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Profit-rich vermicomposting

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Abstract
Vermicomposting which is one of the sustainable techniques to convert organic waste into useful compost for better crop production by replacing the chemical used fertilizers, pesticides, and other chemical-based products. It also has big global market of million dollar which grows by 16.74% from 2020 to 2027. It's most of the consumers used it for home gardening followed by horticulture, golf course, and landscaping. Vermicomposting it also one of the good example or models for circular economy where the waste has potential to convert and used as good resource for other product processes. Many industries like textile and dyeing, as well as sugar industries by product is used to grow vermicomposting industries by providing raw material for their final product.

Keywords: Sustainability, economy, fertilizers and earthworms

Introduction
Vermicomposting is a simple biotechnological procedure for converting organic wastes into organic compost with the help of earthworm's species [1]. Vermicomposting merge firstly, the organic waste. Vermicompost has great potential in circular economy of agricultural sustainability, managing wastes, biogas production and animal production, along with this it also fixes C/N ratio, Nitrogen, and various other soil indicator in soil. Circular economy is an economic model in which waste of one product are recycled to be used as a resource for other processes [2].

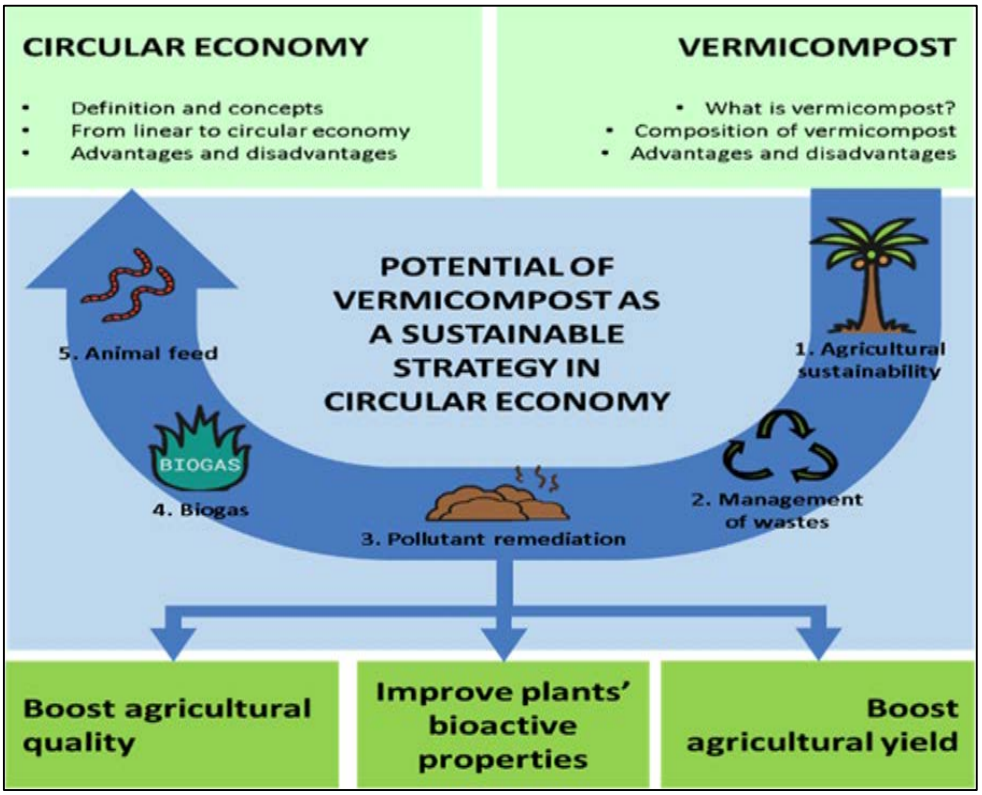

Fig 1: Framework of the study: key points related to circular economy and potential of vermicompost

Earthworms are invertebrates belonging to the phylum Annelida and class Oligochaeta which are found in most parts of the world apart from deserts (where they are rare), areas under constant snow and ice, mountain ranges, areas bereft of soil and vegetation. There are nearly 350 species of earthworms having various food and burrowing habits. *Eisenia fetida*, *Eudrilus eugeniae*, and *Perionyx excavates* are some of the species that effectively converts the organic wastes into manure [4]. Vermicomposting is a good profitable business where the costs involve less than a Rs. 2.0 per kg where the vermicompost can be sold for Rs. 4.0 to Rs, 4.50 per Kg [4]. It has great impact on circular economy for any organisation through which they can make profit from waste which is produced during the formation their final product [2].

Location of Vermicomposting

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 viewpoint 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. Vermicomposting units may be 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.

