Fig.I. Chopping and mixing of biomass and cowdung in the ratio of 60:40

Fig.J. Filling of tanks

Fig. K. A polythene lined earthen pit For predecomposition of Vermicomposting mixture

Fig.L. Covering of bed with gunny bag and sprinkling of water

Fig. M. Harvesting and Packaging of vermicompost

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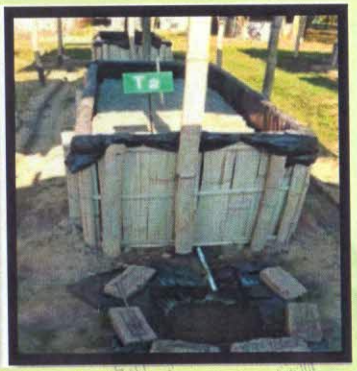
LOW COST VERMICOMPOST PRODUCTION



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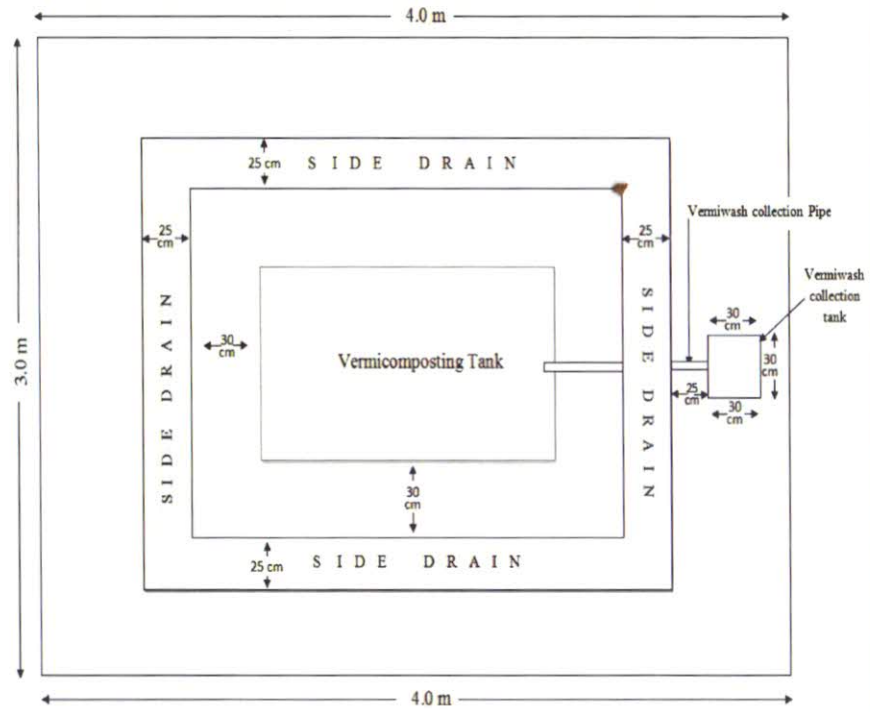
SCHEMATIC DIAGRAM OF LOW COST VERMICOMPOSTING STRUCTURE



1. **Dimension of vermicomposting tank: 2.5 m (L) X 0.91 m (B) X0.91 m (D)**
2. **Dimension of side drain: 25 cm X 30 cm**
3. **Dimension of vermiwash collection tank: 30 cm (L) X 30 cm (B) X 30 cm (D)**
4. **Dimension of shed above the main tank: 4.0 m (L) X 3.0 m (B) X 2.5 m (H)**
5. **Length of vermiwash collection pipe (1/2 inch PVC): 1 m**

***(Measurements not to scale)**

Vermes is a Latin word for worms and vermicomposting is the term given to the process of conversion of biodegradable matter by earthworms into vermicast. It is one of the easiest methods to recycle agricultural wastes and to produce quality compost. Earthworms consume biomass and excrete it in digested form called worm casts. Worm casts are popularly called as Black gold. The casts are rich in nutrients, growth promoting substances, beneficial soil micro flora and having properties of inhibiting pathogenic microbes. Vermicompost is stable, fine granular organic manure, which enriches soil quality by improving its physicochemical and biological properties. The vermicomposting technology for conversion of solid organic wastes to useful product has been ranked higher than composting in certain aspects .Vermicompost contains more of available nutrients than regular FYM or compost. Vermicompost can be effectively utilized as a carrier medium for Azospirillum, Rhizobium and phosphate solubilisers. To popularize the vermicomposting process among the small and marginal farmers there is a need to fabricate a vermicomposting unit involving lower cost so that the economically weaker section of the farmers can adopt the vermicomposting technology as the construction of conventional concrete structure involves higher cost.

