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Production Efficiency, Economic Feasibility, and Market Dynamics of Vermi Composting in Rampur, Chitwan: A Comparative Study of GAVS and ASLF

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Abstract:

Vermicomposting stands at the intersection of ecological wisdom and economic opportunity, and this study conducted at Agriculture and Forestry University (AFU), Rampur, unfolds this dual promise through the hands-on experiences of two student-led technical groups at same location within same period of time; GAVS and ASLF. Using Eisenia fetida as the biological engine, both groups transformed raw organic manure into high-value vermicompost while simultaneously cultivating practical entrepreneurship. Through a rich comparative assessment, this research reveals striking differences in production efficiency, market behavior, cost structures, and economic outcomes. GAVS achieved superior conversion efficiency (53.2%) and a higher multiplication rate of earthworms (twice). Their model demonstrated remarkable profitability, yielding a maximum ROI of 178.29% and BCR of 2.78. Another group ASLF, though more conservative in market strategy, excelled in resource procurement and cost minimization, achieving an impressive ROI of 130.51% and BCR of 2.31. Beyond economics, this article documents a speculation on rare and alarming biological observation: larval predation of red wigglers by click beetle larvae, an interaction previously undocumented in vermiculture settings in Nepal. This unexpected ecological interference underscores the delicate biological balance required for sustainable vermicomposting. The *findings also affirm that vermiculture, when supported by academic infrastructure and guided technical learning, is not only ecologically restorative but also financially rewarding. The contrasting yet complementary models of GAVS and ASLF highlight two viable pathways: adaptive commercialization and cost-efficient conservation, both capable of empowering youth, enriching soils, and strengthening the emerging vermicompost market in Nepal. This research thus positions vermicomposting as a promising, scalable, and socially relevant agro-entrepreneurial frontier for the Chitwan region and beyond.*

Keywords: Eisenia fetida, organic waste management, return on investment, student-led agro-entrepreneurship,

Introduction

Earthworm is one of the most essential annelids under class Oligochaeta that has crucial role in maintaining soil health and fertility. These moist soil environment dwellers enhance nutrient cycling, soil aeration, water infiltration, and organic matter decomposition, making them crucial in sustainable agriculture and soil fertility improvement (Lavelle et al., 1997; Edwards & Bohlen, 1996). These segmented worms feed on litter and manure to excrete more nutritious pellets and worm castings. *Octochaetona beatrix*, *Amynthas corticis*, *Metaphire houlleti* (Julka, Kumar, & Ahmed, 2020) along with 24 earthworm species from 5 families namely Megascolecidae (9 species), Lumbricidae (7 species), Acanthodrilidae (6 species), Almidae (1 species), Moniligastridae (1 species) inhabit in Nepal so far. Notably, four species—*Drawida nepalensis*, *Eutyphoeus lippus*, *Eutyphoeus nepalensis*, and *Eutyphoeus pharpingianus*—were initially described in Nepal and considered endemic. (Reynolds et. al., 2022). Among all, *Eisenia fetida*, ***Perionyx excavatus*** (Indian Blue Worm), *Eisenia Andrei*, etc. are some commonly reared earthworms for vermi composting in Nepal. More precisely in vermi composting systems, species like *Eisenia fetida* (commonly known as red wigglers) are used for their high reproduction rate and efficient decomposition of organic waste into nutrient-rich compost (Domínguez & Edwards, 2011).

As saprophagous organisms feeding mainly on decaying organic matter and soil microorganisms, earthworms have emerged as crucial ecosystem engineers that modify the physical, chemical, and biological properties of soil (Edwards & Bohlen, 1996). They carry a long and versatile history of human appreciation, long before their modern domestication for waste management. Aristotle famously referred to them as the "intestines of the earth" in his work *De Generatione Animalium* (Book III, Chapter 10). Recognizing this same ecological significance, Charles Darwin dedicated 39 years to studying these annelids, culminating in his 1881 publication, *The Formation of Vegetable Mould Through the Action of Worms*. In his writings, Darwin aptly named them the 'unheralded soldiers of mankind' and 'friends of farmers' (Singh et. al., 2024). **Charles Darwin** conducted extensive studies on earthworms, culminating in his 1881 publication, *The Formation of Vegetable Mould Through the Action of Worms*, which emphasized their ecological significance. (Bareja, 2022). All these brilliant minds thus have invested to perorate the cruciality of earthworms in ecology and in the ecosystem.

On the other hand, when the history of vermiculture is considered, the formal worm-based processing of organic waste (vermicomposting) as a scientific and commercial practice was developed and began appearing in literature in the 1970s (Furlong et al., 2017). The first scientific vermicomposting experiment was conducted in Holland in 1970, followed by projects in England and Canada. By the late 1970s, the American Earthworm Company was producing approximately 500 tons of vermicompost monthly. (DARSHANA VERMICOMPOST UNIT, n.d.) Concurrently, biology teacher and environmentalist Mary Appelhof first introduced domestic vermiculture. She developed the idea of using red wiggler worms (*Eisenia fetida*) for composting in indoor and outdoor systems to convert kitchen waste into compost, a concept cemented in her seminal 1982 book, *Worms Eat My Garbage*. (Parrish, 2022)

Nepal also took its first step towards commencement of modernization in vermiculture. In **Nepal**, vermicomposting was introduced in the **late 1980s** by professors **Hari Devi Ranjitkar** and **Ananda Shoba Tamrakar** after attending a conference in India. (Shahi, 2025). Formally, this step drew attention of Nepalese community about the methodologies of vermicomposting and earthworm rearing to some large extent.

In recent scenario, the global vermicompost market was valued at approximately USD 310 million in 2024 and is projected to reach USD 808 million by 2031, growing at a Compound Annual Growth Rate (CAGR) of 14.9% during the forecast period. (Shirsath, 2025). Another report indicates the market size was USD 0.27 billion in 2024, expected to grow to USD 0.95 billion by 2033, at a CAGR of 14.9%. (Business Research Insights, 2025). All this shows the trend which world follows regarding the vermiculture practices.

