Pilot Project B-6

User Manual for Home Compost Bin

“How to Use Home Compost Bin”

How to use Home Compost Bin

User Manual

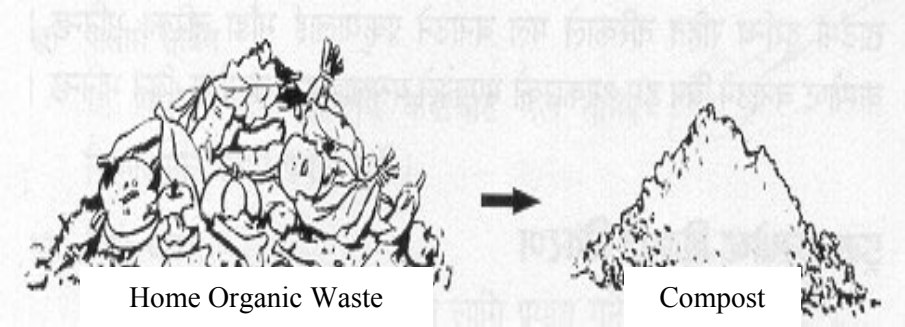
What is Home Organic Waste?

We daily purchase food materials, cloth, medicine and house decorative things for home use. Some waste things are generated after the use of those things. These all-waste materials are called Home Waste. Vegetable waste like roots, leaves, peel and, seed and waste part of fruits, waste food, garden waste, grasses are generated daily in houses, these decomposable wastes from house are called Home Organic Waste (HOW). These organic wastes can be used for compost production.

Home Organic Waste

What is Compost?

Compost is the product of organic decomposition process of waste materials (Vegetable waste like roots, leaves, peels and, seed and waste part of fruits, waste food, garden waste, grasses). The well-decomposed compost is the fine humus, which is odorless, dark brown, friable product like soil and it consists of all nutrients of the decomposed materials as intact, which has been used for compost production. This product can be used as organic manure.



Home Organic Waste Compost

Objective of Producing Compost

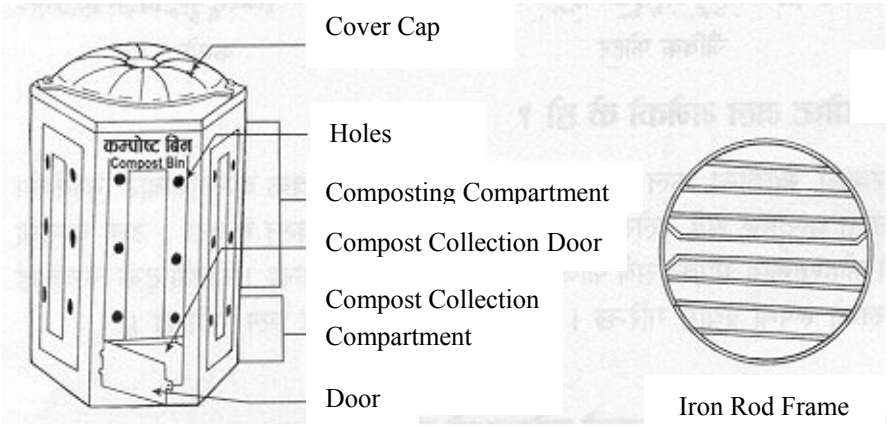
- To use the waste materials into productive purpose by transforming of waste materials into compost.
- To supplement plant requirement of organic mater and other plant nutrients.
- To transform home wastes into compost and reduce pollution.
- To reduce daily generated wastes in the city at the source by minimizing the wastes.

How to Prepare Compost in Bin or Home Composting Bin?

Compost can be prepared in a very simple and environment friendly way in a bin at the corner of house. The bin method of composting is process of collecting waste in a bin by adopting composting technology and making compost in a shorter time without any bad odor in a corner of house is called Bin (Bhanda) Composting or Composting in Bin. The composting bin is like a drum so it is called "Drum Compost Bin" but now it is commonly said "Compost-Bin" instead of "Drum-Compost-Bin".

Sketch and Description of Compost Bin

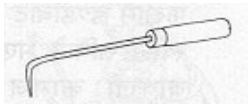
Bin is made up of green thick plastic. It is 19 inches in diameter with 24 inches height and hexagonal in shape. Upper side of bin has an open space and a cover cap is attached. The cap can be open or closed as per need. The bin is internally divided into two parts by iron made frame as upper larger part and lower small part. The iron frame is made with iron rod placing in 2 and 2 inches apart as shown in figure. The upper large portion is called as compost-making compartment and the lower small one is called as compost-collecting compartment. In the compost-collecting compartment there is a small door with door cover, which can be opened and closed as needed. Many small holes are provided in the upper portion (composting compartment) of bin. These holes are helpful for air circulation or air movement in the bin.



Sketch and Description of Compost Bin

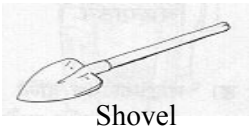
Tools Accompanied with the Bin

a. L-shaped Iron Rod: If compost did not fall down due to compaction, then this tool can be used to pull out the compost.



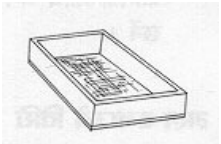
L-Shaped Iron Rod

b. Small Shovel: This is a tool is used to collect the scraped compost from compost collecting compartment.



Shovel

c. Small Sieve: This tool is used for sieving the compost and large not decomposed waste materials are separated out.



Sieve

Pre-preparations for Compost Making

The following pre-preparation arrangements are required for compost making:

a) Site Selection for Compost Bin

Suitable and comfortable site should be selected for compost bin before making compost. As the bin can be placed inside the house or outside but it is better to have protection from direct sun light or rain water. If outside the house, the bin can be placed backyard of the house or a corner of garden or a shed area. If inside the house, the bin can be placed near kitchen room or in the top roof of the house or in ground floor or in Veranda/Balcony.

Platform

b) Preparation of Platform for Bin

After selecting place for bin, manage a 6 inches height platform of available materials and manage for bin placement.

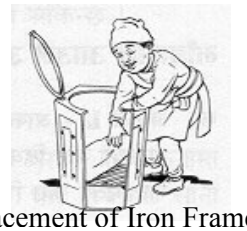
c) Bin Placement

The bin should be placed on the platform and it should be arranged in such a way that the door of compost bin should face well for easy collection of the compost and bin should be arranged in non moving position.

Bin Placement

d) Fixation of Iron Frame in Bin

Iron frame should be kept in bin where its position is provided in the bin.



Placement of Iron Frame

e) Paper Layers Over the Iron Frame

Put three or four fold of newspapers or papers on the iron rod frame so as to protect waste from falling down.

f) Put a Layer of Soil

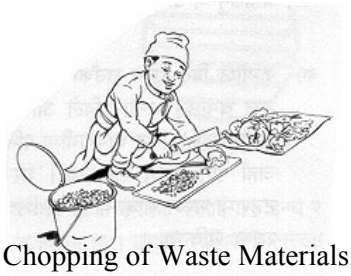
Put about an inch layer of soil (surface soil or garden soil) above the paper. Now, bin is ready for compost preparation. Cut waste materials can be transferred in the bin for compost preparation.

Layer of Soil

Method of Compost Making

a) Collection of Organic Waste

Manage a bucket having lid to collect the organic waste. Collect the home organic waste and cut them into small pieces (1 to 2 inch pieces) and put in the bucket. Transfer the chopped waste in the bin and remain closed the bucket all the time. Thereafter, go on collecting wastes in the same bin.


Chopping of Waste Materials

b) Transferring the Waste in the Bin

Put the collected waste in the bin once a day either in morning or in evening. Check the waste materials that whether the wastes are cut into pieces or not and if some are left unchopped, do pieces and pour in bin.


Transferring Waste in Bin

c) Surface Leveling inside the Bin

After putting the waste inside the bin, the surface of waste heap should be leveled by small shovel so that it could not be heaped in a place or corner. This will result uniform distribution of air, moisture and inoculums in the waste.

d) Spraying or Mixing of Inoculums

Spray approximately one tea glass of EM (active liquid) or some Bokasi powder or available surface soil (top soil) or compost over the waste. The lid of bin has to be immediately closed and should be remained closed. If the compost production rate has reduced due to poor decomposition, then spray the EM once or twice a week for better decomposition. The large pieces of undecomposed waste can be reused as inoculums by mixing over waste or putting back in the bin which was unsieved during sieving compost for sale or own use.


Using Inoculums

e) Regularly Put the Waste in Bin

Have regular practice of putting waste in the bin and if the wastes are too moist or waste includes only fresh vegetables it will be better to wither them in shade and pour in the bin.

f) Put other Waste Materials

Other waste like ash, poultry manure and animal manure can also be put in the bin to make compost. If these things could be well mixed with waste and put into the bin, it will be good inoculums and will help to decompose waste faster.

g) Add Water to keep Waste Moist

Spread or Sprinkle water over waste materials inside the bin, to maintain certain moisture content in the waste. In high moisture condition anaerobic decomposition will be initiated, which will result leachate problems and give bad odor, so give water just to moist waste materials.

Adding Water

h) Time Taken for Compost Decomposition

In general, compost is prepared within three months but it can be prepared in two months if good inoculums could be used. Compost, Bokasi and EM are the good inoculums for composting.

How to Examine Whether Compost is Prepared or Not?

After 2 to 3 months it should be daily checked whether compost is prepared or not. Observe in the compost-collecting chamber of the bin whether compost has falling in it or not. If no compost found, then scrape inside the frame by the iron rod and pull out the compost. If the compost is not prepared then leave as it is for some more days. Waste like rice, fruits and vegetables etc takes 2 months to decompose but hard wastes like potato, cauliflower, radish or waste with hard peels etc takes more than 2 months.