For converting the chemical dependent agriculture to an eco-friendly organic farming system substantial quantities of high quality organic manure will be required to substitute the chemical fertilizer. Vermicomposting process is an answer to meet such huge demand of organic manure for popularizing the organic farming system in developing and underdeveloped countries of the world. The develop design of the low cost vermicomposting structure is capable of meeting the technological requirement for mass production of vermicompost.

I. Importance of Earthworm in Agriculture:

- Bring about the decomposition of organic matter.
- Helps in mixing organic matter in soil.
- Alter soil porosity.
- Increases activity of microbes in soil.

- Earthworm increases water holding capacity in soil
- Roots of the plants grow deep in soil.
- Worms increases aeration capacity of soil.
- Increase percolation of water
- Increase soil fertility.

II. Characteristics of Earthworm:

- Body coloration on dorsal surface deep purple to reddish brown & lower side pale.
- Total length 23-120 mm, diameter 2.5 mm
- Growth rate is 3.5 mg / day , average body weight is 600 mg (0.6g), maturity is attained within 21-22 days, Spp.highly adaptable , tolerate varying degree of moisture & organic matter . It is the best suited for vermin composting in tropical climate.
- Life cycle is about 46 days, reproduction rate is fast, & average cocoon production is 1.1/ worm/ day .

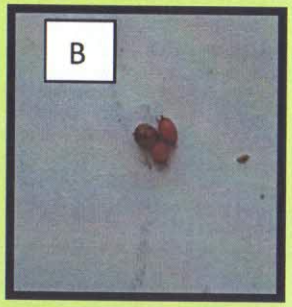


Fig.A. *Perionyx excavates* worms B.Cocoon of *Perionyx excavates*

III. Process of vermicomposting

- The tank can be constructed with locally available low cost materials such as bamboo, dried banana leaves (for shading as side walls) and polythene sheet/ thatch for roof **(Fig. C).**
- The tank should have a dimension of 0.91 m (B) X 0.91 m(D) X 2.5 m(L).The length may be varied as per availability of biomass for vermicomposting **(Fig.D).**
- The construction materials required for vermicomposting unit is locally

available bamboo which is used for constructing the low cost unit.

- Good quality polythene sheet (≃254 μ) should be laid along the floor and side walls to prevent movement of earthworms from the tank as well as preventing flow of water and nutrients from the composting mixture as well as vermicompost **(Fig.E).**
- A layer of pebble (15 cm) and layer of sand (15 cm) were placed over the plastic sheet in the vermicomposting tank and a layer of bedding material was placed over the sand and pebble layer. The first layer at the base is of sand helps in the drainage of excess water from the composting mixture **(Fig.F).**
- The base of the tank should be connected with an earthen pit (0.30 m x 0.30 m x 0.30 m) using a PVC pipe (1.27 cm diameter) for collection of vermiwash **(Fig.G).**
- Earthen drains are provided (0.30m x 0.30m) surrounding the vermicomposting unit as a biocontrol measure against attack of earthworm enemies primarily for preventing entry of ants **(Fig.H).**
- Composting materials consist of a mixture of biomass e.g straw, crop stubble, dry or green leaves , banana pseudostem etc and dried cow dung in the ratio of 60:40 i.e biomass 60 parts by weight and cowdung 40 parts by weight are mixed and are kept for partial decomposition for a period of about one month so that the temperature of the composting materials comes below 30^0C prior to transfer of composting material to the tank **(Fig.I).**
- *Perionyx excavates* or earthworm of other suitable species are released @ 750 gm per tank on the upper layer of bed.
- For pre-decomposition of the vermicomposting mixture, a polythene lined earthen pit can be constructed which should be well protected from sun and rain. This leads to efficient use of the low cost vermicomposting unit **(Fig.J).**
- Each tank has a capacity to hold about 13q of semi decomposed composting mixture. The pre decomposed vermicomposting mixture should be filled in the tank up to a height of 15 cm above the tank **(Fig. K).**
- Beds should be kept moist by sprinkling of water as and when

necessary. Care should be taken to avoid excess accumulation of moisture in the tank as excess moisture is harmful for the earthworm **(Fig.L).**

- The bed should be covered with gunny bags or dried leaves so that the bed remains cool during the vermicomposting process **(Fig.L).**
- The Vermicast appears after 2-3 weeks of release of earthworms and the entire composting bed is converted to vermicompost within 60-90 days depending on nature of composting materials used for preparation of the biomass cowdung mixture. About 70-80 per cent of the biomass is converted to vermicompost at this stage.

