Vermicomposting

1. Introduction

1.1 Vermicomposting is basically a managed process of worms digesting organic matter to transform the material into a beneficial soil amendment. As per the USDA guidelines for compost practices (with effect from Oct 21, 2002), vermicomposts are defined as organic matter of plant and/or animal origin consisting mainly of finely-divided earthworm castings, produced non-thermophilically with biooxidation and stabilization of the organic material, due to interactions between aerobic microorganism and earthworms, as the materials pass through the earthworm gut.

1.2 Good quality compost production in ambient temperature can be accomplished in shorter time by the process of vermicomposting that involves use of proper species of earthworms. The native cellulase activity of earthworms and microorganisms in earthworm gut promote faster decomposition of ingested organic material. The combined effect of enzymatic activity and grinding of organic materials to fineness by earthworms produces the vermicomposting and this is not observed in compost pits without earthworm.

1.3 The earthworms being voracious eaters consume the biodegradable matter and give out a part of the matter as excreta or vermi-castings. The vermi-casting containing nutrients is a rich manure for the plants. Vermicompost, apart from supplying nutrients and growth enhancing hormones to plants, improves the soil structure leading to increase in water and nutrient holding capacities of soil. Fruits, flowers and vegetables and other plant products grown using vermi-compost are reported to have better keeping quality. A growing number of individuals and institutions are taking interest in the production of vermicompost utilising earthworm activity. As the operational cost of production of this compost works out to less than ₹ 2.0/Kg., it is quite profitable to sell the compost even at ₹ 4.00 to ₹ 4.50/Kg.

2. Process

2.1 The process of composting crop residues / agri wastes using earthworms comprise spreading the agricultural wastes and cow dung in gradually built up shallow layers. The pits are kept shallow to avoid heat built-up that could kill earthworms. To enable earthworms to transform the material relatively faster a temperature of around 30^0C is maintained. The final product generated by this process is called vermicompost which essentially consist of the casts made by earthworms eating the raw organic materials. The process consists of constructing brick lined beds generally of 0.9 to 1.5 m width and 0.25 to 0.3 m height are constructed inside a shed open from all sides. For commercial production, the beds can be prepared with 15 m length, 1.5 m width and 0.6 m height spread equally below and above the ground. While the length of the beds can be made as per convenience, the width and height cannot be increased as an increased width affects the ease of operation and an increased height on conversion rate due to heat built up.

2.2 Cow dung and farm waste can be placed in layers to make a heap of about 0.6 to 0.9 m height. Earthworms are introduced in between the layers @ 350 worms per m^3 of bed volume that weighs nearly 1 Kg. The beds are maintained at about

40-50% moisture content and a temperature of 20–30° C by sprinkling water over the beds.

2.3 When the commercial scale production is aimed at, in addition to the cost of production, considerable amount has to be invested initially on capital items. The capital cost may work out to about ₹5000 to ₹6000 for every tonne of vermicompost production capacity. The high unit capital cost is due to the fact that large units require considerable expenditure on preparation of vermi beds, shed to provide shelter to these beds and machinery. However these expenditures are incurred only once.

2.4 Under the operational cost, transportation of raw materials as also the finished product are the key activities. When the source organic wastes and dung are away from the production facility and the finished product requires transportation to far off places before being marketed, the operational cost would increase.

2.5 However, in most of the cases, the activity is viable and bankable. Following are the items required to be considered while setting up a unit for production of vermi-compost.

3. About the worms

3.1 Of about 350 species of earth worms in India with various food and burrowing habits *Eisenia fetida, Eudrilus eugeniae* and *Perionyx excavatus* are some of the species that are reared to convert organic wastes into manure. A combination of epigeic species that form no permanent burrows and live on the surface, anecic that form semi-permanent and vertical burrows extending from the surface and endogeic that typically live throughout the deeper layers may be considered.

3.2 The worms feed on any biodegradable matter and vermicomposting units are ideally suited for locations / units with generation of considerable quantities of organic wastes. One earthworm reaching reproductive age of about six weeks lays one egg capsule (containing 7 embryos) every 7-10 days. Three to seven worms emerge out of each capsule. Thus, the multiplication of worms under optimum growth conditions is very fast. The worms live for about 2 years. Fully grown worms could be separated and dried in an oven to make 'worm meal' which is a rich source of protein (70%) for use in animal feed.

