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DEVELOPMENT CONSTRUCTION AND ASSESSMENT OF ROTARY VERMISORTER FOR INCREASED SORTING EFFICIENCY

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Abstract

The study aimed at developing, constructing and and assessing the performance of a rotary vermisorter as to its throughput capacity, retention time and sorting time. It further aimed at determining the economic analysis in terms of net cost, net income and return of investment. This development technological research that was conducted at Iloilo State College of Fisheries (ISCOF) -Dingle campus, Agri-eco tourism farm at Bongloy, Dingle, Iloilo, Philippines. The developed vermisorter is made of locally available materials. It consists of six (6) main parts: 1) the frame, 2) transmission assembly, 3) motor, 4) inlet hopper, 5) sorting cylinder, and 6) discharge hopper. It has a throughput capacity of 3.8 tons/hour. The machine can be made by locally in 5 to 7 day of continuous working at a cost of twenty-five thousand pesos (PhP 25,000) including labor cost. The data on the performance of rotary sorter were gathered using the weighing scale and stop watch and kilowatt-hour meter. Data were analyzed employing mean and percentages. Cost analysis of operating the machine revealed that it can sort vermiworm from vermicast at PhP 1.37 per bag. The Return of Investment (ROI) is +885.89 percent, with a payback period of 41.2 days. The machine is environmentally-friendly and it can reduce the energy requirement and can sort vermicompost easily.

Keywords: Agricultural Engineering, Innovation, Vermisorter, Vermicompost, Vermicast, Design Construction, Philippines

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INTRODUCTION

Environmental abjection is one of the major threat confronting the globe and the excessive use of inorganic fertilizer contributes mainly to the deterioration of the ecosystem through depletion of fossil fuels, production of carbon dioxide (CO2) and contamination of water source tables. It leads to decline of soil fertility because of the imbalance use of fertilizer that has adversely affected agricultural production and soil quality degradation. There is now a growing realization that the adoption ecological conscious and sustainable farming practices can somehow reverse the declining trend in the global productivity and protection of environment (Aveyard, 1988 and Lee, 1992).

In response to the issue of environmental degradation, the researcher strongly advocates organic agriculture under its project “Save mother earth”. The system considers the practice of organic farming by using vermicompost and vermicompost tea as fertilizer and use biological control of pest by using trichogramma and earwigs to ensure that the products is free of chemicals in the production of vegetable, rice and other plantation

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crops. This will ensure the production of chemical-free crops and environment-friendly system.

Vermicomposting is a simple biological process in which the certain species of earthworm is used to enhance the process of waste conversion and produce a better end product. Vermicomposting differs from composting in several ways (Ghandi et al, 1997, cited by Nagavallemma, KP et al., 2004). It is mesophilic process, utilizing microorganism and worms that are active at 10-32°C within the pile of moist organic material. The process is faster than composting because the material passes through the earthworm gut. This is a significant transformation that takes place, whereby the resulting earthworm castings (worm manure) are rich in microbial activity and plant growth regulators, and fortified with pest control attributes as well. In short, earthworms are capable of transforming garbage into gold (Vermi Co 2001, Tara Crescent 2003 cited by Nagavallemma, KP et al2004.

After worms had digested the rich organic matter, one of its by-product is called vermicast. Vermicast is high in humus and active microbial activity, this will boost soil structure and enhance moisture retention. Compared to natural soil, the worm casting contains five times more nitrogen, 11 times more potassium, and 7 times more phosphorus. It is rich in humic acids and improve soil structure. It is now popular because the benefits it gives to growing organic crops and environmental friendly because it helps mitigate climate change. With maximum feeding of the vermi worms, harvesting the compost and the worms itself will take 1 week. At least, 1 or 2 tons of vermicast could be harvested for the week and it is laborious using a manual method.

Considering the above facts, it is necessary to design a rotary vermisorter to reduce labor requirement, ease of operation and speed up conversion of waste to organic fertilizer.

Objectives of the study

This technological research was conducted in order to: 1) develop and construct a rotary vermi sorter; 2) evaluate its performance in terms of its through put capacity; 3) determine its retention time and sorting time; and 4) determine the economic analysis in terms of net cost, net income and return of investment.

MATERIALS AND METHODS

Design of the Rotary Vermisorter

The rotary-type vermisorter, a developmental technological research was designed to fit the needs of commercial producer of vermicompost. It seperates the vermiworm from the vermicompost.

The sorter was made out of locally available materials. It was constructed out of BI sheet #20, 3”x3” and 2”x2” angle bars, 1 1/4 diameter round bar, welding electrode, perforated sheets#20, 4”x8”x16” gear box, pillow blocks, sprocket and chain, belt and pulley. The total construction cost amounted to PhP25,000 including labor.