Particularly in Nepal, an action research study in **Rupandehi and Nawalparasi Districts** indicated that vermicompost adoption among vegetable growers increased by 60% over three years. Notably, over 80% of farmers were motivated to use vermicompost due to its cost-effectiveness compared to chemical fertilizers. (Kaphle & Bastakoti, 2018). The efficiency of productivity can be the major reason that Nepalese agriculture is positive to flourish the utilization and production of vermicompost. The research performed by (Dulal, Baral, Poudel, Kafle, & Shrestha, 2021) is a sample to exemplify the efficiency of vermicompost in Nepal. Applying 15 tons per hectare of vermicompost resulted in the highest root yield of 47.9 tons per hectare. However, statistically, 5 tons per hectare was also effective, suggesting it as an optimal rate for cost-efficiency. (Dulal, Baral, Poudel, Kafle, & Shrestha, 2021). Similarly, the maximum plant height in radish is applying 15 ton/ha of vermicompost. (Politud, 2016). Also, In Chitwan, using 20 tons per hectare of vermicompost under plastic mulch conditions led to a significant yield increase, reaching up to 18.62 tons per hectare. (Chauhan, Basnet, Adhikari, Budhathoki, & Shrestha, 2024). These outcomes of yield have thus generated positive response of market towards vermicompost.

Research Questions

This article attempts to address the following queries and quests regarding vermi-products:

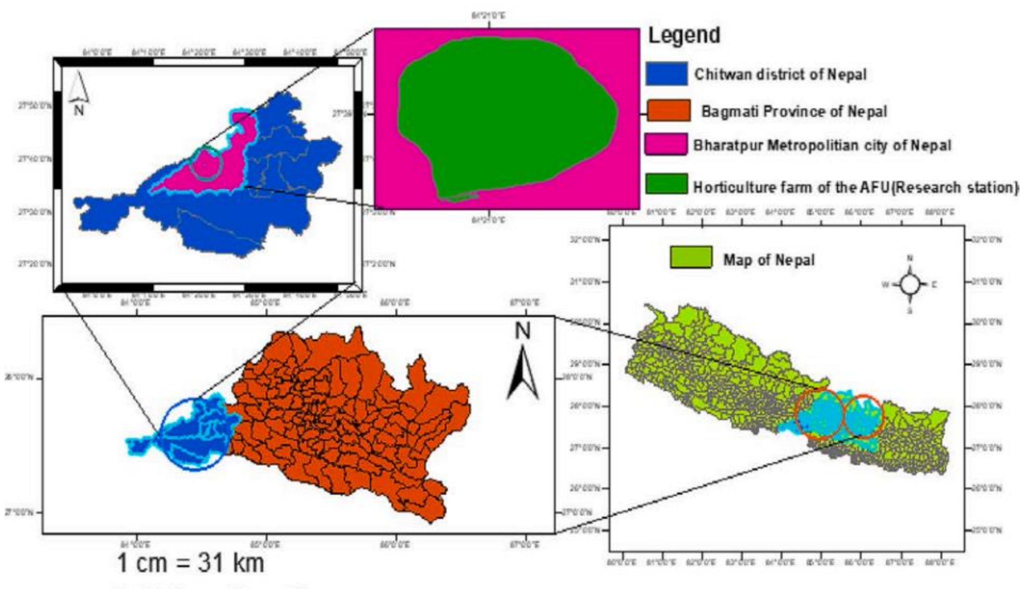
1. What is the cost-benefit ratio of vermicompost production by student-led technical groups at AFU?

2. How does production efficiency vary among different student groups practicing vermiculture?
3. What are the seasonal price variations in earthworm sales, and how do they affect profitability?
4. Which group demonstrates better resource efficiency in vermicompost production?
5. How does the market response to vermicompost products (compost, worms, wash) compare between the groups?
6. Can student-led vermicomposting models be economically viable at commercial scale?

Materials and Methods

- Site selection

The experiments were conducted at the Horticulture farm of Agriculture and Forestry University (AFU), Rampur, Bharatpur-15, Chitwan, Nepal. The experimental sites lie in 27° 38' 59.46" N latitude and 84° 21' 7.07" E longitude. The experimental sites lie in the tropical belt of the country with hot summer and cold winter. All these researches were conducted at the same period of time and at same location.



(Chauhan & al., 2024)

Fig No 1: This GIS map shows the location of the Research Station at Agriculture and Forestry University in Chitwan, Nepal. The map highlights the research station, providing valuable insights into the geographical context of the study area.

Methodology:

- **Study Site and Duration:**

The research was conducted at the Horticulture farm of the Agriculture and Forestry University (AFU) located in Rampur, Chitwan. The study spanned approximately three months, running concurrently from March 10, 2025, to June 14, 2025. This timeframe allowed the experiment to capture environmental conditions across both the local summer and early monsoon seasons.

- **Research Setup and Materials**

The experiment utilized a standard pit method for vermicomposting. A total of ten identical circular pits were constructed at the site, with five pits allocated to each research group. Each pit was designed with a radius of 0.36 meters and a depth of 0.48 meters, resulting in a standard working volume of **0.1955 m³** per pit (calculated using the formula $V = \pi r^2 h$). The primary organic substrate used to feed the system consisted of a mixture of poultry manure and kitchen waste. Once the substrate was prepared, the earthworm species *Eisenia fetida* (commonly known as Red Wigglers) was introduced into the pits. Both groups utilized this specific species due to its reputation as an excellent breeder with highly efficient reproductive capabilities (Edwards & Bohlen, 1996).

- **Team Composition and Task Allocation**

The project was driven by two independent student cohorts with a strong focus on capacity building; Group of Agriculture and Veterinary Science (GAVS**)** was led by 11 technical members from the 11th batch of AFU and

Agriculture Student Liaison Forum (ASLF) was led by 7 technical members of above 4th semester (10^{th} and 11^{th} batch of AFU).

- Within both groups, there was a clear division of labor designed to teach junior members (35 in both groups) the technique of vermicomposting. Junior members were primarily responsible for resource mobilization. Meanwhile, the senior technical members provided the necessary training, prerequisites, and mentorship to ensure the juniors successfully learned the composting techniques.

- **Data Collection and Comparative Outputs**

Primary data was recorded directly from the field by both groups. Respondent 1 and Respondent 2 were representatives from ASLF and GAVS groups respectively, from whom data were obtained through unstructured in-person interview method. The primary variables measured included total vermicompost yield, generation of new earthworm biomass, and overall manure production efficiency. Additionally, the commercial viability of the projects was documented based on the successful sale of active pits.