4. Location

Rural areas with predominance of agriculture, suburbs of cities and peri urban villages are considered ideal locations for setting up of vermicomposting units on a larger scale from the view point of availability of raw material and marketing of the produce. As use of the compost is said to have ameliorative effect more particularly on fruit, vegetable, plantation and ornamental crops, vermi-composting units may be located in areas with concentration of fruit and vegetable growers and floriculture units. Further, the nearness to a commercial dairy unit or large concentration of cattle population will have an added advantage of cheap raw material i.e. cow dung.

5.Components of a Commercial Unit

Commercial units have to be developed based on availability of cow dung locally. If some big dairy is functioning then such unit will be an associated activity. Commercial units must not be designed based on imported cow dung. The philosophy is in-situ development using "Natural Resources".

5.1 Sheds

For a vermi-composting unit, whether small or big, this is an essential item and is required for securing the vermi beds. They could be of thatched roof supported by bamboo rafters and purlins, wooden or steel trusses and stone/ RCC pillars. Locally available roofing materials or HDPE sheet may also be used in roofing to keep the capital investment at reasonably lower level. If the size is so chosen as to prevent wetting of beds due to rain on a windy day, they could be open sheds. While designing the sheds adequate room/pathways has to be left around the beds for easy movement of the labourers attending to the filling and harvesting the beds.

5.2 Vermi-beds

Normally the beds have 0.3 to 0.6 m height depending on the provision for drainage of excess water. Care should be taken to make the bed with uniform height over the entire width to avoid low production owing to low bed volumes. The bed width should not be more that 1.5 m to allow easy access to the centre of the bed.

5.3 Land

About 0.5-0.6 acre of land will be needed to set up a vermiculture production. The centre will have at least 6-8 sheds for convenience and a dedicated area for finished products. It should also have a bore well and pump set or watering arrangement and other equipments as described in the scheme economics. The land can be taken on lease for at least 10-15 years.

5.4 Buildings

When the activity is taken up on a large scale on commercial lines, considerable amount may have to be spent on buildings to house the office, store the raw material and finished product, provide minimum accommodation to the Manager and workers. The cost of the buildings along with the electrification of these buildings and the vermi-sheds may be included under this item.

5.5 Seed Stock

This is an important item requiring considerable expenditure. Though the worms multiply fast to give the required numbers over a period of 6 months to a year, it may not be wise to wait till such a time having invested on the infrastructure heavily. Thus, worms @ 1 kg per m^3 of bed volume should be adequate to start with and to build up the required population in about two or three cycles without unduly affecting the estimated production.

5.6 Fencing and Roads/Paths

The site area needs development for construction of structures and development of roads and pathways for easy movement of hand-drawn trolleys/wheel barrows for conveying the raw material and the finished products to and from the vermi-sheds. The entire area has to be fenced to prevent trespass by animals and other unwanted elements. These could be estimated based on the length of the

periphery of the farm and the length and type of roads/paths required. The costs on fencing and formation of roads should be kept low as these investments are essential for a production unit, yet would not lead to increase in production.

5.7 Water Supply System

As the beds have to be kept moist always with about 50% moisture content, there is a need to plan for a water source, lifting mechanism and a system of conveying and applying the water to the vermi-beds. Drippers with round the clock flow arrangement would be quite handy for continuous supply and saving on water. Such a water supply system requires considerable initial investment. However, it reduces the operational cost on hand watering and proves economical in the long run. The cost of these items would depend on the capacity of the unit and the type of water supply chosen.

5.8 Machinery

Farm machinery and implements are required for cutting (shredding) the raw material into small pieces, conveying shredded raw material to the vermi-sheds, loading, unloading, collection of compost, loosening of beds for aeration, shifting of the compost before packing and for air drying of the compost, automatic packing and stitching for efficient running of the unit.

5.9 Transportation

For any vermi-composting unit transport arrangement is a must. When the source of raw material is away from the production unit, an off-site transport becomes major item of investment. A large sized unit with about 1000 tonnes per annum capacity may require a three tonne capacity mini-truck. With small units particularly with the availability of raw material near the site, expending on transport facility may become infructuous. On-site transport facilities like manually drawn trolleys to convey raw material and finished products between the storage point and the vermi-compost sheds could also be included in the project cost.

