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Effects of Combined Fermented Sheep Manure and Plant Juice on Cucumber Growth, Yield, and Return on Investment

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RESEARCH ARTICLE INFORMATION	ABSTRACT

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Organic inputs such as fermented manures and plant extracts are increasingly explored as alternatives to synthetic fertilizers. This study evaluated the effects of fermented sheep manure and fermented plant juice on cucumber (Cucumis sativus) growth and productivity at the Agri-Tech Eco Tourism Farm, Isabela State University–Roxas Campus. A Randomized Complete Block Design (RCBD) with five treatments was used: 100% recommended fertilizer (control) and four combinations of 50% recommended fertilizer plus varying levels of fermented sheep manure (500–650 ml) with a constant dose of fermented plant juice. The growth and yield parameters measured included fruit number per plant, fruit length and diameter, and weight of marketable and non-marketable fruits. Results showed that while cucumber growth was comparable across treatments at 15 and 30 days after sowing, significant differences were observed at 45 days. The control (T1) produced the heaviest and most numerous marketable fruits, the lowest proportion of non-marketable fruits, and the highest total yield, resulting in a return on investment (ROI) of 94.81%, which was higher than all organic input combinations. Fermented sheep manure and plant juice supported growth and yield but did not surpass the productivity or profitability of full synthetic fertilization. These findings highlight that, under the conditions of this study, the control treatment provided the highest ROI, quantifying the economic advantage of the recommended fertilizer rate.

Keywords: *cucumber growth, fermented sheep manure, organic fertilizer, plant juice, cucumber yield*

Introduction

Cucumber (Cucumis sativus L.) is a widely cultivated cucurbit valued for its rapid maturity and adaptability to diverse soil conditions, especially light, well-drained soils enriched with organic matter. In the Philippines (pipino) and in Southeast Asia, it is consumed fresh, incorporated into salads, and processed into pickles. Cucumbers are also recognized for their potassium, magnesium, and dietary fiber content, which contribute to digestive health, electrolyte balance, and overall wellness.

However, cucumber production often relies heavily on synthetic fertilizers, raising production costs and creating risks of soil degradation and nutrient runoff. Drench application of nutrients is known to enhance nutrient uptake during rapid vegetative and reproductive stages, improving plant vigor and yield (Jang et al., 2021). Recent investigations highlight the growing potential of organic and fermented nutrient sources as supplements or partial substitutes for chemical fertilizers. In China, fermented chicken manure extract successfully replaced part of the synthetic fertilizer requirement while maintaining cucumber yield and improving vegetative growth, fruit quality, and soil microbial structure (Yao et al., 2023). Similarly, poultry manure combined with mineral fertilizers increased cucumber productivity under greenhouse conditions (Sallam et al., 2021).

Although fewer studies are available on sheep manure fertilizers, existing work demonstrates their potential. Sheep manure–derived composts and extracts have been shown to enhance soil organic matter, available nitrogen, and microbial activity, leading to improved plant growth in strawberries (Zha et al., 2024). Mixed fermentation of sheep manure and mushroom residues also improved tomato growth by increasing nutrient availability and enriching beneficial microbial communities (Duan et al., 2024). Fermented sheep manure typically contains appreciable levels of nitrogen (0.6–1.2%), phosphorus (0.3–0.6%), and potassium (0.5–1.0%), along with micronutrients such as Ca, Mg, and Zn (Li et al., 2023), which become more plant-available after fermentation. Meanwhile, fermented plant juice (FPJ) made from leafy vegetables such as Ipomoea aquatica (water spinach) is widely used in natural farming due to its high concentration of soluble nitrogen, potassium, chlorophyll, amino acids, enzymes, and growth-promoting compounds derived from young plant tissues. Analyses of FPJ from green leafy vegetables suggest it contains potassium, nitrogen-rich amino acids, and bioactive metabolites that may stimulate photosynthesis, root growth, and stress resilience (Pant et al., 2012). However, peer-reviewed studies on the nutritional composition of FPJ, particularly for cucumber, remain limited.