Following qualities are observed in well decompose compost:

- Compost will be odorless or no bad odor smells out.
- Compost will be of dark brown in color and friable as soil.
- It would be difficult to identify the original waste because the wastes are already decomposed and converted to compost.

How to Collect Compost?

- If the compost is dry then it will start to fall down in the lower collection compartment of the bin. But if the compost is wet then compost will not fall down. In such condition we should pull out compost by iron rod.
- The collected compost in compost-collecting compartment is taken out by shovel and then collected in a separate bucket. This compost can be immediately used in the field or in garden.
- To prepare compost for selling in the market, product should be dried on the paper or cloths in the shade but not in direct sun.
- If the compost is moist and make shade dry for some hours and make it powder with the help of a tool or small hammer.
- Then sieve the compost by provided sieve, now it can be used as compost or make charming package of one kg packet in polythene bag for sale.
- The unsieved waste things should be put back in bin. These wastes will work as inoculums.

Collecting Compost

Points to be considered while Making Compost

- The waste material should not be too moist or too saturated.
- Avoid water going to bin from bucket while pouring waste in the compost bin.
- If waste is moist or has excess moisture, put in the bin after withering the waste for a while.
- Regularly drain the excess water or leachate from compost-collecting compartment, if collected.
- Add some Bokasi, if bad odor smelled out and/or incidences of insects have increased.
- Egg's shell can be put in the bin but it has to be broken into fine pieces.
- If fresh waste (vegetables and fruits) has to be used as waste, it will be better to wither for few hours in shed and put in the bin.
- Composting materials should be organic waste and brown (dry matter) and green matter (fresh matter) should be in good proportion.
- There should be good air circulation inside the bin (in waste materials)
- Good inoculums should be used and it should be well mixed up with waste materials.
- The waste materials used for composting should be well chopped or cut into small pieces.

Advantages of Compost Bin

- Compost can be prepared in bin placing them either inside or outside of the house.
- As good air circulation is managed in bin, there is no problem of odor.
- As the shape of the bin is good, it does not give bad show even if placed in trans pass way.
- Compost can be available every time in the house because it has been prepared in house from own home waste materials.
- There will not be any problem of insects and flies because wastes are used for composting which are well decomposed.
- Pollution will be reduced with the good management of waste.

Advantages of Compost

- It helps to make soil porous and friable.
- It helps to improve air circulation and drainage of soil.
- It improves soil fertility by providing organic matter and plant nutrients to the plants.
- It provides food to soil microbes that help to provide soil nutrients into available forms to plants.
- It helps to improve physical, chemical and biological condition of soil and enhances water holding and nutrient holding capacity of soil.
- It helps to release soil nutrients slowly and steadily.
- It helps to reduce pollutions by transforming the waste into compost.
- It helps effective management of waste by transforming waste into compost.
- It does not give adverse effect to plants as by chemical fertilizer even if excessively used.

Use of Compost

- It can be used to seedling/sapling and plants of fruit crop, flower plants and vegetables.
- It can be used to vegetable seedbed for seedling production.
- It can be used in any crop for higher production.

How to Use Compost?

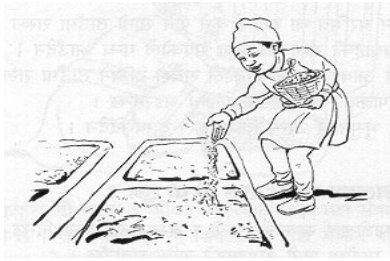
a) Before plantation of flower in flowerpot mix 1-2 handful of compost with the soil and fill up pot and plant the flower sapling.

b) At the flowering stage, spread 1-2 handful of compost around plant making a ring (ring placement) and incorporate well in soil.

Using Compost in Flower Pot

c) Cultivation of field crop by applying compost in field. Generally, compost is applied at the time of land preparation.

d) To the planted plants of vegetable plants or fruit plants or flowers, spread 1-2 handful of compost around plant making a ring and incorporate well in soil.



Application of Compost in Seedbed

"DO'T THROW WASTE PREPARE COMPOST"

Problems Faced by Bin Users and Solutions of the Problems

1. Insect Problems

Insect Problems: Insect problems may occur mainly waste are not decomposing timely due to so many reasons. The reasons might be high moisture content of composting materials or inoculums are not used or good inoculums are not used or not well mixed up or bins are placed in dark and damply /moist location, or no good air circulation or wastes are not cut into pieces. Sometimes season itself favors the breeding of insects so insect problems arises.

Solutions: First of all, all the necessary guidelines or technique has to use for decompositions of waste materials as waste should be cut into pieces, bin should be placed in open (good air circulation area), waste materials should not be too moist, good inoculums has to be used, brown (dry matters) and fresh (green matters) matters should be in good proportion. Wet or moist waste materials are the main reasons for insect problems. Put withered waste (partially dry) materials in bin and use compost or Bokasi in waste materials for quicker decomposition.

2. Leachate Problems

Leachate Problems: This problem is faced when wet or too moist waste materials are used for composting otherwise, bins are placed in damply area, dark area or there is no good air circulation.

Solutions: Bins should be placed in open or good air circulated area. Too moist waste materials should not be used or if the fresh wastes or moist wastes have to be used, it could be wither (air dry) for a while (few hours) and put into the bins. Attention should be given for proportion of dry and green matter. Leachate problem is created if only green or fresh matters are used for composting.

3. Good Inoculums

Good Inoculums: Inoculums has to be used for faster decomposition of wastes. There may be questions of good inoculums. Bin users are using various inoculums (EM, compost, bokasi, surface soil) and some time ash as inoculums.

Solution: Compost, EM and Bokasi are the good inoculums but ash cannot take as inoculums. Soil (surface soil) can be taken as inoculums but it is not as good as compost, EM and bokasi.

4. Brown (Dry) Matter:

What is Dry Matter?: Any organic dry waste can be used as dry matter and can be used for composting which will be good source of Carbon for microorganisms. Leachate problems might occur when no dry matters are used for composting.

Use of Dry Matters: All the organic dry wastes are dry matter. Waste papers, dry matters of farm wastes, rice husks, wood dusts etc are dry matters. At least, dry and fresh waste should be in 1:1 ratio (one part dry and one part green) proportion. That will help to increase organic content of compost and leachate problem will be minimized.

5. Compost Quality

How will be Compost Quality: It is first experience, no information available about quality of home compost (Home Compost Bin). But it is expected that quality should be better and should contain higher rates of nutrients. The composting materials used in home composting all are purely organic wastes no inorganic wastes are mixed up.

Compost Quality: As indicated by compost analysis, the nutrient contents (Nitrogen, Phosphorus and Potassium) is better than other compost reported by different agencies and organic matter is in average range. Organic matter content of compost can be increased by increasing proportion of dry matter for composting. The pH of compost is also in safer side

Pilot Project B-7

Practice of Medium-Scale Vermi-Composting in KMC

Table of Contents

CHAPTER 1 INTRODUCTION

1.1 Background

Vermi-composting is a process that utilizes special types of earthworms to produce worm castings, which can be a very useful organic fertilizer. Recently, vermi-composting has been introduced in Nepal and its use is growing. Experience from India has shown that vermi-composting can be done at the household level or on a larger scale. In Kathmandu, however, vermi-composting has so far been limited to household level.

Kathmandu Metropolitan City (KMC) has started conducting experiments in vermi-composting seven years ago by importing earthworms of the species Eisenia foetida, from India. KMC is now selling vermi-composting kits, which include a plastic tub, other necessary accessories and 300 worms, for Rs 500. This includes a half-day training on vermi-composting. These compost kits can be set up in a small space inside the kitchen and it does not cause odor problems. KMC estimates that there are about 100 households practicing vermi-composting.

In order to upscale the use of vermi-composting technology and demonstrate the use of vermi-composting to treat waste from vegetable markets, KMC implemented a pilot project to set up and operate a medium-scale vermi-composting facility with a capacity to treat about 500 kg per day of vegetable market waste with the support of JICA Study Team. Pesticides Monitor Nepal (PEMON) is a local non-government organization involved in promoting vermi-composting, organic farming, proper use of pesticides and sustainable agriculture. It has organized several training program on vermi-composting.

1.2 Objectives

The main objectives of the pilot project are as follows:

- Demonstrate use of vermi-composting for managing market waste
- Upscale the use of vermi-composting technology
- Test different methods for aerobic composting and vermi-composting
- Strengthen KMC's ability to minimize waste using an environment-friendly technology.