- **Pattern of Analysis:**

This article attempts for the comparative analysis of vermicompost experiments (until 06/14/2025) between the 2 major technical groups namely ASLF and GAVS. Both the groups conducted practical on vermicompost and its marketing as a part of their training for teaching and learning process. While this single-season, single-location setup limits multi-site ecological replication, it serves as an optimal, controlled framework for this descriptive comparative economic assessment

Results and Findings:

- **Observations Recorded:**
    1. **Data from GAVS:**
        a. Cost of production:

Type of cost	S. N	Particulars	Unit	Quantity	Rate	Total
Total Fixed Cost (TFC)	1.	Transportation	Rs	-	Rs 500/delivery	Rs 500
Total Variable Cost (TVC)	2.	Manure	Sack (50kg)	5	Rs 100/sack	Rs 500
	3.	Earthworm	kg	3	Rs 2000/kg	Rs 6000
	4.	Labors	persons	35	-	-
	Total input: Rs 7,000					

Table no 1: The investments of GAVS for vermicomposting

The total input cost of Rs 7,000 was incurred by the GAVS group for their vermicomposting project. This investment is broken down into a Total Fixed Cost (TFC) of Rs 500 for transportation and Total Variable Costs (TVC) comprising Rs 500 for five sacks of manure and a primary expense of Rs 6,000 for 3 kg of earthworms.

b. Income from experiment:

S. N	Particulars	Unit	Quantity produced	Quantity sold	Rate	Total
1.	Earthworms	Kg	6	1	Rs 2000/kg	Rs 2000
2.	Vermi compost	Kg	133	98	Rs 35/kg	Rs 3430
3.	Vermi wash	liter	3	3	Rs 50/liter	Rs 150
Total output: 5,580						

Table no 2: The return of GAVS from the research

This table details the initial revenue generated by the GAVS group from their vermicomposting research from 3 pits of 5, which culminated in a total current output of Rs 5,580. This income was achieved by selling 1 kg of their 6 kg earthworm yield for Rs 2,000, alongside 98 kg of the 133 kg of vermicompost produced for Rs 3,430. Additionally, they successfully sold their entire 3-liter production of vermiwash for Rs 150.

The data clearly illustrates that while vermicompost provided the bulk of the sales volume, the high unit price of the earthworms significantly bolstered the total revenue. It also highlights that a substantial portion of the produced earthworms (5 kg) and vermicompost (35 kg) remains unsold, representing potential additional income for the group.

c. Remaining income if sold,

S.N.	Particulars	Unit	Quantity remaining	Type of selling	Rate expected	Total
1.	Earthworm	kg	5	Off season	Rs 1000/kg	Rs 5000
				Breeding Season	Rs 2500/kg	Rs 12,500
2.	Vermi compost	kg	35	Formal	Rs 25/kg	Rs 875
				Informal	Rs 40/kg	Rs 1400
Additional income expected:				Maximum return		Rs 13,900
				Minimum return		Rs 5,875

Table no 3: The expected additional return from remaining products

This table outlines the expected additional returns from the GAVS group's unsold inventory, projecting potential revenue based on varying market scenarios. It breaks down the anticipated income for their remaining 5 kg of earthworms and 35 kg of vermicompost under different selling conditions. GAVS members has speculated possible income considering market fluctuation according to seasons and off-seasons.

For the earthworms, selling during the off-season at a rate of Rs 1,000/kg would yield Rs 5,000, whereas waiting for the breeding season could command a premium rate of Rs 2,500/kg, generating Rs 12,500. Similarly, the remaining vermicompost is projected to earn Rs 875 through formal market channels at Rs 25/kg, compared to a higher yield of Rs 1,400 if sold informally at Rs 40/kg. Depending on which market avenues they successfully navigate, the group can expect a minimum additional return of Rs 5,875 or maximize their earnings up to Rs 13,900.

2. Data from ASLF:

a. Cost of production:

Type of cost	S. N	Particulars	Unit	Quantity	Rate	Total
Total Fixed Cost (TFC)	1.	Transportation	Rs	-	-	-
Total Variable Cost (TVC)	2.	Manure	Sack (60kg)	5	Rs 100/sack	Rs 500
	3.	Earthworm	kg	3	Rs 1800/kg	Rs 5400
	4.	Labors	persons	35	-	-
	Total Input: Rs 5,900					

Table no 4: The investments of ASLF for vermicomposting

This table details the total input cost of Rs 5,900 incurred by the ASLF group for their vermicomposting operations. Notably, ASLF managed to avoid any Total Fixed Cost (TFC) for transportation owing to their good socialization ability to retain close relation with transportation head. Their entire financial investment consisted of Total Variable Costs (TVC), comprising Rs 500 for five 60-kg sacks of manure and a primary expense of Rs 5,400 for 3 kg of earthworms. Similar to the other group, the labor contributed by 35 individuals did not add to the overall financial expenses.

b. Income from research:

S.N	Particulars	Unit	Quantity produced	Quantity sold	Rate	Total
1.	Earthworms	kg	5	-	Rs 2000/kg	-
2.	Vermi compost	kg	120	70	Rs 30/kg	Rs 2100
3.	Vermi wash	liter	-	-	-	-
Total Output: Rs 2100						

Table no 5: The return of GAVS from the research

This table details the initial revenue generated by the ASLF group from their vermicomposting research, which culminated in a total current output of Rs 2,100.

This entire income was derived exclusively from selling 70 kg of their 120 kg vermicompost production at a rate of Rs 30/kg. Notably, ASLF did not record any sales for their 5 kg of produced earthworms, despite an expected rate of Rs 2,000/kg, and they did not produce or sell any vermiwash. This highlights a conservative early market approach, with the group retaining their entire earthworm biomass, which represents a significant portion of their unsold inventory and potential future revenue.

c. Remaining income if sold,

S.N.	Particulars	Unit	Quantity remaining	Rate expected	Total
1.	Earthworm	kg	5	Rs 2000/kg	Rs 10,000
2.	Vermi compost	kg	50	Rs 30/kg	Rs 1500
Additional income expected:				Rs 11500	

Table no 6: The expected additional return from remaining products

This table outlines the expected additional returns from the ASLF group's unsold inventory, projecting their potential future revenue. It breaks down the anticipated income for their retained 5 kg of earthworms, which are expected to generate Rs 10,000 at a steady rate of Rs 2,000/kg. Additionally, their remaining 50 kg of vermicompost is projected to earn Rs 1,500 at a rate of Rs 30/kg. If ASLF successfully liquidates this remaining stock, they can expect a total additional income of Rs 11,500, which would significantly bolster their overall financial performance.