Despite the growing interest in organic drench applications, a clear research gap persists: very few studies have examined fermented sheep manure as a drench fertilizer, and even fewer have evaluated its combined application with water spinach FPJ. Organic drench inputs may offer advantages such as improved nutrient-use efficiency, reduced nutrient losses, lower input costs, and minimized risk of plant damage compared with high-nitrogen synthetic sprays. Fermented sheep manure provides slow-release phosphorus and potassium, while FPJ contributes readily available nitrogen, micronutrients, and bioactive compounds that can enhance photosynthesis and disease tolerance.

Therefore, this study evaluated the effects of fermented sheep manure and FPJ as drench applications on the growth, yield, and profitability of cucumber. It identified the most effective treatment combinations, determined whether these organic inputs can replace 50% of the recommended synthetic fertilizer, and assessed which treatment delivered the highest return on investment. The results aimed to support the development of sustainable, low-cost, and farmer-friendly fertilization strategies for cucumber growers.

Methods

Procurement of Cucumber Seeds

Seeds of the cucumber hybrid variety *Ambassador F1* were procured from KVC Villame General Merchandise and Agricultural Supply, Sta. Rosa, Aurora, Isabela.

Selection, Preparation, and Land Preparation of the Experimental Site

The study was conducted at the ISU–AgriTech Ecotourism Farm, Matusalem, Roxas, Isabela (coordinates: 17.0645° N, 121.5915° E), which features light and well-drained soils with adequate sunlight, suitable for cucumber cultivation, from August 30 to October 25, 2024. Before planting, the 352-m^2 experimental area was thoroughly cleared of weeds, debris, and other unwanted materials, then plowed and harrowed twice to achieve good tilth, enhance root penetration, improve moisture retention, and manage weeds. Plots were also irrigated before sowing to restore soil moisture and ensure uniform growing conditions.

Soil Sampling and Analysis

Soil samples were randomly collected within the experimental area with the use of a shovel. The soil samples were pulverized, air-dried, and sieved after three days. One (1) kilogram of composite soil sample was submitted to the Department of Agriculture - Cagayan Valley Integrated Agricultural Laboratory (DA CVIAL), at Carig, Tuguegarao City, to determine the macro and micronutrients and pH of the soil material. The result of the analysis served as the basis for the amount of the fertilizer applied per treatment.

Preparation of Fermented Sheep Manure Tea (FSMT) and Fermented Plant Juice (FPJ)

Fermented sheep manure tea (FSMT) was prepared by mixing three (3) kg of sheep manure with three (3) kg of molasses and 50 L of water and fermenting the mixture for 7–14 days in a shaded area to produce a nutrient-rich drench fertilizer supplying slow-release phosphorus and potassium for cucumber growth. FSMT levels were selected based on the effective range of 200–300 mL per plant (Arinong, 2025) to avoid nutrient imbalance, with higher rates (350–400 mL per plant) included to determine if additional application could further enhance growth and yield, and lower rates (250–300 mL per plant) tested to identify minimal effective dosages for cost efficiency. Fermented plant juice (FPJ) was produced from water spinach (Ipomoea aquatica) leaves mixed with an equal weight of molasses and fermented for 7–14 days in a shaded container, and a constant 20 mL per plant of FPJ was applied to ensure a uniform supply of nitrogen, micronutrients, and bioactive compounds, allowing clear evaluation of FSMT dosage effects and the economic feasibility of partially substituting synthetic fertilizers with organic liquid inputs.

Layout of the Experimental Area

The 352-m² area was divided into three blocks, each containing five plots measuring 4 m × 4 m, with 1-m alleys between blocks and 0.5-m alleys between plots. The experiment followed a Randomized Complete Block Design (RCBD).

Sowing and Thinning

Three seeds were sown per hill and irrigated immediately. Thinning was done seven days after emergence, retaining one healthy seedling per hill. Spacing was 50 cm between rows and 70 cm between hills.

Experimental Treatments

Treatments involved varying levels of FSMT combined with a fixed volume of FPJ, applied weekly:

- T1 – Control (100% RRSA)
- T2 – 50% RRSA + 400 ml FSMT + 20 ml FPJ per plant
- T3 – 50% RRSA + 350 ml FSMT + 20 ml FPJ per plant
- T4 – 50% RRSA + 300 ml FSMT + 20 ml FPJ per plant
- T5 – 50% RRSA + 250 ml FSMT + 20 ml FPJ per plant

Application of Treatments

FSMT and FPJ were applied as soil drenches at 15, 30, and 45 days after sowing. Application rates followed previously reported effective ranges for sheep manure extracts (Arinong, 2025) to ensure consistent nutrient availability during vegetative and reproductive stages.