1.3 Pilot Project Components

This pilot project was implemented in two phases. The first phase focused on setting up the vermi-composting facility. Activities conducted during the first phase are as follows:

- Review experiences in vermi-composting
- Site selection and design of vermi beds, aerobic composting chamber and compost box
- Construction of vermi-composting shed, composting chamber, composting box and other related infrastructure
- Procurement of necessary equipment and materials, including earthworms, for vermi-composting

The second phase focused on operating the facility and conducting research to sustain the facility. Activities conducted during the second phase are as follows:

- Operation of vermi-composting facility
- Quality analysis of vermi-compost
- Preparation of marketing strategy for vermi-compost
- Preparation of vermi-composting manual

CHAPTER 2 PROCESS OF VERMI-COMPOSTING

The process of vermi-composting as practiced during pilot project involves several steps. These are described below and shown the figure below:

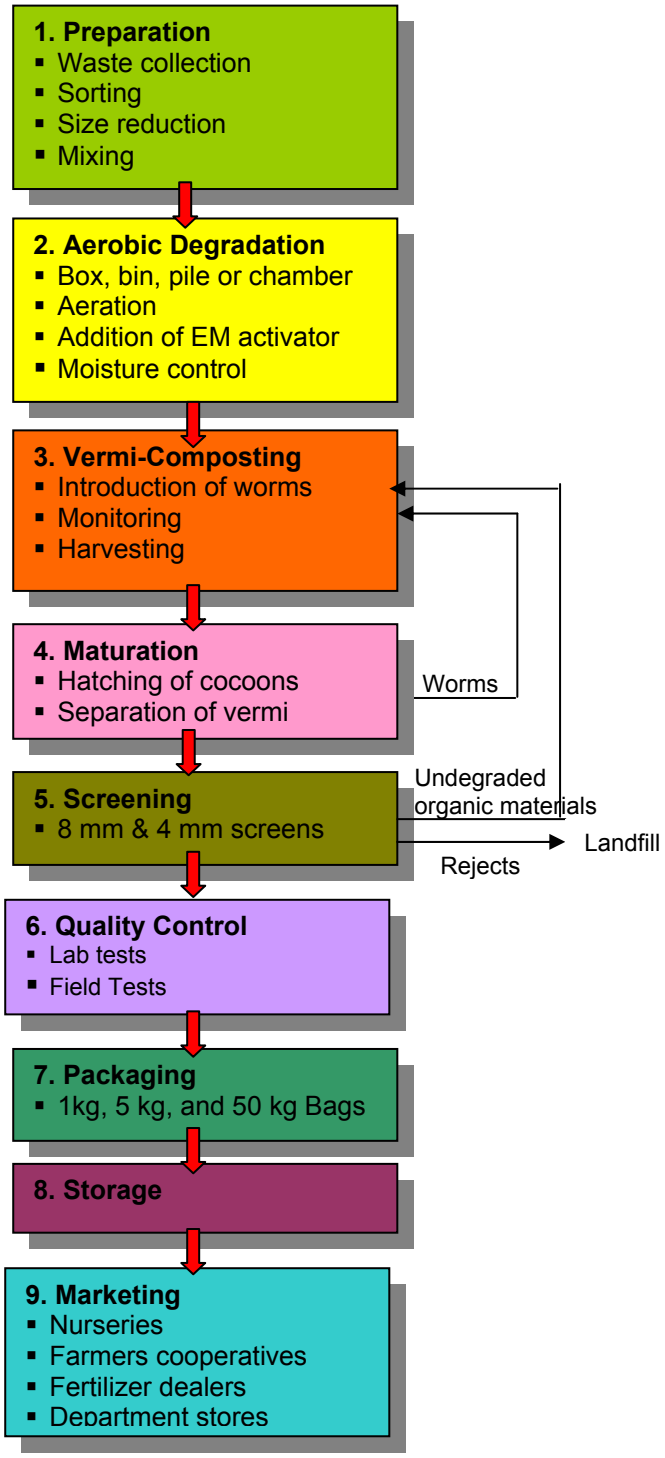


Figure 2-1 Process of Vermi-Composting

2.1 Preparation

The first step is to collect the organic waste and convert it into raw material for vermi-composting. This step involves collection of organic materials, sorting it to remove any contaminants, cutting large pieces of waste to about 1 cubic inch in size and mixing the waste with other materials if necessary. If the waste is rich in nitrogen, then materials with high carbon content, such as saw dust or ash or rice husk will be added. Similarly, if the waste seems to be rich in carbon, then materials with high nitrogen content such as sewage sludge, urine or fresh dung will be added. In order to improve aeration, hollow materials with air pockets, such as small pieces of pipes can be also be added. This process is completed within one day.

2.2 Aerobic Degradation

The waste is initially degraded in an aerobic environment for two to four weeks to ensure that the waste can be consumed easily by the worms. The challenge is to allow the temperature to increase due to biological degradation, while keeping the waste well aerated in order to ensure that the temperature does not rise once the waste is placed in the worm bed.

Aerobic degradation can be done in several ways. Some of these include the following:

Honeycomb Compost Box made from bricks – In this method, a box is made from bricks arranged with holes in between, and the bottom has a grill made from steel rods or bamboo sticks to allow drainage and aeration. This method is also being used by Waste Concern in Bangladesh for aerobic composting.

Compost Barrels made from plastics – 60 to 200 litre capacity plastic bins, with holes on the side for aeration and holes on the bottom for drainage, can be used to store the waste for two weeks while it degrades. Smaller (60 litre) containers will take up more space but because they can be lifted by one or two persons their use makes waste handling easier.

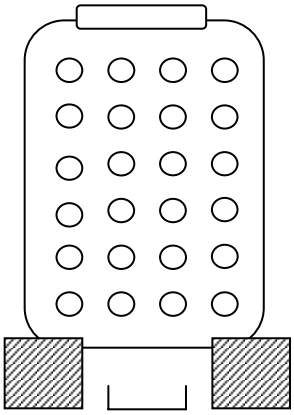


Figure 2-2 Compost Barrel

Aerated Windrows – In this method, waste is piled in windrows that are about 1.5 wide and 1 meter high. The windrows aerated through perforated pipes or a bamboo frame at the bottom as seen in figure 2-3. This method is simple and inexpensive but it requires more space and because the waste is exposed, it can get wet and it may not look very good.

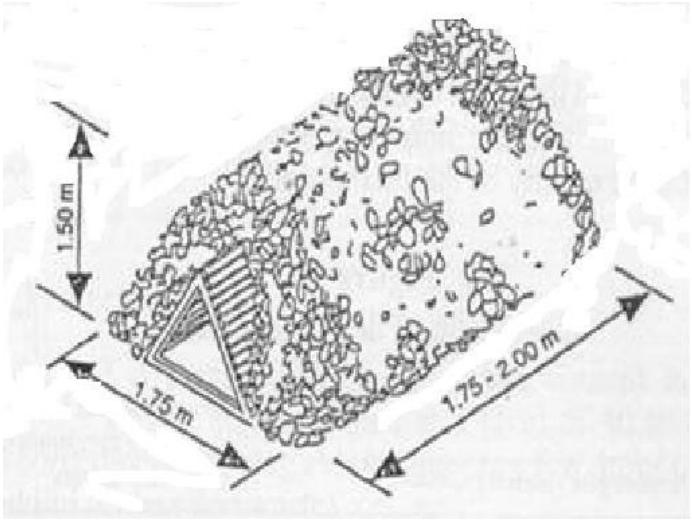


Figure 2-3 Compost Pile with Bamboo Frame for Aeration

Compost Chamber - Some municipalities, such as Madhyapur Thimi, have built compost chambers to make compost. During this project, a modified version of this chamber was designed and used for aerobic composting. The chamber consists of two sets of three chambers each that are arranged vertically one on top of another. The waste is placed in the top chamber and after about ten days, the bamboo sticks at the bottom of the chamber is removed to drop the waste into the second chamber. The process of dropping the waste will aerate the waste. Similarly, after another 10 days, the bamboo sticks at the bottom of the second chamber is also removed to drop the waste in the bottom chamber where the waste stays for another 10 days before it is taken to the vermi beds.

Vermi Tank – The initial composting can also be done in the vermi tanks. The waste is piled at a height of about 0.5 meter on the beds and after about two weeks the required number of woms is released on the waste. This will reduce the need for waste handling, thus reducing operating costs, but this will need more area and more vermi beds. There is also a possibility of insufficient aeration during the initial degradation phase. This could result in anaerobic conditions.

The advantages and disadvantages of various methods are described in Table 2-1.

Table 2-1 Advantages and Disadvantages of Various Methods for Aerobic Degradation

Method	Advantage	Disadvantage
Vermi Tank	No need to transfer the waste after aerobic composting.	Requires more space Anaerobic conditions may be a problem
Honeycomb Box	Relatively low cost Good natural aeration	Waste is partially visible
Barrel	Waste handling is easy Waste is not visible	Relatively expensive
Pile	Very low cost	Requires a lot of space Waste is visible Aeration may be difficult
Chamber	Waste is not visible Amount of space required is relatively low	Relatively expensive

2.3 Vermi-Composting

After two to four weeks of aerobic decomposition, the waste will be placed in vermi tanks made from bricks and cement. The beds are 1 meter wide, 0.6 meter high and three meter long. Two beds are placed next to each other and in between each set of two beds there will be a passage way of about 0.6 meter or two feet.

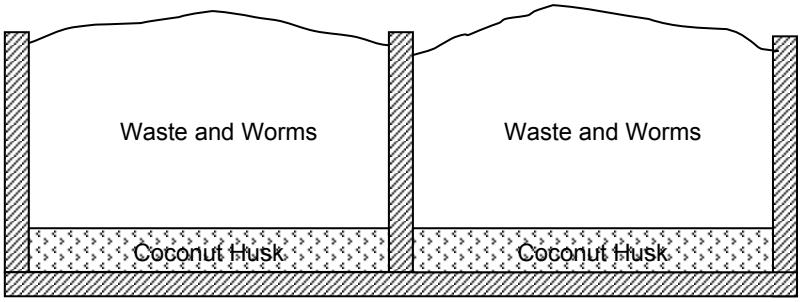


Figure 2-4 Vermi Beds

The beds have a layer of coconut husk at the bottom to facilitate drainage and movement of the worms. Worms of the species *Eisenia foetida* will be released on top of the waste. Approximately 30 kg of worms or about 100,000 worms is required for each of the vermi bed.