- **Required Formulae to deal:**

1. *Total Cost (Input)= Sum of all investments (Total Fixed Cost + Total Variable Cost)*
2. *Total Revenue= Sum of income from sold products*
3. *Return on Investment (ROI)* = $\frac{Net\ Profit\ (Total\ Benefit - Total\ Cost)}{Cost\ of\ Investment\ (Total\ Cost)} \times 100$
4. *Benefit-Cost Ratio (BCR)*= $\frac{Total\ Benefit}{Total\ Cost}$

5. *Revenue Shortfall= Expected Revenue – Actual Revenue*
6. *Extra Compost to Sell for BEP=* $\frac{Required\ Additional\ Revenue}{Selling\ Price\ per\ kg}$
7. *Breakeven Compost Sales=* $\frac{Shortfall}{Rate\ of\ sell} + Total\ quantity\ sold$

- **Terminologies and Calculations:**

1) Total Fixed Cost (TFC):

Total fixed cost (TFC) refers to the sum of all expenses incurred by a business that do not change with the level of production or output. In this context the only fixed cost parameter is transportation cost. Thus, TFC for GAVS is Rs. 500 while ASLF avoided this cost owing to their own social channel as well as use of their owned transportation tools.

2) Total Variable Cost (TVC):

Total variable cost (TVC) is the sum of all expenses that change in direct proportion to the level of production or output. As output increases, TVC increases and vice versa. All other costs for both technical groups fall under TVC (i.e., Manure, earthworm and labors). This results in TVC of Rs. 6,500 for GAVS while Rs. 5,900 for ASLF group.

3) Total Cost (TC):

Total cost (TC) is the sum of all fixed costs and all variable costs incurred in producing a certain level of output.

TC = TFC + TVC

TC_{GAVS}= Rs. 500 + Rs. 6,500 = Rs. 7,000

TC_{ASLF}= Rs. 0 + Ts. 5,900 = Rs. 5,900

4) Total Revenue (TR):

Total revenue (TR) is the total amount of money a firm receives from selling its goods or services.

TR = Price × Quantity

Calculation for TR of GAVS group:

Total Revenue from sold products =

- Earthworm (1 kg × Rs 2000) = Rs **2,000**
- Vermicompost (98 kg × Rs 35) = Rs **3,430**
- Vermiwash (3 L × Rs 50) = Rs **150**

Thus, Total Revenue (TR_{GAVS}) = Rs 2,000 + 3,430 + 150 = Rs 5,580

Calculation for TR of ASLF group:

Total Revenue from sold products =

- Earthworms: 0 kg sold = Rs 0
- Vermicompost: 70 kg × Rs 30 = Rs **2,100**

Thus**, Total Revenue (TR_{ASLF}) = Rs 2,100**

5) Potential Additional Income:

Potential additional income refers to the possible extra earnings or revenue that a business or individual could generate through specific actions, investments, or opportunities. It can be taken as the projections or estimations of the future gains.

- The Potential Additional Income (Unsold Stocks) for GAVS group derives as:
  1. Maximum prospect:
     - Earthworms (5 kg × Rs 2,500) = Rs 12,500
     - Vermicompost (35 kg × Rs 40) = Rs 1,400

  2. Minimum Prospect:
     - Earthworms (5 kg × Rs 1,000) = Rs 5,000
     - Vermicompost (35 kg × Rs 25) = Rs 875

  Thus, Total Additional Potential Income $(PAI_{GAVS})_{max}$ = Rs 13,900

Thus, Total Additional Potential Income $(PAI_{GAVS})_{min}$ = Rs 5,875

- The Potential Additional Income (Unsold Stocks) for ASLF group derives as:
  - Earthworms (5 kg × Rs 2,000) = Rs 10,000
  - Vermicompost (50 kg × Rs 30) = Rs 1,500

  Thus, Total Additional Potential Income (PAI_{ASLF}) = Rs 11,500

6) *Total Income (TI):*

Total income generally refers to the sum of all revenues, earnings, or money received by an individual or entity over a specific period.

Total Income (TI)= TR + PAI

$(TI_{GAVS})_{max}$= Rs. 5,580 + Rs. 13,900 = Rs. 19,480

$(TI_{GAVS})_{min}$= Rs. 5,580 + Rs. 5,875 = Rs 11,455

TI_{ASLF}= Rs. 2,100 + Rs. 11,500 = Rs. 13,600

7) *Return on Investment (ROI):*

Return on Investment (ROI) is a performance measure used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments.

$$\textbf{ROI} = \frac{\textit{Gain from Investment} - \textit{Cost of Investment}}{\textit{Cost of Investment}} \times \mathbf{100}\%$$

$$(ROI_{GAVS})_{min} = \frac{11{,}455 - 7{,}000}{7{,}000} \times 100\% = 63.64\%$$

$$(ROI_{GAVS})_{max} = \frac{19{,}480 - 7{,}000}{7{,}000} \times 100\% = 178.29\%$$

$$(ROI_{ASLF}) = \frac{13{,}600 - 5{,}900}{5{,}900} \times 100\% = 130.50\%$$

8) Benefit-Cost Ratio (BCR):

The Benefit-Cost Ratio (BCR) is a ratio that summarizes the overall relationship between the relative costs and benefits of a proposed project or investment. It's used in capital budgeting and project evaluation.

$$\text{BCR} = \frac{\textit{Present Benefit}}{\textit{Present Cost}}$$

$$(\text{BCR}_{\text{GAVS}})_{\text{current}} = \frac{5{,}580}{7{,}000} = 0.80 \text{ [Not profitable/ Moderate loss]}$$

$$(\text{BCR}_{\text{ASLF}})_{\text{current}} = \frac{2{,}100}{5{,}900} = 0.36 \text{ [Not viable/ Severe loss]}$$

Since both the technical groups are in their progressive marketing stage, their expected BCR can be observed to be 1.64, 2.78 and 2.31 for GAVS minimum, GAVS maximum and ASLF respectively making their part time business profitable.