5.10 Furniture

A reasonable amount could also be considered for furnishing the office-cum-stores including the storage racks and other office equipments. This will enhance the efficiency of operations.

6.Financial aspects

6.1 Benefits

It is assumed that there will be around 2-3 cycles of production in the first year and 5 – 6 cycles in the subsequent years with a duration of each cycle at around 65-70 days. Further, taking into account various limitations and operational problems, the capacity utilization is further assumed at 50% in the 1st year and 90% from 2nd year onwards. Benefits include the income from sale of vermi-compost @ ₹4500 per MT and worm @ ₹200/- per kg. The net income from the 2nd year onwards would be about Rs.6,48,000 annually.

6.2 Project Cost

Vermi-composting could be taken up on any scale starting from 10 MT per annum (TPA) to 1000 TPA and above. As the production is proportional to the vermi-bed space, it is advantageous to start with less capacities and later expand the unit

after gaining production experience and developing assured market for the product.

A bed volume of 324 m^3 spread over 24 beds - 15 m long, 1.5 m wide and 0.6 m high is estimated to produce vermi-compost of 200 TPA over 6 cycles/crops of 65-70 days each annually. Total of 24 such beds may be housed under 2 to 4 different open sheds.

The particulars of capitalised costs including mother stock of earthworms, cost of machinery and tools and operational cost/production cost of compost are set out in Annexure I and II. The costs and benefits of the unit are set out in Annexure III. As can be seen, the investment cost is ₹13,50,000/-, operational cost ₹3,42,000. Operational cost of two cycles amounting to ₹1,24,800/- has been capitalised.

6.3 Margin

The margin money/down payment has been considered at 25% in the present model, which works out to ₹3.375 lakh.

6.4 Bank loan

Bank loan considered in the model is 75% which works out to ₹10.125 lakh.

6.5 Rate of interest

Banks are free to decide the rate of interest within the overall RBI guidelines issued from time to time. While the interest rate may vary from 13 to 15%, for the purpose of financial analysis and bankability of the project, the ultimate lending rate has been assumed at 13%.

6.6 Security

Banks are guided by RBI guidelines issued from time to time in this regard.

6.7 Financial analysis

The financial analysis are shown in Annexure IV. It indicates that the model is viable. The major financial indicators are given below:

NPV : ₹7.621 lakh
BCR : 1.23 : 1
IRR : 34 %

6.8 Repayment

Based on the cash flow the detailed repayment schedule has been worked out and furnished in Annexure V. The loan outstanding can be repaid in 6 years.

DISCLAIMER

The views expressed in this model project are advisory in nature. NABARD assume no financial liability to anyone using the report for any purpose. The actual cost and returns of projects will have to be taken on a case by case basis considering the specific requirement of projects

Annexure I
Vermi-Composting (200 TPA)

Capital Cost

Sr	Particulars of item	Amt (₹)	
		Year 1	Year 2 onwards
A.	**Land and Building**		
1.	Land (On lease)	----	----
2.	Levelling and earth filling for vermicompost sheds	7500	----
3.	Fencing and gate	25000	----
4.	Open Shed with brick lined bed bottom & platform with RCC / MS pipe post & truss and thatch /HDPE / locally available roof (@ 1000/m^2) for :		
a.	Vermicompost beds (15 m*1.5 m*24 nos = 540 m^2 + 20 m^2 pathways/utility = 560 m^2)	560000	
b.	For finished products 30 m^2	30000	----
5.	Godown / Store cum office 50 m^2 @ 5000/-per m^2	250000	----
	Sub total	**872500**	----
B.	**Implements and machinery**		----
1	Shovels, spades, crowbars, iron baskets, dung fork, buckets, bamboo baskets, trowel,	5000	----
2	Plumbing and fitting tools	1500	----
3	Power operated shredder	25000	----
4	Sieving machine with 3 wire mesh sieves- 0.6 m x 0.9 m size - power operated with motor	45000	----
5	Weighing scale (100 kg capacity)	2500	----
6	Weighing machine (platform type)	6000	----
7	Bag sealing machine	5000	----
8	Culture trays (plastic) (35 cm x 45 cm) - 4 Nos	1600	----
9	Wheel barrows - 2 Nos.	12000	----
	Sub total	**103600**	----
C.	**Water provision – Borewell with hand pump, pipe, dripper**	**75000**	----
D.	**Electrical installation**	**10000**	----
E.	**Furniture & fixtures**	**25000**	----
F.	**Earthworms (@1 Kg per m^3 and @` 300/Kg, total utilized bed volume = 324 m^3)**	**97200**	----
	TOTAL CAPITAL COST	**1183300**	