Vermi-composting is done for 30 to 40 days. During this time the waste is regularly monitored to ensure that the temperature does not go up, the moisture content is about 50 percent and the worms are healthy.

2.4 Maturation

After 30 to 40 days, the vermi-compost is harvested manually and the harvested compost is stored for about two weeks to allow cocoons to hatch. At the end of this period the worms in the compost is again separated and the worms are placed back in the vermi beds.

2.5 Screening

The compost is screened manually using inclined screens with mesh size of 8 mm and 4 mm.

2.6 Quality Control

In order to ensure that quality of the compost is tested in a lab to determine the nitrogen, phosphorus and potassium and organic content. The compost will also be tested in the field by applying it in test plots. This will provide suggestions for improving the quality of the compost and also assists in its marketing.

2.7 Packaging

The compost, which is now ready for marketing is weighed packed in 1 kg, 5 kg and 50 kg bags. The bags are designed to be attractive and informative. It also contains the brand name of the compost, its content and its application rates.

2.8 Storage

The packed compost is stored before it is distributed in the market. This will require a storeroom with a capacity of storing at least 5 tons of compost.

2.9 Marketing

A marketing strategy has been prepared to market the compost in various market segments such as farmers, nurseries, institutions and home gardeners. The strategy includes product design, pricing, distribution and promotional strategies. The strategy will be used to market the compost in order to ensure that project is sustainable.

CHAPTER 3 PROJECT ACTIVITIES

3.1 Review of Information on Vermi-Composting

The project reviewed available information on vermi-composting and submitted a report to CKV JICA on 20 March 2004. The report included a synopsis of 9 reports related to vermi-composting that was available in Kathmandu and it also presented some articles and information from the internet.

A google search using "vermi" as key word resulted in more than 141,000 sites. Some of the sites reviewed were as follows:

- http://www.howtocompost.org
- www.erfindia.org
- http://www.morarkango.com/vermicompost.html

The short study of available information on vermi-composting concluded that although there is very little literature on vermi-composting in Nepal, there is plenty of information on vermi-composting in general on the Internet. Some of this information can be useful.

There are others as well. The study recommended that additional research is required to generate more information on vermi-composting in Nepal. It also recommended that it would be useful to obtain some books on vermi-composting. One such book is, "Recycle with Earthworms" available at www.vemicoast.com.

3.2 Preparation

The following activities were conducted during the first few weeks of the project as part of the preparatory work.

- Site selection
- Evaluation of design options
- Preparation of Detailed Design

3.2.1 Site Selection

Initially KMC had suggested a site on the southern end of the garden located on the western side of Teku Transfer Station (T/S) for the vermi-composting project. However, more detail investigations revealed several disadvantages related to the site. These include the following:

- The space available is limited
- As the location is away from the Teku T/S, operation of the facility would require transportation of the fresh waste by handcarts
- The project would partially damage the existing garden
- As the area consists of an old dump site, building structures on the site may not be technically feasible.

Several other sites were considered during the initial stages of the projects. These sites are briefly described below.

Area Next to the Existing Incinerator

This site is located within the Teku T/S and is closer to the waste transfer area than the original site. However the space is limited and the space has been allocated for vehicle parking. KMC had built a vermi bed near this site in 1998 but it was never used for vermi-composting and it is now used as a sludge drying bed (see photo 1). This area, along with the sludge drying bed can be used for expanding the vermi-composting project in the future if necessary.

Area Below the New Waste Transfer Ramp

This site is located at the newly constructed waste transfer Ramp at Teku T/S (see Photo 2). The main advantages of this site is that it is located next to the existing transfer station and it will require less initial investment as there is no need for the shed. Although the site is very good for setting up a vermi-composting unit, it had to be disregarded because KMC wants to use the site as a storage area or parking space. In the future, if the site is not used as a store it may be used for vermi-composting instead of leaving it open.

Tukucha Vegetable Market

An area is available south of the Tukucha Vegetable market immediately south of Exhibition Road and west of Tukucha river (see photo 3). The site was previously used as part of the market but now it has some vacant sheds. The main advantage of the site is that it is located right next to the source of the waste and because it is in the centre of the city, it will have good visibility. The main disadvantage of the site is that the site is currently being leased by a private party from the Social Welfare Council and the pilot project would have to pay a certain amount for using the site. This would have increased the cost of the project. Plus, because the site is located next to a crowded market, even slight problems at the site can cause opposition from the local people. Therefore, it may be possible to use the site once KMC is more confident about the technology following the pilot project.

Along Eastern Wall of Teku Transfer Station

The north-east corner of the Teku T/S along the eastern wall (see Photo 5) was finally selected as the project site because it is easily accessible and located right next to the area where waste is being dumped at Teku T/S. In the Teku T/S Improvement Plan the north-east corner is designated as a Tipping area where approximately 40 percent of the waste (80 tons per day) will be tipped and sorted by waste pickers. According to the plan, the tipping area will have six unloading bays, an area for waste pickers and six storage bays for sorted materials, an area for operating the loader and a road for trucks to collect the sorted materials and it will occupy a total area of 675 m^2. The vermi-composting facility is located east of the tipping area and will not disturb the waste sorting activities as it will only take up the space allocated as the driving lane for vehicles that collect scrap materials. These vehicles do not need a separate lane and can access the materials from platform its self as collection of the recyclable materials and their transport will not happen at the same time.

3.2.2 Evaluation of Design Options

Several design options were considered. Originally, the vermi tanks had been designed in two rows along a semi-circular corridor. This had to be changed because of the limitations in

the new location. Finally it was decided to have 20 tanks of three meters length so that it was easier to access the bed and the beds could be filled up in batches if necessary. This also allowed different experiments to be done in different beds. The height of the beds was fixed at 60 cm in order to facilitate loading and unloading of the waste in the beds.

Originally, the aerobic composting area was located next to the vermi-composting beds within the main shed, but this had to be changed because of the presence of a large drain at the site. The aerobic composting area was therefore separated from the vermi-composting area. Compost boxes and a compost chamber were designed for aerobic composting. In addition, aerobic composting was also done in open piles and in barrels. Three compost boxes 1 meter wide, 1.5 meter long and 1 meter high were designed for construction under the existing compost shed north of the vermi-composting area. The size of the compost boxes was designed to fit within the available space. Similarly, the design of the compost chamber has also been done based on available space.

3.2.3 Preparation of Detail Designs

Uni-Tech Consortium prepared the detail designs for the vermi shed, aerobic compost box and compost chamber. Structural strength, cost effectiveness, operation of the facility and aesthetics were considered in preparing the final designs.

3.3 Construction of Shed and Procurement of Equipment

The project included construction of the following structures:

- Vermi shed
- Compost Boxes
- Compost Chamber

PEMON signed an agreement with a private contractor for the construction of the vermi shed in the last week of February and the construction was completed in 3 weeks. Although the contractor had some difficulties because of the large amount of waste at the site, there was no major problem and KMC helped in clearing the site.

A shed that is 33 meter long and 3 meter wide, was constructed. The shed has 20 vermi tanks, each of which is 3 meter long, 1 meter wide and 60 cm high, and a screening area that is 5 meter long and 3 meter wide.

For aerobic composting three aerobic compost boxes that are 1.5 meter long, 1 meter wide and 1 meter high have also been constructed. The size of these boxes had to be reduced slightly from the original plan because of site limitations.

Similarly, an aerobic composting chamber was also constructed.

In order to start the composting process, the project has also procured some necessary equipment such as a rickshaw, a handcart, shovels, rakes, chopping equipment and screens.

3.4 Inauguration and Interaction Programme

The vermi-composting facility was inaugurated during a function on 21 March 2005 and the inauguration ceremony was followed by an interaction programme on vermi-composting.

The inauguration was of the facility was officially done by Mr. Som Nath Subedi, Joint Secretary of Ministry of Local Development and the function was attended and addressed by various guests including Mr. Surya Man Shakya, General Manager of SWMRMC, Mr. Surya Silwal, Executive Officer at KMC, Mr. Indra Man Singh Suwal, Head of KMC's Environment Department KMC, Mr. Toshiyuki Ujiie, Team Leader CKV JICA Study Team, Ms. Shriju Pradhan Tuladhar, Coordinator of Community Mobilisation Unit of KMC and Ms. Ananda Shova Tamrakar, Chairperson of PEMON.

After the formal session, the participants were given a tour of the vermi-composting facility and the facility was inaugurated by releasing earthworms in the vermi beds.

During the interaction programme, Ms. Shriju Pradhan Tuladhar from KMC presented a paper titled "Introduction to Vermi-Composting," and Ms. Ananda Shova Tamrakar of PEMON presented a paper on the technical aspects of vermi-composting. The first paper introduced the concept of vermi-composting and explained how it was introduced in Kathmandu and what KMC is doing to promote it. The paper also highlighted some of the objectives and activities of the pilot project. The second paper explained vermi-composting technology, its use around the world, and the characteristics and benefits of vermi-compost. The two papers were followed by an open interaction where the paper presenters answered the questions of the participants.

A small exhibition was also set up during the inauguration programme. The exhibition demonstrated home vermi-composting kits being sold by KMC, various literature on vermi-composting, vermi-compost produced in Nepal and India and various promotional materials on vermi-composting. All together more than 60 people, including many people from the media, attended the inauguration ceremony and it was well covered in the national news on radio, television and major newspapers, the following day.

3.5 Operation of Vermi-Composting Facility

Operation of the vermi-composting facility started on March 21, 2005. However due to various difficulties, such as the unavailability of sufficient quantities of earthworms, unavailability of trained workers and irregularity in the delivery of waste, the amount of waste processed was very low in the initial stages.