9) Revenue Shortfall:

Revenue shortfall occurs when the actual revenue generated is less than the projected, budgeted, or expected revenue. It indicates that a company or entity has not met its financial targets for a given period.

Revenue Shortfall (RS) = Total Cost − Current Revenue

RS_{GAVS}= Rs. 7,000 – Rs. 5,580 = Rs. 1,420

RS_{ASLF}= Rs. 5,900 – Rs. 2,100 = Rs. 3,800

10) Extra Compost to Sell for BEP:

It refers to the additional quantity of compost that needs to be sold beyond current sales levels to reach the breakeven point.

$$\textbf{Extra Compost to Sell for BEP} = \textbf{Revenue Shortfall}\ (\boldsymbol{RS}) \big/ \textbf{Compost Selling Rate}$$

$$\textit{Extra Compost to Sell for BEP for GAVS} = \frac{1{,}420}{35} = 41\ kg$$

$$\textit{Extra Compost to Sell for BEP for ASLF} = \frac{3{,}800}{30} = 127\ kg$$

11) Breakeven Compost Sales (BCS):

Breakeven compost sales represent the total quantity of compost that a business needs to sell in order to cover all of its fixed and variable costs.

$$\textbf{Units to Break-even} = \frac{\textit{Total Fixed Cost}}{\textit{Price per unit} - \textit{Variable Cost per unit}}$$

Simply,

BCS = Already sold units + Extra units needed to be sold

$BCS_{GAVS} = 98 + 41 = 139$ kg

$BCS_{ASLF} = 70 + 127 = 197$ kg

While these figures represent the theoretical breakeven threshold for compost sales, they highlight a critical inventory constraint for the ASLF group. Because ASLF requires 127 kg of extra compost sales to breakeven but only possesses 50 kg in remaining inventory (having produced a total of 120 kg), it is mathematically impossible for the group to break even on compost sales alone. To achieve profitability, ASLF must successfully liquidate their high-value earthworm biomass.

12) Shutdown Point Revenue (SDPR):

The shutdown point revenue is the level of total revenue at which a firm should cease production in the short run because it cannot even cover its total variable costs. If revenue falls below this point, the firm would lose more money by continuing to operate than by shutting down. Similarly, Shutdown point is that point at which total revenue equals total variable cost (i.e., TR=TVC).

In the short run, a firm should shut down if:

Total Revenue < Total Variable Cost

Thus,

$SDPR_{GAVS}$= Rs 6,500

$SDPR_{ASLF}$= Rs. 5,900

Thus, tabular representation of the data can be illustrated as:

Parameters	***GAVS (Min Scenario)***	***GAVS (Max Scenario)***	***ASLF (Single Scenario)***
Total Fixed Cost (TFC)	*Rs 500*		-
Total Variable Cost (TVC)	*Rs 6500*		*Rs 5,900*
Total Cost (Input)	Rs. 7,000		Rs. 5,900
Total Revenue	Rs. 5,580		Rs. 2,100
Potential Additional Income	Rs. 5,875	Rs. 13,900	Rs. 11,500
Total Income	Rs. 11,455	Rs. 19,480	Rs. 13,600
Return on Investment (ROI)	63.64%	178.29%	130.51%
Expected Benefit-Cost Ratio (BCR)	1.64	2.78	2.31
Current Benefit Cost Ratio (BCR)	0.80		0.36
Revenue Shortfall	Rs 1,420		Rs. 3,800
Extra Compost to Sell for BEP	41 kg extra		127 kg
Breakeven Compost Sales	139 kg (98 + 41)		197 kg (70+127)
Shutdown Point Revenue	Rs 6,500		Rs. 5,900

Table no 7: Tabular representation of various economic parameters of GAVS and ASLF

Data Analysis:

- **Economic Feasibility**

Initial Investments & Resource Allocation: Both groups invested in manure and earthworms, but their procurement efficiencies varied. ASLF secured 30 kg more manure than GAVS for the same price and avoided transportation costs entirely, limiting their total cost at Rs 5,900. Conversely, GAVS incurred a higher total cost of Rs 7,000, paying an additional Rs 200/kg for earthworms and including a fixed transportation cost.

Current Revenue & Market Strategy: At the 60% project completion mark for both groups (3 of 5 pits), GAVS demonstrated superior early monetization, generating Rs 5,580. This places them just Rs 920 below their shutdown threshold (Rs 6,500) and Rs 1,420 short of breaking even. To reach the breakeven point, GAVS needs to sell only 41 additional kg of compost (139 kg total).

However, ASLF adopted a conservative approach by preserving their reproduced earthworms for future use, resulting in a significantly lower current income of Rs 2,100. Because they had zero fixed costs, their breakeven point and shutdown threshold are identical (Rs 5,900), leaving them with a substantial revenue shortfall of Rs 3,800. To bridge this gap strictly through compost, ASLF faces an impossible climb: requiring the sale of 127 additional kg of compost despite only possessing 50 kg in remaining inventory. Consequently, even if ASLF sold their retained earthworms at cost price, their adjusted income (Rs 4,100) would still trail behind GAVS, proving they must liquidate their high-value biomass at a premium to achieve profitability.

Profitability Projections & Long-Term Viability: Despite the current revenue gap, both models prove highly feasible when analyzing unsold inventory. GAVS operates with a transparent, adaptable vision that responds to market fluctuations (such as breeding seasons and formal versus informal markets). They project a maximum potential profit of Rs 12,480, achieving a Return on Investment (ROI) ranging from 63.64% to 178.29%, and a Benefit-Cost Ratio (BCR) of 1.64 to 2.78.

While ASLF's current revenue is lower, their sales trend is increasing exponentially. Liquidating their unsold stock could yield a maximum profit of Rs 7,700, an ROI of 130.51%, and a strong BCR of 2.31. They expect up to Rs 11,500 in potential additional income from remaining products, compared to GAVS's Rs 13,900.