Annexure II

Vermi-Composting unit (200 TPA)
Total operational cost for one year with 7 cycles of 65-75 days

Bed volume 324 m^3
Recovery : 30 %

Operational Cost

Sr	Particulars of item	Amt (₹)	
		Year 1	Year 2 onwards
1.	Agricultural wastes (cost, collection and transportation) @ 320 kg per m^3 and Rs.200/MT (15*1.5*0.6*24*5*320*200/1000) [at 50% in 1st year]	51840	103680
2.	Cow dung (cost, collection and transportation) @ 80 kg/m3 and Rs.250/MT (15*1.5*0.6*24*5*80*250/1000) [at 50% in 1st year]	16200	32400
3.	Salary wages for 2 permanent skilled labourers @ Rs.6000/month	12000	12000
4.	Labour wages on day to day basis in formation of vermibed with agro-waste, cow dung and worms, watering, stirring, harvesting, sieving, packing, etc., including cost of bags (250 mds[@ Rs.200/md) [at 50% in 1st year]	25000	50000
5.	Electrical charges for pump, machinery, lighting etc. [at 50% in 1st year]	12000	24000
6.	Repair and maintenance [at 50% in 1st year]	30000	60000
7.	Cost of bags and marketing cost [at 50% in 1st year]	15000	30000
	Sub Total	**156040**	**312080**
8.	Lease rent, Miscellaneous etc.	30000	30000
	Total Operational Cost	**186040**	**342080**

Annexure III

Vermi-Composting units (200 TPA)

Costs and Benefits

Sr	Cost	Amt (₹)	
		Year 1	Year 2 onwards
1.	Total Capital cost	1183300	---
2.	Total Operational cost	186040	342080
3.	Total cost	1369340	342080
4.	Benefit		
4a.	Sale of vermicompost (200 MT @ 30% conversion) [@ Rs.4500/MT at 60% in 1st year and 90% in 2nd year onwards]	405000	810000
4b.	Sale of worms [@ 5 Kg/MT of compost and @ Rs.200/Kg.]	90000	180000
4c.	Total benefit	495000	990000
5.	Net benefit	(874340)	647920

Annexure IV

Vermi-Composting unit (200 TPA)

Financial Analysis

Sr	Cost	Amt (₹)	
		Year 1	Year 2 onwards
1.	Total Capital cost	1183300	---
2.	Total Operational cost	186040	342080
3.	Total cost	1369340	342080
4.	Benefit		
4a.	Vermicompost	405000	810000
4b.	Sale of worms	90000	180000
4c.	Total benefit	495000	990000
5.	Net benefit	(874340)	647920
6.	Discounting rate – 15%		
7.	PVC - ₹2893538		
8.	PVB - ₹3655654		
9.	NPV - ₹762116		
10.	BCR - ₹1.226		
11.	IRR – 34%		

Annexure V

Vermi-Composting (200 TPA)

Repayment Schedule

TFO (₹.) = 1338132 (Say ₹13.50 lakh)

(Capital cost + Operational cost for two cycles + lease rent for 1st year)

Bank Loan (₹.) = 1012500 337500

Rate of Interest = 13%

Year	Loan O/s	Net Income*	Principal	Interest	Total outgo	Net surplus
1	1012500	456584	75000	131625	206625	249959
2	937500	647920	160000	121875	281875	366045
3	777500	647920	180000	101075	281075	366845
4	597500	647920	200000	77675	277675	370245
5	397500	647920	220000	51675	271675	376245
6	177500	647920	177500	23075	200575	447345

** 1st year net income = 1st year total income -operational cost of 1 cycle + insurance and lease [As 2 operational cycle and lease rent are capitalized].*