During the two-month period between April 7, 2005 and June 7th 2005, a total of 11 tons of waste was processed in the facility. This is equivalent to an average waste intake of 182 kg per day. This rate is much lower than the proposed rate of 500 kg per day. The waste intake is thus being increased now and at present about 500 kg of waste is being processed per day.

Waste is either brought in a truck by KMC or in a rickshaw by one of the workers. The delivery of required amount of waste by a KMC truck is not always reliable because sometimes the waste is mixed with the rest of the waste in Teku T/S. Although collection of waste by the rickshaw is more reliable, this is a time consuming activity. Collection of one rickshaw full of waste takes more than one hour and at one time only about 150 kg of waste can be collected.

Once the waste is collected it is unloaded at the project site and then sorted and chopped if necessary. Usually, about 97 percent of the collected waste is organic waste that can be used. The waste is then weighed and mixed with saw dust in about 10:1 ratio.

Once the waste is ready for composting it is then composted for about 30 days in an aerobic system. During the two-month project period, various options for aerobic composting has been tried.

In the compost chamber, the top compartment holds about 1,000 kg of waste. After 10 days, the waste is dropped to the second compartment and from there it is dropped to the third compartment after 10 more days. Therefore, the existing compost chamber with two sets of three compartments, is capable of processing 2,000kg of waste every 10 days or 6 tons of waste per month. Smell was not a problem and by the end of 10 days the volume of waste had reduced by 40 percent.

In the honeycomb compost box, each box is able to hold about 600 kg of waste. In the beginning two of the boxes are filled with waste. After 15 days, the volume of the waste reduces by about half and the semi decomposed waste from the boxes is transferred in to the empty box. Therefore the set of three honeycomb boxes is capable of processing 1,200 kg of waste every 15 days or 2.4 tons per month.

The compost barrel is capable of holding about 100 kg of waste at one time. As the volume of the waste reduces by about 50 percent by the end of 15 days, waste from two barrels can be emptied into another barrel at the end of 15 days. In this way, a set of three barrels can process 400 kg of waster per month.

During the pilot project, composting was also done in piles, 1 m^3 old waste containers and vermi beds. However, aeration in these methods were difficult and in the case of pile composting protection from rain was also a problem.

During aerobic composting, the temperature and volume was regularly monitored. The temperature usually reached a maximum of about 60 degrees C after about six days. At the end of 10 days the temperature was between 40 to 50 degrees C and by the end of 10 days the temperature went down to 26 to 32 degrees C.

After aerobic composting it was placed in the vermi tanks with earthworms. Initially, waste that had been composted for about 15 days was placed in the vermi beds. But this resulted in increase in temperature in the vermi beds and this caused worms to die. During the pilot project 200,000 worms were used. But it is clear that a lot more worms are required.

If we are to process 500 kg of fresh waste per day, then by the end of one month of aerobic composting the amount of waste will have decreased to about 250 kg per day. Each of the vermi tanks has a capacity of 1.8 m^3 or about 1 ton. This means that one tank will be filled in about four days. If we let the worms feed on the waste for about 40 days than a total of about 10 vermi tanks will be required. Furthermore, if we put 1 ton of waste in one vermi tank and plan to leave the waste in the tank for 40 days then we need enough worms to consume 25 kg of waste per day. According to different literature, worms can eat waste equivalent to 0.5 to 1 time their body weight each day. This means we need 25 kg to 50 kg of worms per tank. As each kg of worms consists of approximately 3,000 worms, the total number of worms required per tank is 75,000 to 150,000. As we require a total of 10 tanks to process 500 kg of fresh waste or 250 kg of partially decomposed waste per day, the total number of worms is 7.5 million to 15 million.

After 40 days in the vermi tanks, the vermi-compost removed and harvested, then the compost is put aside for about two days to allow hatching of worms from cocoons. At present this is being done in a few of the tanks. As the vermi-composting process further

reduces the volume of compost by about half, the total amount of vermi-compost produced will be only about 125 kg per day if we start with 500 kg of fresh waste per day. This means that one of the vermi tanks will be filled with vermi-compost in about 8 days. Therefore two of the vermi tanks or equivalent amount of space will be required for maturation of the compost.

After the composting process is complete, it needs to be screened and then packed and stored. At present, there is a small area for screening at the end of the vermi tanks but this area seems to be insufficient. In the future some of the vermi tanks will be used for screening and storage of final product as well.

In the two months of the project a total of 926 kg of vermi-compost was produced. In the future the project should be able to produce at least 125 kg of vermi-compost per day. Originally, it was assumed that 500 kg of fresh waste will result in about 200 kg of vermi-compost. But experiments done during the pilot project indicates that volume reduction is more than expected and therefore the capacity of the facility is probably closer to 125 kg per day.

3.6 Quality Analysis

Six samples of the compost were tested in a lab for nitrogen, phosphorus, potassium and organic content. The results of the quality analysis are presented in Table 3-1.

Table 3-1 Results of Compost Quality Analysis

No.	pH	Nitrogen	Phosphorus	Potassium	Organic Matter	Moisture	C:N Ratio
1	7.5	0.67	0.92	4.2	22.11	52.51	19
2	8.2	0.61	0.82	3.5	16.17	70.85	15
3	8.0	0.60	0.78	2.93	12.21	57.26	12
4	7.9	0.62	0.87	3.62	18.48	56.6	17
5	7.9	0.61	0.79	2.99	14.52	53.26	14
6	8.5	0.63	0.88	3.69	18.81	61.72	18
Avg.	8.0	0.62	0.84	3.49	17.05	58.70	15.83

Source : KMC

The results of the analysis were quite different from what can be expected from vermi-compost based on previous studies. The results show that the amounts of major nutrients, particularly nitrogen, as well as organic matter in the tested samples, are much lower than results obtained from previous studies. Most recently, Maharjan (2004) had analyzed vermi-compost made from vegetable waste from Kalimati Vegetable Market on a small scale and found the nitrogen, phosphorus, potassium and organic content to be 1.81 percent, 2.49 percent, 4.59 percent and 35.16 percent respectively.

Some possible reasons for the extremely low values of NPK and organic matter found in the vermi-compost samples from this pilot project are as follows:

- As the number of earthworms was very low in the initial stages, most of the compost in the samples is probably ordinary aerobic compost instead of vermi cast. The values for NPK for ordinary compost are usually much lower than vermi-compost.
- In the initial stages, the waste had been left outside for several days, as a result much of the nutrients were lost during this stage through the air as well as leachate.

Whatever the reasons may be, the initial quality analysis clearly indicates the need to improve the quality of the compost. This needs to be done by significantly increasing the quantity of earthworms and reduce the possibilities of nutrient losses through the air or leachate. There is a need to do additional tests once the vermi-composting process is improved in order to ensure the production of better quality compost.

3.7 Training

During the project, two training workshops were conducted for gardeners, agricultural extension workers and farmers. During the workshops, the main concepts and process of vermi-composting were explained and the participants leaned about the pilot project. The main objectives of the workshop were to raise awareness on vermi-composting among potential users and also expand the market for vermi-compost.

The first training workshop was organized on May 29, 2005 and had 31 participants mostly gardeners from various hotels, embassies and other institutions. The second training workshop was organized on the following day on May 30, 2005 and had 31 participants, most of whom were farmers.

3.8 Marketing Strategy

As product marketing is a very important part of any compost project and most composting projects tend to fail because of poor marketing, during this pilot project a market survey was conducted and a marketing strategy was developed to market the vermi-compost.

The first part of marketing strategy formulation was a situational analysis that was conducted based on primary as well as secondary information. The primary research involved questionnaire survey of 23 nurseries and agro-vets, and 100 customers visiting nurseries. Discussions with department stores and grocery stores were also held. The situational analysis included the following types of analysis:

Market Analysis – Assessment of potential markets included farmers, nurseries, households and institution. The analysis recommended prioritization of household and institutions.

Competitive Analysis – The strengths and weaknesses of four competing products – household compost, household vermi-compost, other organic fertilizer and chemical fertilizer – were assessed.

Product/Price Analysis – The current market price of various types of competing products were analyzed

Distribution Analysis – Potential distribution channels – nurseries, agro-vets, department stores and grocery stores – were analyzed.

Promotional Analysis – This analysis recommended communications materials to focus on product feature, product benefits, product use and availability channels.

Based on the situational analysis marketing objectives and marketing strategy was formulated. The marketing strategy includes recommendations for product development, prices, distributional channels and promotional activities.

The draft marketing strategy was presented and discussed at an interaction program organized in KMC on June 19, 2005. Based on the marketing strategy and discussion with stakeholders, the brand name "Healthy Gro" has been recommended and the recommended price for distributors, retailers and consumers is Rs 10, 12, and 15 respectively per kg. Assuming that the cost of production is Rs 7.5 per kg, this pricing structure would result in profit margins of 33 percent to the producer, 20 percent to the distributor and 25 percent to the retailer. For 5 kg and 50 kg packets the price per kg will be slightly lower. The prices will also be slightly lower during the initial promotional stage.

About 150 nurseries and agro-vets will be the primary channels to take the vermi-compost to the consumers. A two-tier (distributor & retailer) distribution mechanism is proposed. A distributor with facilities for storing and transporting the products, and good networking with retailers will be selected.

For promotional activities, the objectives will be to create brand awareness and encourage product trial. This will be done through marketing communications and sales promotion. Marketing communications will primarily focus on in-store-advertisement such as leaflets and point-of-purchase (POP) display. Other means of communication will be advertorials and product watch. The objective of sales promotional activities such as special promotional prices and exhibitions is rapid penetration of the brand among consumers.