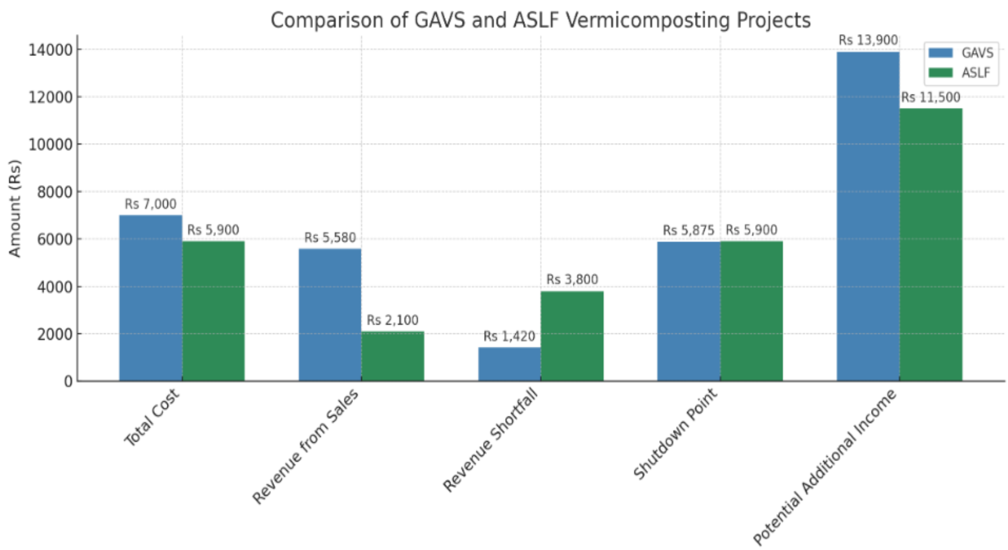


Fig No 2: Graphical representation of various economic parameters of GAVS and ASLF

In summary, comparative financial metrics indicate that GAVS currently occupies a stronger economic position. By operating with a smaller revenue shortfall and a Break-Even Point (BEP) that requires only 41 kg of additional compost sales, GAVS is nearing sustainable operation. Conversely, while ASLF successfully minimized initial variable costs, their current Benefit-Cost Ratio (BCR) of 0.36 places them below calculated sustainability thresholds, requiring a steeper sales volume (127 kg) to break even. While projected models suggest both projects possess strong potential profitability through unsold inventory (yielding maximum ROIs of 178.29% and 130.51%, respectively), standard financial indicators demonstrate that GAVS has achieved higher immediate commercial efficiency at this stage.

Diagrammatic Representation of Breakdown of Income Source

- Group of Agriculture and Veterinary Science - GAVS (Max)