Vermicompost Market Size and Forecast

According to Verified Market Research, the Global Vermicompost Market was valued at USD 63.55 Million in 2019 and is projected to reach USD 222.42 Million by 2027**,** growing at a CAGR of 16.74% from 2020 to 2027.The global vermicompost market has witnessed significant growth over the past years owing to the increasing use of vermicompost for various purposes such as agriculture, home gardening, landscaping, and horticulture. The growing demand from vermicompost from private laboratories, universities, and high schools for research and classroom needs is further propelling the market growth. The Global Vermicompost Market report provides a holistic evaluation of the market. The report offers a comprehensive analysis of key segments, trends, drivers, restraints, competitive landscape, and factors that are playing a substantial role in the market. Large-scale vermicomposting is mainly practiced in Canada, Italy, Japan, India, Malaysia, the Philippines, and the United States. It is used for farming, landscaping, to create compost tea, or for sale. Some of these services produce worms for bait and home vermicomposting. For vermicomposting at home, a wide variety of bins are commercially available, or a variety of modified containers may be used. Small-scale vermicomposting is well-suited to utilize kitchen waste into high-quality soil amendments, where space is limited. Worms can disintegrate organic matter without the additional human physical effort that bin composting needs [3].

Source: https://www.verifiedmarketresearch.com/download-sample/?rid=52357

Vermicompost Market by Application

Based on Application, the global vermicompost market has been segmented into home gardening, horticulture, golf courses, and landscaping. Horticulture is expected to register high CAGR in the global market over the estimated timeframe. Vermicompost when utilized as soil additives or an essential component of horticultural media, they improve seedling growth and provide result in overall enhanced productivity of a wide range of crops. Vermicompost that is a product of the breakup of organic waste of earthworms has been recognized to be a prospective source of nutrients for the plants' growth and beautification in horticulture crops [3].