IV. Harvesting:

When the raw material is completely decomposed it appears black and granular. Watering should be stopped as compost gets ready for harvest. At this stage the vermicompost in the tank should be gathered in heaps (Fig. M(i)) because when the top layer of the heap dry up the earthworms move to the deeper and moist layer which facilitates easy separation of the vermicompost from the earthworm. Once the heaps are dry the vermicompost should be screened (Fig. M(ii)) using sieve to separate the remaining earthworms (Fig. M (iii)) from the vermicompost. The sieved vermicompost is now ready for use in the crop field or may be bagged and sold in the market. The separated earthworms should be released in a fresh vermicomposting mixture.

V. Precautions:

- Earthworms of only suitable species should be used.
- The organic wastes should be free of broken glass, spicy and pungent materials, plastic, iron, stone , chemicals, pesticides, metals and other non biodegradable materials etc.
- The vermicomposting unit should be protected from direct sunlight and rain for this purpose the composting unit should well protected for which a shed should be erected and side should be covered using locally available biomass for e.g dried banana leaves and thatch can be used for roof.
- Aeration should be maintained for proper growth and multiplication of earthworms.
- Optimum moisture level (30-40 %) should be maintained.
- 25 - 30^{0}C temperature should be maintained for proper decomposition.

VI. Nutrient Content in vermicompost:

Composition of vermicompost: The average chemical composition of vermicompost (banana pseudostem) is presented (Table:1) which shows that the vermicompost is alkaline in reaction with a pH value of 7.43 containing macro and micronutrients required for plant growth also shows that the vermicomposting process is also helpful in carbon sequestration as indicated by presence of high level of organic carbon content (26.45%).

Table-1: Average Chemical composition of vermicompost (banana pseudostem)

Composition of vermicompost											
pH	Org. C	N	P_2O_5 (%)	K_20 (%)	Ca (ppm)	Mg (ppm)	S (ppm)	Fe (%)	Mn (ppm)	Cu (ppm)	Zn (ppm)
7.43	26.45	2.30	2.90	3.10	170.0	64.0	182.0	0.078	207.0	11.98	81.55

Composition of vermiwash: Vermiwash is a mixture (Table. 2) of earthworm urine and water applied for keeping the biomass in the vermicomposting tank in a moist condition. The vermiwash is reddish in colour with an alkaline reaction (pH =7.87) and carries the dissolved nutrients present in vermicompost. The vermiwash is collected through a drainage pipe fitted at the bottom of the vermicomposting tank and connected to a small chamber (earthen pit lined with polythene). An analysis of vermiwash revealed that it contains 1482 mgL^{-1} nitrogen, 189 mgL^{-1} phosphorus and 1513 mgL^{-1} of potash. The electrical conductivity value indicated that vermiwash is non saline and non alkaline (EC 0.09 dsm^{-1}). The maximum quantity of vermiwash (12 L per week) was collected from a tank.

Table: 2: Composition of vermiwash

pH	E.C (dsm^{-1})	Total N (mgL^{-1})	Total P (mgL^{-1})	Total K (mgL^{-1})
7.87	0.09	1482	189	1513

VII. Benefits of vermicompost in Agriculture:

- Vermicompost contains a large number of plant nutrients which helps in growth and development of the plants and improves quality of the produce.
- Vermicompost contains a number of beneficial microorganisms which improves the soil fertility.
- Earthworms also contains vitamins, hormones and enzymes which helps in balanced plant nutrition and plant growth.
- Vermicompost do not have any offensive smell and do not stick to the hand for which it can be easily applied in the field.
- Vermicompost improves the physical and chemical properties of the soil and helps in improving the soil fertility on a sustainable basis.
- Lesser time is required for the vermicompost production process as compared to composting as it is mediated by earthworms.
- Under proper environmental condition the earthworms multiplies rapidly. The multiplied earthworms can be sold in the market at a premium price bringing economic benefit to the farmers. Additionally, the aged earthworms can be used as a feed of the poultry and fish as a protein supplement.
- Vermicompost production process is less costly as only organic biowaste is used in the process.
- During the vermicomposting process vermiwash is also produced which is a mixture of earthworm urine and water which can be used as spray in standing crop for supplementing nutrient requirement.

VIII. Economics

Size of each tank : 0.91m (B) X 0.91 m (D) X 2.5 m (L) .
Annual production capacity : 900 kg/one cycle X 3 Cycle =2700
Duration of each run : 3 months during summer and 4 months during Winter.