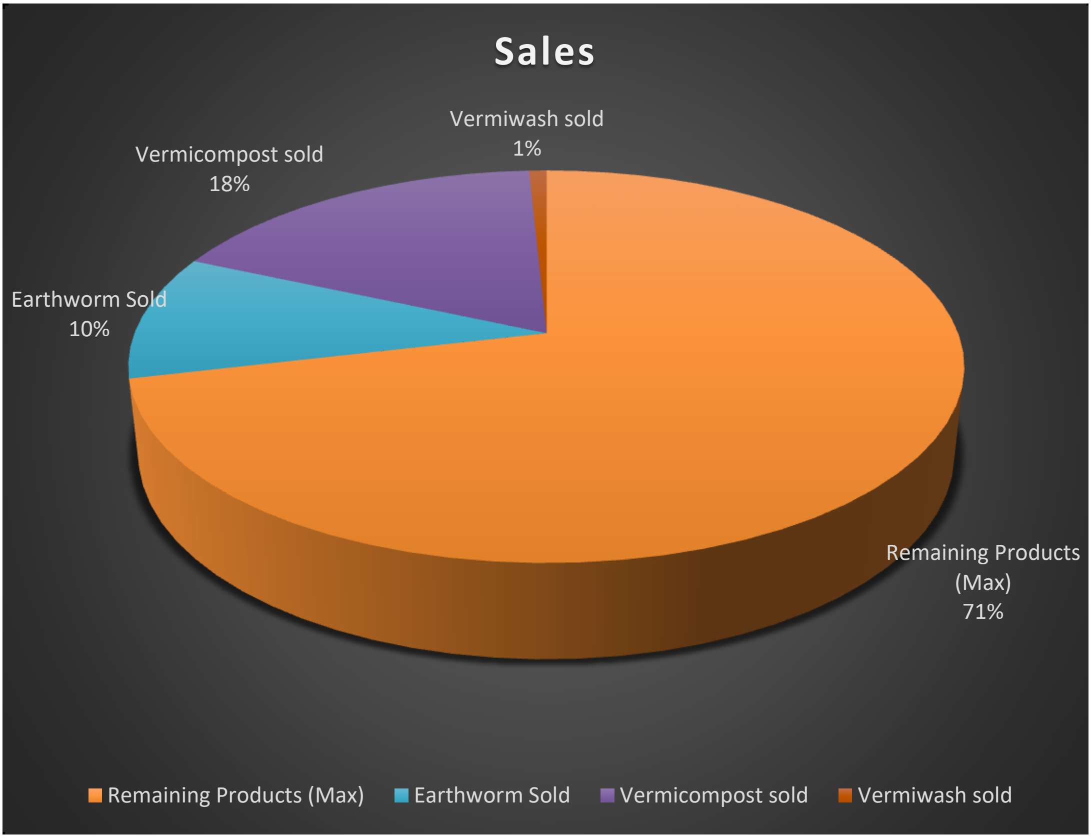


Fig No 3: Diagrammatic Representation of Breakdown of Income Source of GAVS

- Agriculture Student Liaison Forum - ASLF

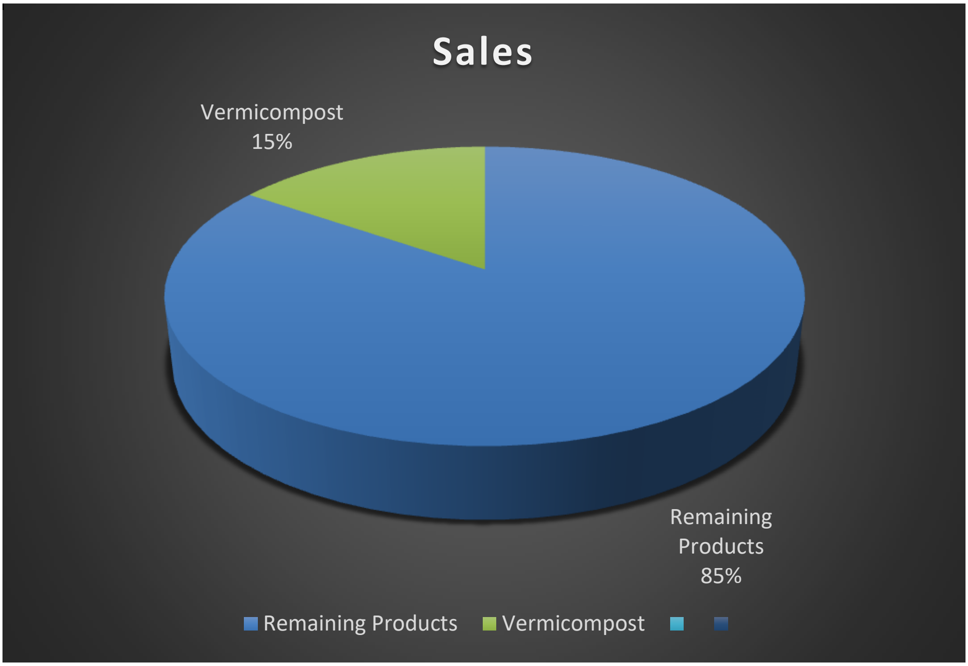


Fig No 4: Diagrammatic Representation of Breakdown of Income Source of ASLF

- **Production Efficiency:**

Parameter	**GAVS**	**ASLF**
Manure Used (kg)	250	300
Vermicompost Produced (kg)	133	120
Production Efficiency	**53.2%**	**40.0%**
Initial Earthworm Biomass (kg)	3	3
Final Earthworm Biomass (kg)	6	5
Multiplication Rate	**2.0 times**	**1.67 times**

Table No 8: Production efficiency of compost and Multiplication rate of earthworm by GAVS and ASLF

The vermicomposting in both groups attempts to maximize their gain in the ways they could, for both the facets of their training (i.e., production efficiency and multiplication rate). Production efficiency is the percentage ratio of vermicompost produced to total manure used for production whereas multiplication rate shows how much the earthworm biomass increased during the composting period.

The GAVS group attained a production efficiency of 53.2%, whereas ASLF recorded a lower efficiency of 40.0%. This variation in yield highlights the critical role of operational management in vermiculture. While both groups operated under nearly identical environmental conditions, GAVS implemented strict activity regulation, meticulous record-keeping, and a highly consistent periodic nutrient supply. Previous studies also emphasize that the precise regulation of feed and environmental parameters directly correlates with enhanced decomposition efficiency and higher earthworm reproduction rates (Domínguez & Edwards, 2011). Consistent nutrient availability and optimal substrate management are well-documented factors that stimulate earthworm biomass increase. Consequently, the systematic management practices and superior earthworm care adopted by GAVS align with established literature as the primary drivers for both their enhanced production efficiency and their higher earthworm multiplication rate (2.0 compared to ASLF’s 1.67).

- **Market Potential Analysis:**

Analyzing the supply chain mechanisms reveals that the two groups adopted distinctly different market strategies, directly influencing their respective financial outcomes. The GAVS group implemented a dynamic, dual-channel distribution model, segmenting their market into commercial (formal) and retail (informal) sectors. For commercial bulk sales, GAVS utilized a competitive, demand-responsive pricing range of Rs 22/kg to Rs 30/kg depending upon the demand of a season or breeding cycle (i.e., breeding season or off-season). When informal selling mechanism is considered, such system delivered products directly to their known consumers where they capitalized on high-margin informal networks for smaller quantities, projecting sales up to Rs 40/kg. This adaptive market segmentation directly correlates with their higher early revenue generation (Rs 5,580). These consumers were not the regular consumers but were reason of greater profitability margin. Such consumers seek qualitative manure and owing to the close relations between seller and buyer, products could be sold at the expected margin. That’s why, GAVS intended to sell its remaining vermicompost at Rs 40/kg through this channel.

In contrast, the ASLF model utilized a fixed-pricing strategy. By resisting situation-based price fluctuations allowing only minor volume-based discounts (Rs 5/kg). ASLF prioritized accounting transparency and market risk mitigation over immediate high-margin returns. While this procedure is followed, constant-rate approach resulted in lower initial revenue generation (Rs 2,100) but it established a highly stable market valuation. Ultimately, the analysis indicates that while ASLF's fixed-rate strategy ensures operational stability, GAVS's adaptive pricing model currently yields a significantly higher commercial advantage. However, if ASLF liquidates its remaining 40% inventory under its stable pricing model, the data suggests they are still positioned for strong, sustainable economic returns.

- **Descriptive Comparative Assessment**

Criteria	**GAVS**	**ASLF**
Production Capacity	Vermicompost: 133 kg Earthworm: 6 kg	Vermicompost:120 kg Earthworm: 5 kg
Production Efficiency	53.2%	40.0%
Earthworm Multiplication Rate	2.0× (from 3 kg to 6 kg)	1.67× (from 3 kg to 5 kg)
Sale Efficiency	Rs. 5,580 Up to Rs. 19,480 with remaining stock	Rs. 2,100 Up to Rs. 13,600 total
Input Usage (Cost)	Rs. 7,000 total Earthworm: Rs. 2000/kg Manure: 250 kg (Rs. 500)	Rs. 5,900 total Earthworm: Rs. 1800/kg Manure: 300 kg (Rs. 500)
Labor Use	35 persons (members)	35 persons (members)
Resource Optimization	▪ Systematic recording, guidance, and market adaptation. ▪ Used formal and informal market channels for pricing optimization	▪ No transportation cost. ▪ Followed fixed pricing approach for transparency.
ROI (Return on Investment)	63.64% (min) to 178.29% (max)	130.51% (single case)
Benefit-Cost Ratio (BCR)	1.64 – 2.78	2.31

Table No 9: Tabular representation of various comparison criteria over ASLF and GAVS

Reflecting the contraposition, the analysis specifies the kind of strength that each possessed in their vermicomposting operation. Based on the aggregate metrics, GAVS was better in terms of production capacity, earthworm multiplication, and efficiency. Through their well-developed method of keeping good records, local coordination, and provision of timely advice, bigger yield of vermicompost could be obtained together with the higher multiplication rate of earthworms. They also followed a flexible approach toward marketing, combining both formal and informal channels of sale, thereby having the opportunity to change prices according to market demand and seasonality, so as to maximize profits.