3.9 Vermi-Composting Manual

A manual for medium scale vermi-composting has been produced. The manual describes vermi-composting, the process of vermi-composting and the uses of vermi-compost as well as the worms. The manual has been prepared based on the experiences of the pilot project and will be helpful for anyone interested in replicating the project.

CHAPTER 4 PROJECT MANAGEMENT

The pilot project had two project coordinators, one from KMC and one from PEMON to provide overall guidance and supervision. Shriju Pradhan Tuladhar, Coordinator of Community Mobilization Unit, was responsible for the project implementation from KMC and Dr. Ananda Shova Tamrakar, Chairperson of PEMON, was the project coordinators. Bhushan Tuladhar from Clean Energy Nepal provided technical advice.

The responsibilities of Coordinator from KMC were as follows:

- Coordinate project related activities within KMC
- Ensure the availability of required land within the Teku Transfer Station
- Ensure the timely delivery of the 500 kg of market waste per day
- Organize an interaction programme on vermi-composting
- Assist in making and marketing the compost
- Monitor the project activities and ensure its smooth implementation
- Based on the project outcome, develop plans for operating and expanding the facility

The responsibility of Project Coordinator from PEMON were as follows:

- Design the composting facility
- Ensure proper and timely construction of the facility
- Develop and implement appropriate operating procedures to ensure that 500 kg of waste is composted in a proper manner
- Test the quality of the compost
- Design and implement a strategy for marketing the vermi-compost
- Organize workshop for farmers
- Design and Develop a vermi-composting manual
- Submit and mid-term and final reports.

The pilot project had three supervisors with experience in vermi-composting, who were responsible for implementing the activities in the field. Although the supervisors, Mr. Kishor Maharjan, Ms. Karuna Maharjan and Ms. Srijana Shakya, were working on a part-time basis, there were always one or more supervisors at the site.

The responsibilities of the supervisors were as follows:

- Supervise the day-to-day operation of the composting facility, including the work of the compost makers
- Conduct experiments on various methods of operating the composting facility.
- Report progress to project coordinators

The project had three compost makers, who were responsible for the following:

- Collect market waste and bring it to the project site
- Sort the waste
- Cut the waste into small pieces
- Compost the waste
- Screen and package the compost

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Overall the pilot project has been successful in demonstrating the application of vermi-composting technology to process vegetable market waste. Both technical and financial feasibility of the application of this technology on a medium scale has been demonstrated.

Technically, although there have been some initial problems in operating the facility and the quality and quantity of compost needs to be improved, overall, there are enough reasons to believe that the facility can produce at least 125 kg per day of good quality vermi-compost.

Cost calculations and the results of the marketing survey also indicate that the facility can be operated in a sustainable manner. At present, the cost of vermi-compost production is estimated to be approximately Rs 7.5 per kg. As the market survey indicates that this compost can be sold for Rs 15 to 20 per kg and there is a sufficiently large market for this compost, the facility can be operated as a profit center.

5.2 Problems to be Addressed

Some of the main problems encountered during the project are as follows:

Problems Related to Facility Design and Construction

1. The vermi tanks are exposed to direct sunlight in the afternoon. Now plastic sheets have been set up to block direct sunlight and rain. In the future, the roof should be made a bit lower and it should be extended beyond the shed to block sunlight and rain.
2. As trails for walking and transporting of waste was not originally constructed, transporting the waste, particularly during rainy days is very difficult in the area. Therefore, the site should be improved by constructing a paved trail for walking and transporting waste. This will also improve the overall aesthetics in the area.
3. More slope should be maintained for proper flow of leachate and in the case of the vermi tank, a drainage layer consisting of small stones should be tried. This layer should be separated from the waste by a layer of geo membrane or sack. In the case of compost chamber and honeycomb boxes, a drainage system for the leachate should be made.
4. As composting in the one cubic meter container is difficult, some more honeycomb boxes or compost chambers need to be constructed or more compost barrels need to be set up. Right now the existing compost chamber, honeycomb boxes and barrels have a capacity to process about 8.8 tons of waste per month. This needs to be increased to at least 15 tons per month. This can be either done by adding a compost chamber and three more compost barrels or by adding six more honeycomb boxes and 12 more compost barrels.
5. As there is no shed for workers involved in waste sorting and preparation, this becomes a difficult task during hot sunning days or during rain.
6. There is no adequate provision for drainage at the transfer station. As a result, during rain, the runoff from the entire paved area within the transfer station comes to the project site and damages the compost as well as cause difficulties in operating the facility due to water

logging. Therefore there is an urgent need to properly manage the runoff by providing adequate drainage infrastructure.

7. As the site is located next to the transfer station, air-borne litter is also a major problem at the site. Some kind of barrier between the project site and the tipping floor of the transfer station is required.

Problems Associated with Operation and Management of the Facility

1. The delivery of waste to the compost site has not been very regular. KMC should ensure that at least 500 kg of vegetable market waste is delivered to the site each day. Alternatively about 1 ton of waste can be delivered once every two days.
2. The number of worms needs to be increased significantly in order to ensure proper vermi-composting. When the project was designed an assumption was made that 200,000 worms would be enough but now it looks like at least five times more worms than this number is required.
3. The quality of the compost needs to be improved. This should be done by increasing the number of worms and reducing losses due to leachate and exposure to air.
4. Efforts should be made to implement the marketing plan as soon as possible. This will require finalization of promotional materials, selection of a distributor and retailers.

5.3 Recommendations

The challenge now is to operate the facility in full capacity in a sustainable manner. Key recommendations for future action are as follows:

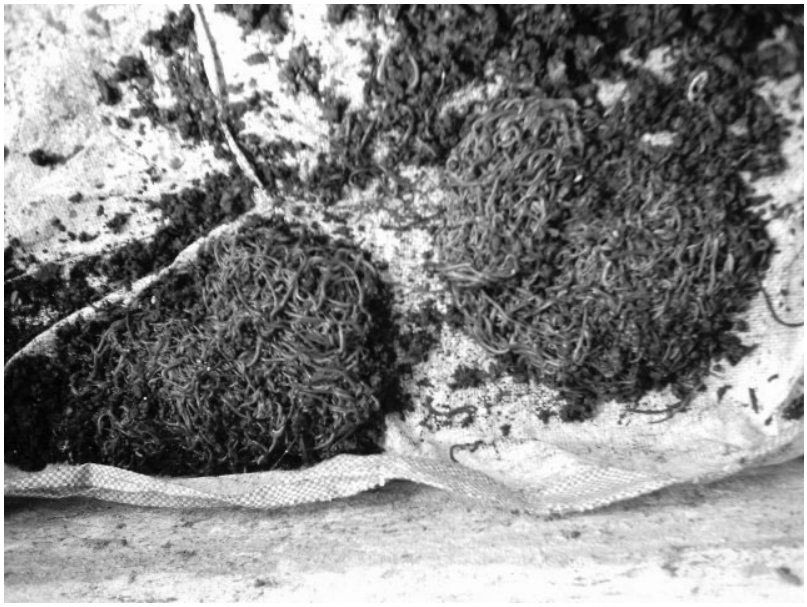
1. KMC should improve the drainage system around the site immediately so as to ensure proper operation of the facility, particularly during the rainy season.
2. The area next to the vermi tanks should be paved so as to assist in transporting of waste and compost.
3. Additional facilities should be set up for aerobic composting. This can be in the form of honeycomb compost boxes, compost chamber or compost barrels. Additional facilities should have the capacity to process at least 6 tons of waste per month, although the target should be to double the existing capacity for aerobic composting.
4. Leachate collection system needs to be improved. The bottom slopes of the vermi tanks, honeycomb boxes and compost chambers should be increased so that the leachate flows properly. In the vermi tanks, a separate drainage layer with stones or gravel should be tried out.
5. The number of worms in the vermi tanks should be increased, either by purchasing worms or waiting for the existing worms to reproduce. Ultimately each tank should have about 100,000 worms.
6. KMC should provide more space for screening and storing the compost, as well as sorting the waste when it firs arrives. This can be done by building a large shed immediately west of the existing vermi tanks and aerobic composting chamber. .
7. The quality of the compost should be regularly tested to ensure that the quality improves.

8. The capacity of the facility should be fully utilized by increasing the amount of waste processed and making the system more efficient in terms of space and time required for composting.
9. Once the facility start to operate smoothly, the responsibility of operating the facility can be transferred to a suitable private party in order to ensure the sustainable operation of the facility.
10. The responsibility for marketing the compost should be given to a private company and the marketing strategy should be followed. As proper marketing is very important to ensure that the project is sustainable in the long run, KMC should also provide necessary support in marketing the compost.
11. Once the facility starts to operate in full capacity, the capacity of the facility should be expanded by developing additional infrastructure for aerobic and vermi-composting. The capacity of the facility should be increased to at least one ton per day and preferably it should have the capacity to compost all the organic waste generated by Kalimati Vegetable Market. Some possible areas for expansion is the area immediately north or south of the existing project area or the area next to the exiting wastewater treatment facility or the area beneath the newly constructed ramp.
12. Similar facilities should also be established in other locations where feasible, as public-private partnership ventures. For this, the municipality or vegetable market owner should provide the initial investment and a private operator should operate the facility and market the compost. Some possible areas include the area along the northern wall of the Kalimati Vegetable Market or the area south of the Tukucha Vegetable Market.
13. SWMRMC should provide technical and financial assistance to further promote vermi-composting technology in other municipalities as well. This will require extensive training, field visits and initial support in establishing vermi-composting facilities.
14. The government and municipalities should continue to support research and development activities on vermi-composting. Potential areas of research include application of vermi-composting technology for various types of waste, optimization of the use of vermi-composting technology in various conditions and techniques for quality control and improvement. Academic institutions and NGOs can be involved in conducting such research.