Durability of the structure : 3 years

A. Estimated capital investment:

i. Polythene Sheet
   a. For composting tank (5.5 m L X 4.0 m B) 2.2 kg@140 =Rs.308.00
b. For vermiwash collection tank (2.0 m L X 1.5 m B) 0.4 kg @140 = Rs.56.00
= (a+ b) Rs.364.00
ii. Procurement for initial culture of earthworms 200 g@2500/kg = Rs.500.00
iii. Bamboo : 7 @ 70.00 = Rs. 490.00
iv. ½ ? PVC Pipe (1 m length @ Rs.42.00) : Rs. 42.00
v. Sand : 5 tins @20.00 =100.00
vi. Gravel : 4 tins @ 30.00 = 120.00
vii. Construction materials eg wire etc : 25.00
viii. Labour cost (5 unit@ Rs.134.00) : 670.00
ix. Construction of shed above the tank using Bamboo and locally available agricultural waste materials like dried banana leaves and thatch/hay etc.
a. Bamboo : 3 @ 70.00 = Rs. 210.00
b. Labour cost : 1 unit @ 134.00 = Rs. 134.00
c. Rope, Sutli etc : 0.5 kg @ 140.00 = Rs. 70.00
Total Fixed cost : Rs.2725.00

B. Variable Costs:

i. Cost of earthworms : 750 gm = Rs. 1875.00 @ Rs.2500/kg
ii. Labour (inclusive Processing, Harvesting and Packing) : 10 units @ Rs.134.00 =Rs. 1340.00
iii. Cowdung : Rs. 560 kg(@ Rs. 1.50/kg) = 840.00
Total variable cost : Rs. 4055.00

C. Cost Return Analysis:

i. Estimated Production (vermicompost) : 9.00 q/tank
ii. Sale revenue from vermicompost @ Rs.10/kg : Rs.9000.00
iii. Earthworms generated : 3.39 kg/tank
iv. Sale revenue of Earthworm - @ Rs.2500/kg : Rs. 6600.00

[Since 750 gm of earthworms generated after completion of first cycle has to be used during the second cycle, we consider the sale revenue of (3.390

- 0.750) kg = 2.64 kg of earthworms from the first cycle.]

v. Vermiwash generated : 72 lit

vi. Sale revenue form vermiwash- @ Rs.2/lit : Rs. 144.00

Total revenue generated : Rs. 15744.00

D. Net profit:

i. Total Fixed cost : Rs. 2725.00

ii. Total Variable cost : Rs. 4055.00

Total (i + ii) : Rs. 6780.00

iii. **Profit**

[The low cost unit can be used for production of vermicompost for a period of at least three years with minimal maintenance. Therefore, assuming three cycles per year a total of 9 cycles of vermicomposting can be achieved from the low cost unit therefore, the fixed cost per cycle may be assumed as Rs. 303.00]

i. First cycle : Rs. 11386.00 [15744-303 (F.C)-4055 (V.C)]

ii. Second cycle : Rs. 13261.00 [15744-303(F.C)-2180 (V.C)]

[As we have used 750 gm of earthworms generated in the first cycle, the variable cost is reduced by Rs. 1875.00 i.e the cost of 750 gm of the earthworms @ 2500/kg].

iii. Third cycle : Rs. 13261.00 [15744-303(F.C)-2180 (V.C)]

Total Profit from 3 cycles : Rs. 37,908.00

Cost for roofing material of the vermicomposting unit have been excluded as locally available thatch material can be used for the roof of the vermicomposting shed.

Fig.C. View of Low cost vermicomposting unit

Fig.D. Dimension of Low cost Vermiccomposting unit [0.91 m (B) X 0.91 m(D) X 2.5 m(L)]

Fig .E. Laying of Good quality polythene sheet (≃254μ) micron)

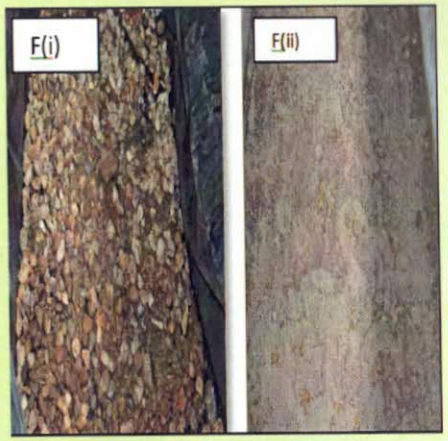


Fig.F. A layer of pebble (15 cm) and layer of sand (15 cm)

Fig.G. Connection of vermicomposting tank with vermiwash collection pit using a PVC pipe

Fig.H. Earthen drains are provided (0.30mx0.30m) surrounding the vermicomposting unit as a biocontrol measure against attack of earthworm enemies .