ASLF, by contrast, maintained cost-effectiveness with its minimal-cost system, avoiding transport costs and acquiring larger amounts of manure for the same price as that paid by GAVS. The returns gained early on were lower, as ASLF's concern was on the explicit preservation of resources for future use, especially retaining earthworms for subsequent cycles. Their fixed prices were based less on adapting to changing market considerations and more on transparency and consistent accounting.

In summary, GAVS seems to be more commercially oriented with immediate returns on investment and adaptability, while ASLF employs a more conservative and resourceful approach leading to long-term sustainability. Both are evidence that vermicomposting can be scalable and economically viable.

Major Constraints, Opportunities, and Post-Experiment Analysis

Throughout the experimental phase, both technical groups identified critical methodological constraints and future opportunities to optimize vermicomposting operations. Evaluating these practical hurdles is essential for maximizing both biological yield and economic returns in future endeavors.

- **Operational Constraints and Opportunities for Optimization:** A primary operational opportunity identified by researchers is the potential use of a supplemental solution mixture of molasses and gram flour. While the groups exclusively utilized livestock and kitchen manures, they observed that these standard feeds did not maximize the earthworm multiplication rate. Introducing a nutrient-dense solution is hypothesized to rapidly boost earthworm populations, presenting a distinct avenue for subsequent experimental research.

- Conversely, a shared operational constraint was the vermicast harvesting and screening process. Both groups observed that conventional net sieving resulted in the inadvertent loss of juvenile earthworms and cocoons. This mechanical inefficiency highlights a significant hurdle for both small-scale projects and large commercial productions, necessitating the development of more refined, less destructive harvesting techniques.
- **Biological Constraints: A Novel Predation Observation**: The production of vermiculture is highly sensitive, requiring rigorous management of ecological and biological risks. A major biological constraint emerged when a severe predator infestation was noticed in specific experimental pits. Initial morphological observations suspected the presence of click beetle larvae (wireworms) engaging in a previously undocumented parasitic-predatory relationship with earthworms, potentially consuming visceral organs and causing significant mortality.
- However, subsequent morphological examinations suggested the organisms also shared traits with crane fly (leatherjacket) or white grub larvae. Because no prior global records of click beetle predation on earthworms exist, this observation is currently being treated as tentative. The exact taxonomic identification and predation mechanism are currently under expert entomological verification. Regardless of the specific species, these unknown larvae intensified interspecific competition for food and shelter. Researchers attributed the introduction of these predators to nearby vegetation, contaminated manure, or inadvertent mixing with the initial earthworm stock. Since this impact was noticed in 5th and 6th pit, the economic analysis of this impact remains undisturbed for this research. But this result has awakened them to properly sterilize and clean the location of experiment, the next time they commence their research.

Fig No 5: Vermi composting and predator larva spotting

- **Market Constraints and Socio-Economic Opportunities** Beyond biological factors, market dynamics presented significant constraints. Observations indicated that consumers often prioritize cheaper manure alternatives with lower opportunity costs, neglecting the irreplaceable biological value of vermi-products. Furthermore, small-scale producers faced a relative loss in consumer surplus; purchasing manure from commercial distributors in small quantities weakened negotiation power. This highlights a clear opportunity for producers to
- adopt bulk-purchasing strategies and establish better supply chain management.

- Finally, administrative and socio-cultural barriers were prevalent. Both groups navigated extensive administrative formalities for site permissions and managed resource price fluctuations. A major external constraint was the lack of initial cooperation from local farmers, driven by traditional prejudices and an unwarranted aversion to earthworm culture. To counter this, researchers identified a key opportunity for community extension: advocating for the establishment of at least four vermiculture pits in individual home gardens (*Karesa bari*) to demonstrate field efficacy. A transformative shift in public perception, driven by proven results, is essential for the broader commercial adoption of vermiculture.

Conclusion

This study conclusively demonstrates that small-scale, student-led vermicomposting is a highly viable and scalable agro-enterprise in the Chitwan region. By comparing two distinct operational frameworks, the research yields concrete strategic takeaways for future producers. The GAVS model proves that dynamic market segmentation and meticulous record-keeping drive rapid commercialization, superior production efficiency, and higher immediate returns. Conversely, the ASLF model highlights that minimizing initial overhead and prioritizing resource conservation ensures a strong foundation for long-term sustainability, albeit with a slower initial revenue stream.

Beyond financial metrics, this study contributes a critical biological observation to the field of vermiculture: the tentative discovery of a parasitic-predatory relationship between unidentified larvae (suspected to be click beetles) and *Eisenia fetida*. This novel finding highlights that economic success in vermicomposting is intrinsically tied to strict biological management, necessitating rigorous substrate screening and biosecurity protocols to prevent sudden colony collapse.

Ultimately, this research establishes that vermiculture is not a one-size-fits-all venture. Both adaptive commercialization and cost-efficient conservation models can succeed depending on the producer's immediate capital and market access. For vermi-products to realize their full potential in Nepal's agricultural market, producers must integrate flexible business strategies with rigorous ecological care. Supported by institutional backing and academic infrastructure, vermicomposting stands as a transformative, profitable avenue for youth-led sustainable agriculture.

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Author Contributions:

CRediT:

Author 1 (Samyak Raj Chalise): Conceptualization, Methodology, Software, Formal Analysis, Investigation, Resources, Data Curation, Writing – Original Draft, Visualization, Funding Acquisition

Author 2 (Prof. Arjun Kumar Shrestha): Validation, Writing – Review & Editing, Supervision, Project Administration

Disclosure Statement

The author(s) agree in not having any conflict of interest regarding the published material. All the authors had gone through the document prior to the submission. The author(s) affirm that this research is original and not generated by artificial intelligence. All research design, data collection, analysis, and interpretation were conducted entirely by the author(s).

Ethics Approval

The study was conducted in accordance with the ethical principles outlined by the general ethical research principles. Participation in the study was entirely voluntary. All participants were informed about the objectives and purpose of the research, assured of confidentiality and anonymity, and provided written informed consent prior to data collection. No sensitive personal or health-related data were collected. Permission was obtained before taking photographs, which were used solely for academic purposes.

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