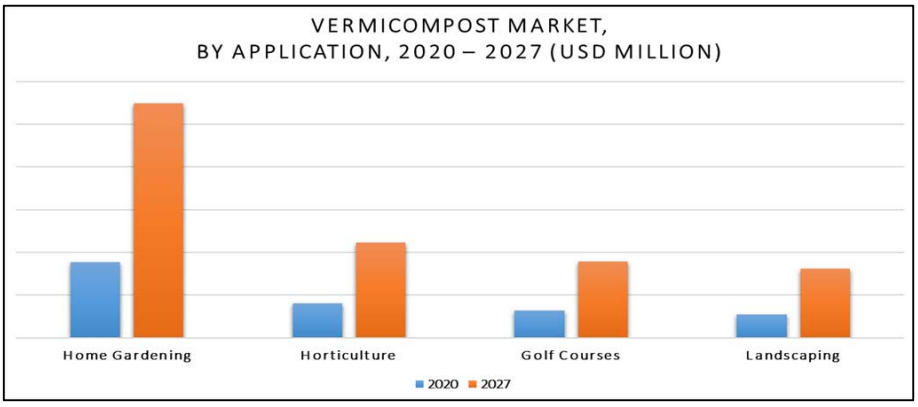

Fig 3: Summarized market report by product

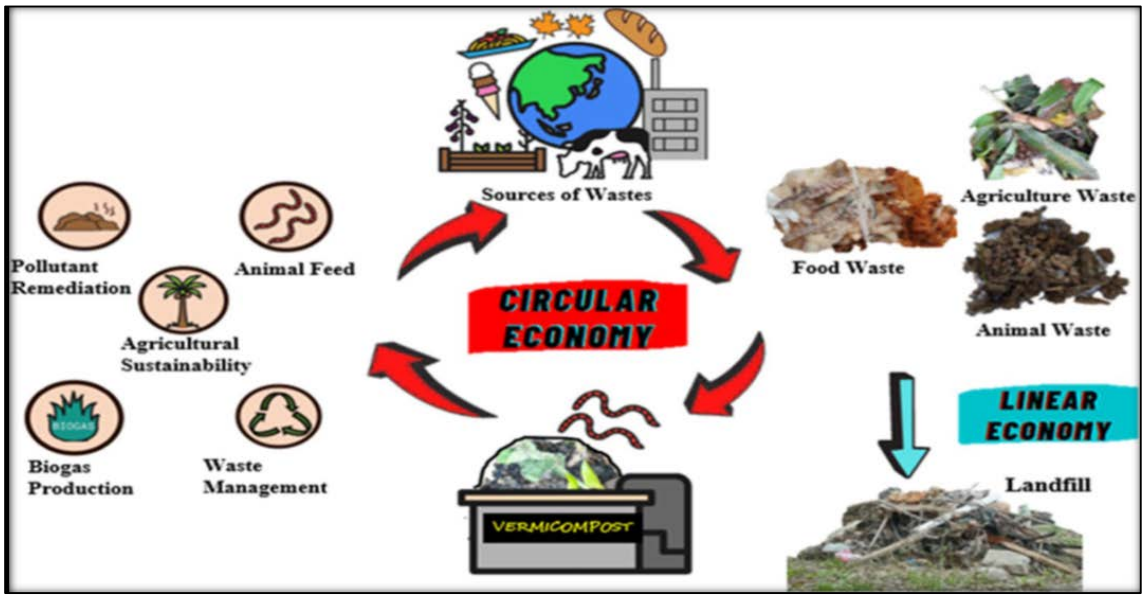

Fig 4: Potential of vermicompost as a sustainable strategy in circular economy

Potential of vermicomposting as a sustainable strategy in circular economy

In Todays, Economic system, humans utilise resource from the nature in huge amount and convert it in various products that are discard lately after use and these types of action seems to not so big for individual or organisation, but if we look at world level then it unsustainable approach of linear economy. Due to this economy system, it has the potential to release almost 3.3 billion tonnes of greenhouse gases [8]. Thus, circular economy comes which exists within our planetary boundaries for some individuals and organisations to survive. Circular Economy is a model that focuses on waste management and resource conservation over a long time [9]. Scientific research suggests that circular economy is a long-term solution for all three sustainable development dimensions: i) Environmental, ii) Social, iii) Environmental. In Circular economy vermicomposting principle is associated with collection of waste and recycled to high-quality compost that can be used as organic fertilisers. Normal consumers can also easily the part of this circular economy by preventing final waste disposal and leftover materials can be converted into new secondary items [2].

Table 1: Total cost, gross income, and net income for Constructed method of vermicompost production (per quintal)

Particulars	Unit-1	Unit-2	Unit-3	Unit-4	Average
		Variable Cost			
Culture	16.67	18.18	20	25	19
Cowdung	30	16.36	20	45	27.84
Crop wastage	35	38.18	42	52.5	41.92
Electricity & water charges	2.86	3.64	2.67	3	3.04
Packaging cost	49.7				49.7
Labour charges	43.71	74.18	136	33.75	71.91
Miscellaneous cost	16.67	18.18	6	3.5	8.88
7% charges on variable	13.62	11.17	16.76	11.41	13.24
Total variable cost(A)	208.22	170.81	256.15	174.41	202.4
		Fixed Cost			
Construction Cost	10.12	9.09	11.11	12.5	10.7
Depreciation Cost	9.61	8.63	10.55	11.88	10.17
Intrested on fixed capital @10%	1.97	1.77	2.17	2.44	2.09
Total fixed cost(B)	21.7	19.49	23.83	26.81	22.96
Total Cost (A+B)	229.92	190.3	279.98	201.22	225.36
Gross Income	500	500	500	500	500
Input-output Ratio					
Net Income	270.08	309.7	220.02	298.78	274.64
Net Benefit-Cosrt Ratio					

Table 2: Total cost, gross income, and net income for vermibed method of vermicompost production (per Quintal)

Particulars	UNIT-1	UNIT-3	UNIT-3	UNIT-4	UNIT-5	UNIT-6	AVERAGE
			Variable Cost				
Culture	83.33	50	31.25	60	31.25	50	50.97
Cow Dung	22.22	30	37.5	40	37.5	30	34.95
Crop wastage	38.88	40	50	50	37.5	40	34.95
Electricity & water charges	2.47	1.87	5	6.67	18.75	10	7.46
Packaging cost	50						50
Labour charges	27.41	56.25	180	110	187.5	150	118.53
Miscellaneous cost	13.89	20	21.87	15	18.75	15	17.42
7%charges on variable	16.67	13.86	20.69	19.71	20.56	20.65	18.69
Total Variable cost (A)	254.88	21199	316.31	301.38	314.31	315.65	285.75
			Fixed Cost				
Vermibed price	55.55	100	125	100	125	100	100.92
Interest on fixed capital @ 10%	5.55	10	12.5	10	12.5	10	10.09
Tota Fixed cost (B)	61.11	110	137.5	110	137.5	110	111.02
Total Cost (A+B)	315.99	321.99	453.82	411.38	491.94	425.65	396.77
Gross Income	500	500	500	500	500	500	500
Inut- Output Ratio							
Net Income	184	178	46.18	88.61	48.19	74.35	103.22
Benefit- Cost Ratio							

Case Studies

Case 1: Vermicomposting of Textile Industries Dyeing Sludge by Using *Eisenia fetida*

Surat which is one of the famous textile and dyeing industries which also generate huge quantity of sludge that contain harmful chemicals poisonous and cancer causing, which become the challenge for government and textile industries to dispose it safely. By studying this paper, we get to know that we can vermicompost textile sludge with cow dung and *Eisenia foetida.* Vermicompost reactor of 0.3m^3 capacity was used vermicomposting. Textile dyeing sludge was mixed with cow dung in different combination of mixture i.e., 0:100 (C1), 10:90 (C2), 20:80 (C3), 30:70 (C4) for 120 days. For the mixtures the pH was increased to range between 7.45-7.78, organic carbon was decreased by 31-33.3%, Nitrogen was decreased by1.15-1.32% and total phosphorous increase by 60.2-7.9(g/Kg) [8].