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Table 1: Expenses Incurred in the Production of Rotary Vermisorter

A. Materials					
Item	**Qty.**	**Unit**	**Description**	**Unit Cost (PhP)**	**Total Amount (PhP)**
1	5	pcs	3”x3” x 1/4 angle bar	500.00	2,500.00
2	1	pc	2”x2”x20” angle bars	400.00	400.00
3	1	pc	Shafting 1 1/4” dia X12	1,000.00	1,000.00
4	3	sheet	Perforated sheet gauge #20	500.00	1,500.00
5	10	kg	Welding electrode	100.00	1,000.00
6	1	sheet	BI sheets #20	500.00	500.00
7	2	pc	Pillow Block	300.00	600.00
8	1	unit	Gear box 1:50	4,800.00	4,800.00
9	1	pc	V belt 65	200.00	200.00
10	2	pc	Pulley 3”	200.00	400.00
11	1	set	Chain and sprocket	500.00	500.00
12	1	pc	Electric motor 2hp	5,000.00	5,000.00
Sub-Total					18,400.00
B. Other expenses					
1			Admin Cost		1,340.00
2			Labor		5,260.00
Sub-Total					6,600.00
Over-all Total					25,000.00

Data Collected

a. Weight of vermicompost
b. Sorting Time
c. Retention Time
d. Number of worm that pass the cylinder
e. Labor requirement

Instruments used

Weighing scale (10-ks and 250 kg capacity), stop watch, kw-hr meter and steel-tape.

RESULTS AND DISCUSSION

Description of the machine

The machine composed of six major parts, namely: 1) the frame, 2) transmission assembly, 3) motor, 4) inlet hopper, 5) sorting cylinder, and 6) discharge hopper. As shown in figure 1, the unsorted vermicompost was feed in the inlet hopper whose sliding door is is made up of BI sheet. During the process of sorting, the rotating cylinder separates the vermicast, the worms and the larger particles. The gear box controls the speed of rotation of the cylinder to allow sorting and reduces the stress to the worms. The discharge hopper receives the sorted worm and larger particles. All parts of the machine is supported by the frame assembly. The belt, pulley, chain and sprocket assemblies transmit power from 2.0 hp electric motor at a required speed.

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Figure 1: Rotary Vermi sorter machine

Performance of the machine

The performance of the machine was tested and evaluated employing three runs using 250 kilograms of unsorted vermicompost per trial. The vermisorter obtained a thorough capacity ranges from 3,171 to 4,518 kg/hr of vermicompost without casualties, since the retention inside the sorting cylinder is only 12.23 seconds. Furthermore, no worms passed out of the cylinder during the operation.

Table 2: Performance of the Rotary Vermi sorter Machine

Trial Run	Wt. Of Sample (kg)	Retention time (Sec)	Sorting time (Min)	No. of worms pass the cylinder	Through put capacity (kg/min)	Through put capacity (kg/hour)
1	250	13.19	3.9	0	64.10	3,846
2	250	12.20	3.32	0	75.30	4,518
3	250	11.3	4.73	0	52.85	3,171
Total	750	36.69	11.95	0	192.25	11,535
Ave.	250	12.23	3.98	0	64.08	3,844.8

The Operating Cost Analysis of the Vermisorter

The operating cost analysis of the vermi sorter revealed that the machine can sort waste with an operating cost of PhP1.37/bag of vermicompost. The return of investment (ROI) is 885.89% and payback period of 41.20 days.

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Table 3: Operating Cost Analysis of the Rotary Vermisorter

Description		Value
Investment Cost (IC)	:	
Vermisorter	:	PhP 20,000.00
Motor	:	PhP 5,000.00
Fixed Cost (P/day)	:	
Depreciation[a]	:	.51
Interest on Investment [b]	:	16.44
Repair and Maintenance [c]	:	6.85
Insurance [d]	:	2.05
Total	:	25.85
Variable Cost (P/day)	:	
Electricity@6hr/day [e]		105.04
Labor [f]		500.00
Total		605.04
Total Cost (P/day)		630.89
Throughput capacity (tons/day) @6hr		23.07
Operating cost (P/kg)		0.027
Operating cost (P/bag)		1.37

a. Straight line method at 10% salvage and 10years life span

b. 24% Investment Cost

c. 10% of Investment Cost

d. 3% of investment Cost

e. P11.75/kw-hr of electricity at a consumption rate of 1.49kw/hr.

f. Two (2) operators at P250/8 hr-a-day

Table 4: Cost Return Analysis of the Vermisorter

Description		Value
Investment Cost	:	PhP 25,000.00
Fixed Cost	:	PhP 25.85
Variable Cost	:	PhP 605.04
Total Operating Cost	:	PhP151,413.60 per year
Net Income	:	PhP221, 472. 00 per year
Return on Investment (ROI)	:	885.89%

CONCLUSION

The rotary type vermisorter can be made using locally available materials, can help convert biodegradable wastes into organic fertilizer and can sort vermiworm from vermi compost in easiest and fastest way.

Recommendation

Based on the result of the study, it is recommended to improve the machine by 1) increasing the size of the inlet hopper to accommodate larger volume of vermicompost

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and to minimize wastage during loading, and 2) conduct further study on the harvesting and sorting vermicompost.

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