Pilot Project B-8

Manual for Medium-Scale Vermi-Composting

Manual for Medium-Scale Vermi-Composting



June 2005

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1. Introduction:

Our country produces massive amount of organic waste, which has high economic value if it is harnessed properly by means of vermi-composting. Vermi-composting (Latin Vermes=Worm) is a process of composting where certain species of earthworm is used to enhance the process of organic waste conversion and produce nutrient rich humus which is called vermi-compost. It is of high quality manure and has manifold advantages over chemical fertilizer. It is popular throughout the world. Many institutions and countries are now promoting vermi-composting for economic and environmental reasons. Cuba has developed 170 vermi-composting centers that use cow manure, sugarcane, pulp and coffee pulp.

Why is Vermi culture becoming popular?

- Vermi culture does not require sophisticated equipments.
- It does not need heavy capital investment.
- It is made from eco-friendly technology using organic wastes and biotechnology process.
- It does not require skilled and technical person.

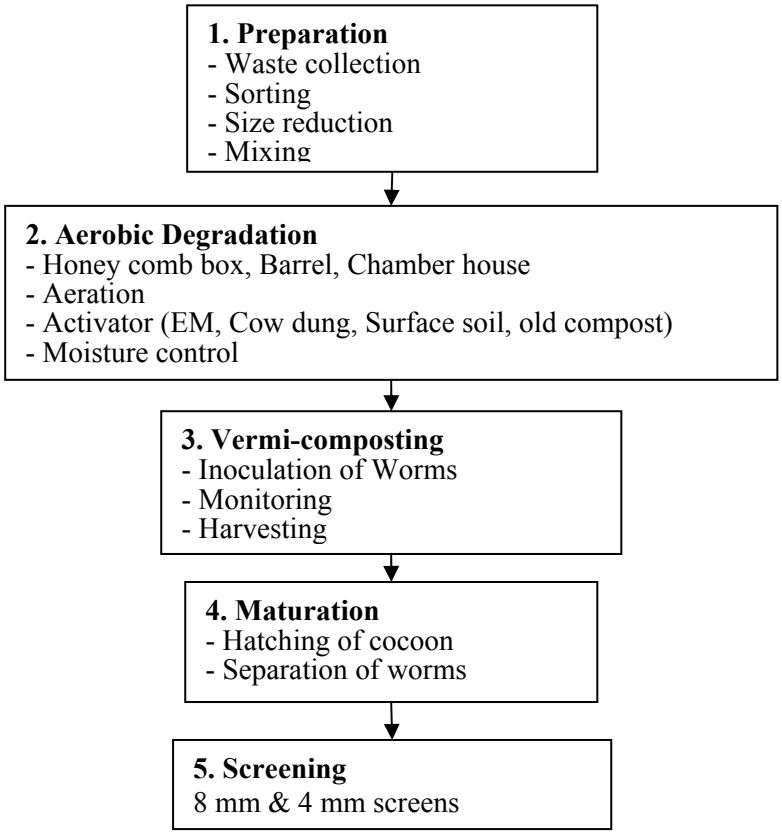
Earthworm species for compost production

There are about 4000 species of earthworm but only half of dozen species are used world wide for waste management. They are:

1) *Eisenia foetida*
2) *Lampito mauritti*
3) *Lumbricus rubellus*
4) *Eudrillus euginea*
5) *Perionyx excavatus*
6) *Perionyx favatus*

The earthworm *Eisenia foetida* i.e red worm is the most suitable species for the use of vermicomposting. It has very good efficiency with high reproductive rates. The culturing process of this species is quite easy due to its feeding adjustment to organic matter. They can live on the wide variety of decomposable waste. It can consume organic material equal to their body weight per day. Moreover, it can consume food more than 3 to 4 times to their body weight if the environmental condition is favorable for them.

2. Process of Vermi-Composting



Preparation

For vermi-composting the basic needs are food i.e., organic waste, space or house for earthworm and water for moisture control.

For the preparation of food for earthworm, following steps should be carried out;

1) Collect the organic waste and sorting is must.
2) Cut the large pieces of organic waste to about 1 cubic inch in size.
3) Mix the waste with other materials if necessary. (The vegetable waste is rich in Nitrogen so mix it with waste that is rich in Carbon such as sawdust, rice husk, paper, etc. The mixing percentage of carbonaceous material should be 10%.)

Photo 1 Organic waste collection

Photo 2 Sorting and chopping of vegetable wastes

2.1 Aerobic Digestion:

The earthworm prefers partially degraded organic waste rather than fresh waste. Aerobic degradation in medium scale vermi-composting has higher significance. Too much fresh vegetable wastes can generate maximum temperature that can kill the worms, so it is better to digest aerobically. The aerobic digestion can be done in different composting units such as;

i) Honey comb box
ii) Barrel
iii) Chamber house
iv) Pile, etc

2.1.1 Honey Comb Box

The box made from brick walls with holes in between and bottom has a grill made from iron rod to allow drainage and aeration. A box having volume 1.14 cubic meters can hold about 800 kg of fresh vegetable waste that means its specific weight is 700.28 Kg/m^3.

Photo 3 Honey Comb Box

2.1.2 Barrel

A barrel having 200 liter capacity can accommodate about 100 Kg of fresh vegetable waste. It has number of holes around its wall for the circulation of air.

Photo 4 Barrel composting

2.1.3 Chamber House

This type of composting unit is also used for aerobic digestion. It has three partitions i.e., top, middle and bottom which are separated by bamboo sticks.

It can accommodate about 900-1000 Kg of vegetable waste having volume of 1.31 cubic meter in the top most chamber.

The procedure of aerobic digestion in Chamber house involves;

a) Put the organic waste (maintaining with C:N ratio) in the top of the chamber.

b) After about 10 days, remove the bamboo sticks at the bottom of the first chamber to drop the partially decomposed waste into the second or middle portion of the chamber.

c) Similarly the waste in the middle portion is dropped after 10 days to the bottom portion which remains there for 10 days. This waste is now ready for vermi as a food.

Photo 5 Chamber House

2.2 Vermi-composting:

For vermi-composting following steps should be carried out;

2.2.1 Selection of Container:

Size of cement tank or container depends on the amount of waste and the number of earthworms to be introduced. The container/ tank should not be too deep. The base of the tank should be inclined about 3-5^{o} to maintain the flow of produced vermiwash and minimize water logging. The vermiwash outlet should be constructed at the inclined position of the tank. The volume of the tank having 1.8 cubic meter require about 10,000 worms.

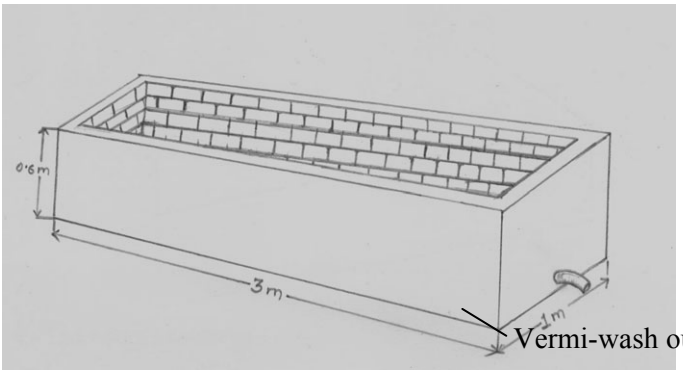


Figure 1: Dimension of cemented of Vermi Tank

Photo 6 Cemented Vermi Tanks

2.2.2 Bedding Materials

i) Select bedding materials, which is resistant to fast decomposition.
ii) Soak the bedding material by chlorine free water.
iii) Spread the material for about 4 to 6 inch in a tank/container.
iv) Spread half inch of dried cow dung.

(Bedding for worms can be made from coconut husk, sawdust, hay, straw, shredded leaves or compost. Coconut husk is an excellent material for bedding. The bedding materials should be thoroughly moistened before adding the worms. The bedding should be loosely packed in order to create air space for the worms to breathe and to control odors. Varying the bedding materials provides a richer source of nutrients).

Photo 7 Bedding Material for Worms (Coconut coir)

Photo 8 Bedding with Activator (Cow dung) in Tank

2.2.3 Feeding Materials

The food of earthworms include admixture of cow-dung, green foliage, vegetable wastes, discarded parts of fruit, paper or scarp of cardboards.

The organic wastes i.e biodegradable waste can be partially composted in different composting unit such as containers, honeycomb box, Barrel, Chamber house etc. Such partially decomposed waste can be good source of nutrient / food for them. They can easily feed on those materials. A size of tank having 3x1x0.6 cubic meter is sufficient to accommodate partially digested waste if 100 kg of waste is added per week for 2 months.

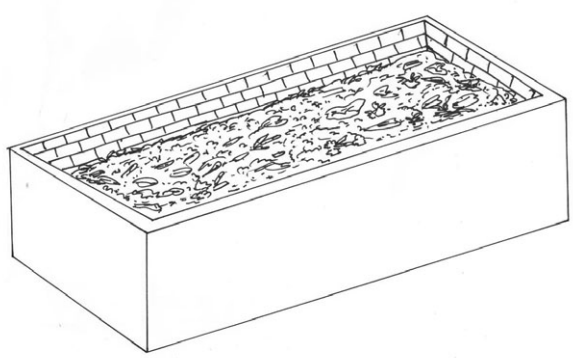


Figure 2 Feeding Materials for Worms

Food to be avoided

Bones, dairy products, meats that may attract pests and garlic, onions and spicy foods should be avoided. Limited amounts of citrus can be added but too much can make compost too acidic and earthworms do not prefer acidic foods.

