanted pathogens. Water is sprayed as and when required to keep the moisture content in the desired range of 40 - 65%.

Screening

Composting is usually completed within 7 to 8 weeks and from the semi-processed compost, the wastes like plastic, glass etc. are again separated manually which ensures clean job and makes mechanization highly feasible. The compost thus obtained is then fed to the screening machineries of different mesh size to produce different grades of organic manure. The finished product is uniformly dark brown with a pleasant earthy aroma. The compost can also be enriched with rock phosphate, bio fertilizers and other prescribed additives.

Before packing, the product is tested in a lab for its organic quality such as humus content, organic carbon, nitrogen, phosphorus, potassium and micro nutrients including the population of useful bacteria, fungi etc. The compost is also tested for pathogens, presence of inert material and odour. The compost is then packed in HDPE/LDPE bags.

The important feature of this composting method is the controlled fermentation/degradation, resulting in production of enriched compost with desired specifications and devoid of toxicity. The end product, the enriched manure is therefore safe for use in agricultural and horticultural crops.

Desired Characteristics for the Composting Process

S.No.	Characteristics for Composting Process	Metric Unit	Common Unit	Range
1	Carbon to Nitrogen (C:N) ratio	-----	-----	20:1 – 25:1
2	Moisture Content	g water per g of compost	(% W/W)	15-25% W/W of final product
3	Inerts or sand content	g inerts per g compost	%(dw)	<10%
4	pH	-----	-----	6.5 – 7.5
5	Bulk Density	g compost per cm3 of compost	-----	0.7 – 0.9
6	Colour	-----	-----	Dark brown to black
7	Particle Size	-----	% passing sieve	>90% passes through4mm sieve
8	Total Organic Carbon	mg kg-1	%	Min. 16-20%
9	Conductivity	dSm-1	-----	<4 dSm-1
10	Pathogens	-----	-----	Free from pathogens