Case 2: Vermicomposting of Press mud from Sugar Industries

India is one of the largest growers of sugarcane which is estimated to be 333lakh tonnes during this Sugar season (October 2021-Spetember 2022) against 312 lakh tonnes previous year, with this sugarcane industries also produce large amount of waste in the form of bagasse and Press mud per day. Most of them then burnt into fields which produce field hazards and severe environmental pollution, so we can use vermicomposting one of the eco-friendly methods to decompose and using bagasse and Press mud for plant growth and sustain the environment. In this method, both wastes (Bagasse & Press mud) were pre-treated with an organic nutrient preparation Jeevamritham (effective microbial suspension) for 15 days at 30 ^{0}C. Than it fills up into the 2Kg plastic tubs with *Eisenia fetida* for six weeks. Optimum parameters of vermicomposting of sugarcane wastes should be 25^{0}C temperature, pH- 7.0, 1-2 mm particle size and 80% moisture content. Later it was found that above method of vermicomposting is rich in [7].

Nitrogen	Phosphorus	Potassium	Sodium	Calcium	Magnesium
2.3%	2.57%	1.72%	3.34%	2.27%	1.98%

While it also rich in micronutrient i.e.

Iron	Zinc	Manganese	Copper	Boron	Aluminium
1052ppm	163ppm	407ppm	167ppm	276ppm	964ppm

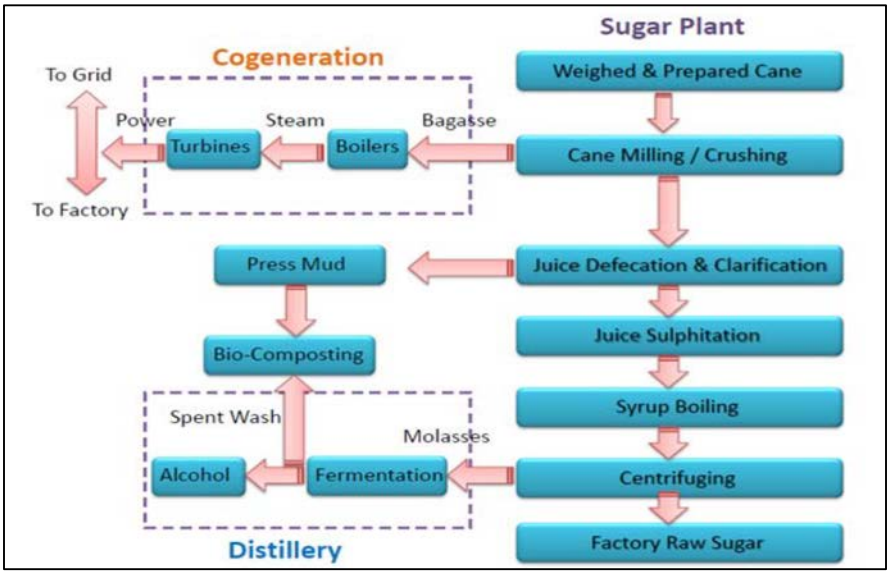

Fig 5: Schematic diagram of formation of press mud waste in Sugar Mill [7]

Table 3: Financial Aspect of Vermicomposting

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].*

Conclusion

Vermicomposting is simple biotechnological procedure which convert organic waste into compost for agricultural sustainability, pollutant remediation and improve carbon-nitrogen ratio in soil. Along it is a good profitable business with the margin of 2-2.50 Rs/Kg. Suburbs cities, and peri urban cities are considered as best location of vermicomposting. The future of vermicomposting is huge which will we expected to grow by 16.74% by 2027 from 2020. But vermicomposting market is much segmented into home gardening, horticulture, golf courses and landscaping. Due to the practicing of vermicomposting, we can replace the

linear economy structure to circular economy in agriculture which disturbed after the green revolution by using lots of pesticides, insecticides, and many other chemicals. It has potential to sustain waste of agricultural product as well as other industries waste such as textile and sugar mill, compost made by sugar industries is also rich with many micro and micro-nutrients. Due to having these many advantages for vermicomposting this industry has a good scope of financial aspect.

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