2.2.4 Earthworm Inoculation:

The most suitable types of earthworms used for vermi-composting is tiger worm (*Eisenia foetida*). It can consume organic material equal to their body weight per day.

Release about 5,000-6,000 earthworms per square meter on the top of the partially decomposed waste. These earthworms will start penetrating to the bottom. Once all these

earthworms disappear, cover the surface with jute bags and keep them moist by sprinkling water in a judicious way.

Photo 9 Weighing of Vermi for Inoculation in Tank

Photo 10 Water Spraying in Vermi Tank

2.2.5 Maturation:

After 45 to 60 days, harvest the vermi-compost manually and store it inside the jute bags for about two weeks to allow cocoon to hatch. The jute bags soaks the excess of moisture.

2.2.6 Harvesting the Worms and Compost:

It is important to separate the earthworms from their castings; otherwise the worms will begin to die. So harvesting is must. After 2 months, it is ready to harvest. There are mainly two basic ways to separate the worms from the finished product i.e., vermi-compost.

Procedure 1:

i) Move the finished compost and worms over to one side of the tank.
ii) Add new bedding material and food waste to the other side of the tank. Worms in the finished compost should move over to the new bedding for searching fresh food.
iii) Then the finished compost can be removed.

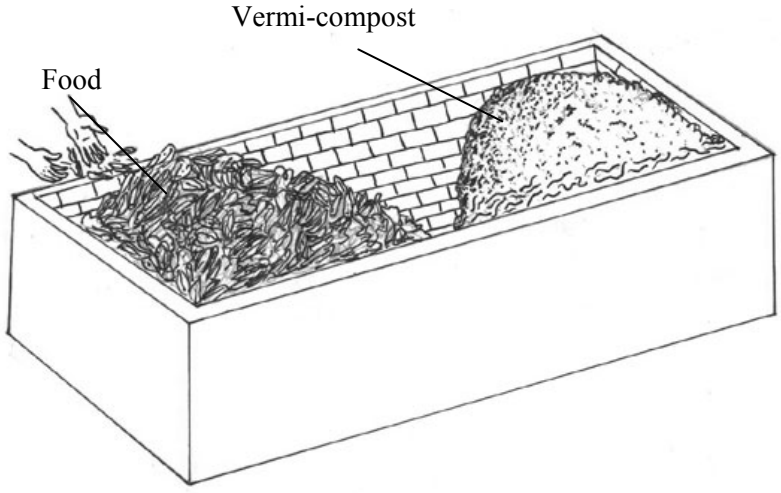


Figure 3 Separation of Worms from Vermi-compost in Cemented Vermi Tank

Procedure 2 (heap method):

i) Spread a plastic sheet on the ground and empty the contents of the tank in sunlight making a pyramid like heap.
ii) Let this heap remain in daylight for about half to one hour, which will induce the earthworms to penetrate deep and reach the bottom.
iii) The upper layer of organic manure can be lifted slowly.
iv) Later the earthworms at the bottom may be separated from one another and deposited in the refilled tank.

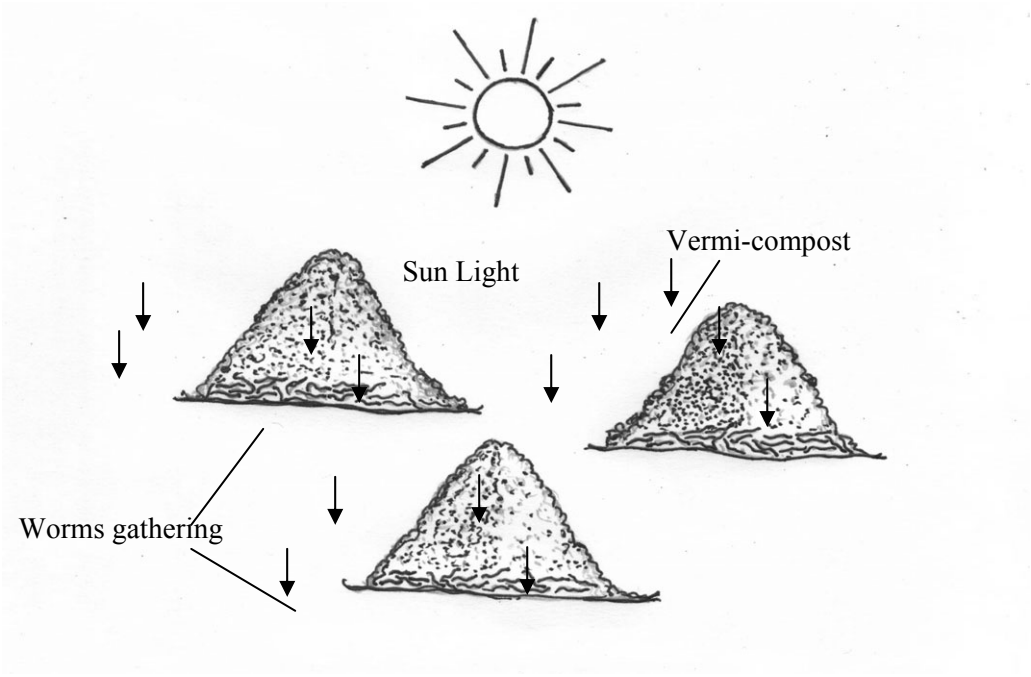


Figure 4 Separation of Worms from Vermi-compost

2.2.7 Screening

The vermi-compost might need screening if rough stuff (sticks) is used in the bedding that takes time to break down. The compost can be screened manually using inclined screens with mesh size of 8 mm and 4 mm.

3. Multiple Uses of Vermi-Compost:

The vermi-compost can be used in

a) Agriculture
b) Floriculture
c) Horticulture
d) Silviculture
e) Mushroom culture
f) Bio gas production
g) Fish pond

4. Multiple Uses of Earthworm:

The earthworm can be used as

a) Fish food
b) Aquarium
c) Poultry
d) Piggery
e) Human food and
f) Medicine

5. Some Biological Information about Earthworm:

i) Earthworm has one brain and five hearts.

ii) They have neither eyes nor ears.

iii) They breathe through its moist skin.

iv) They have no teeth but it has gizzard for grinding its food.

v) Worms are hermophrodic animals i.e each worm has both male and female reproductive organ and each produce cocoon. Reproductive rate is very fast.

vi) Mature worms have a swollen with a glandular thickening of the skin in the anterior region of the worm called clitellum.

vii) Locomotion takes place with the help of setae.

viii) Earthworms have the power to regenerate. Regeneration takes place at the posterior end more easily than it does at the anterior end. It it is accidentally cut, it can grow again its lost part of the body.

ix) Cocoon or egg case of redworm is round or oval shaped and small. They change color during their development, first white, becoming yellow, later brown. When new worms are ready to emerge, the cocoons are turning red. It takes at least 3 weeks for the worms to develop in the cocoon.

x) Redworms reproduce very rapidly. A healthy, adult redworm can produce an egg capsule every seven to ten days under optimum condition. In one year, a breeder (earthworm) can produce 50 capsules.

6. Some Precautions

- **Compost making worm tolerate a wide range of temperatures. Survival of earthworm is even upto 38 ^{0}C. However, the requirement for optimal temperature is 10-25 0C. Greater than 30 ^{0}C is however unfavorable for them.**
  - Keep the vermi box / container from direct heat and strong sunlight.
  - Protect from freezing temperatures.

  (A straw or dried leaves covering is good method to keep the vermi box /container from drying out during hot summer weather. Moreover, this straw in the winter work as an insulating material to keep the worms from freezing).

- **Earthworms need a moist environment. They breathe through their skin. Skin must be moist in order to breathe. They suffocate if the water moisture is very high.**
  - Moisture content should be 50-60%
  - Protect from heavy rain
  - If moisture content is high, mix dry cow dung/leaf litter/paper with substrate.

- **Worms need Oxygen to survive and produce Carbon dioxide like human.**
  - Air circulation is a must in and around a worm container.
  - Do not cover container by plastic material tightly.
  - Jute bag is a good covering material that can pass oxygen and hold moisture content.

- **Worms need food to survive i.e bio- degradable wastes. Heavy load of food can kill them and give foul odor as well as generate high temperature.**
  - Add decomposed waste after loosing its heat as possible while doing in medium and large scale Vermi-composting.

- **Although they have no ears, but they are very sensitive to vibrations. They do not like disturbance by anybody. Further construction on vermi tank or container should be avoided.**
  - Do not disturb/ observed frequently.
  - Observation once a week is sufficient.

The less you disturb worms, the better off they are however, regular observations should be done to know what is going on in the tank or container. The best time to do this is at feeding time.

7. Enemies of Worms:

Rat/moles, Frog, Birds, Flatworms, Red ant, Ferficula, Centipedes.

Protection from Rat
- Use of Trap, Net, Cat and Rodenticides

Protection from Frog/Toad
- Pick up manually

Protection from Birds
- Cover by Jute bags at vermi tank/container

Protection from Flatworms
- Pick up manually, and kill

Protection from Red ant/Ferficula/Centipedes
- Use of Neem and Bakaino

Protection from Fly larvae:
- Cover with soaked newspaper and jute bags in container.

8. Equipment for Vermi-Composting

Different types of Rake

Water Sprayers

Hand cart

Net

EM Sprayer

Waste Collecting Rickshaw