Crop Care and Management

Cultivation was conducted 10 days after sowing to improve aeration and reduce weeds. Manual weeding minimized competition for nutrients. The recommended synthetic fertilizer served as the basal application, while FSMT and FPJ supplemented nutrient supply. Pest management followed integrated pest management (IPM) practices, including neem extract and manual insect removal.

Harvesting

Fruits were harvested at 50–60 days after sowing once they reached marketable size. Harvesting was performed every five days in the early morning to reduce postharvest losses.

Data Collection

Ten representative plants per plot were randomly tagged. The following data were collected:

a. Vine length (cm) at 15, 30, 45, and 60 DAS, measured from base to shoot tip.
b. Number of marketable and nonmarketable fruits per plant, counted every priming.
c. Fruit length (cm) measured using a meter stick.
d. Fruit diameter (mm) measured using a vernier caliper.
e. Average weight of marketable fruits (g) obtained using a platform balance.
f. Yield per plot (kg) determined by weighing harvested fruits.
g. Computed yield per hectare, calculated using the formula: Yield/ha = (Yield per plot × 10,000 m²)/Plot area (m²).

h. Cost and return analysis was conducted by computing total production cost, gross income, net income, and return on investment (ROI).

Statistical Analysis

Data were analyzed using Analysis of Variance (ANOVA) under RCBD. Significant differences among treatment means were determined using the least significant difference (LSD) test at the 5% level of significance, with the Statistical Tool for Agricultural Research (STAR).

Results and Discussion

Vine Length at 15th, 30th, 45th Days after Sowing (centimeter)

At 15 days after sowing (DAS), cucumber vine length did not differ significantly among treatments (P > 0.05), with means ranging from 12.55 to 14.90 cm (Table 1). This indicates that early growth was largely unaffected by either inorganic fertilizer or organic supplements, as seedlings mainly relied on inherent seed reserves and initial soil fertility.

By 30 DAS, vine length was significantly influenced by fertilization (P<0.01). Plants treated with 100% of the recommended inorganic fertilizer rate (T1) had the longest vines (72.18 cm), but these were statistically comparable to plants supplied with 50% RR plus organic amendments (T3 and T4). In contrast, plants receiving only the organic treatment (T5) produced the shortest vines (50.62 cm). These results suggest that integrating the organic inputs with reduced inorganic fertilizer can maintain vegetative growth comparable to full fertilization. Similar findings were reported by Ghosh et al. (2004), who observed that organic manure applications enhanced vegetable growth by improving nutrient supply and soil quality, while Pant et al. (2012) demonstrated that compost teas stimulate vegetable growth through increased nutrient availability and plant physiological responses.

At 45 DAS, significant differences remained (P<0.01). The tallest vines were obtained in T1 (145.92 cm), followed by T4 (136.30 cm), which was statistically similar. The shortest vines were recorded in T5 (105.22 cm). The positive effect of the organic amendments can be attributed to the release of soluble nutrients and beneficial microbial metabolites during fermentation, which enhance nutrient uptake and promote vegetative growth. Furthermore, Zha et al. (2024) highlighted that sheep manure-based fertilizers improve plant growth by enhancing soil properties and microbial activity, reinforcing the potential of these inputs as a sustainable supplement to reduce chemical fertilizer use.

Table 1. Plant Vine Length at 15th, 30th, 45th DAS (cm)

Treatments	Mean		
	15 DAS	**30 DAS**	**45 DAS**
T_1	14.90	72.18^{a}	145.92^{a}
T_2	14.27	61.70^{ab}	127.03^{b}
T_3	13.83	63.88^{a}	133.93^{ab}
T_4	13.52	68.85^{a}	136.30^{ab}
T_5	12.55	50.62^{b}	105.22^{c}
F- Result	ns	**	**
C.V (%)	5.97	7.20	4.33
$LSD_{0.01}$		12.52	15.39

Note: Means with the same letter within a column are not significant.
*** - (P < 0.01), * - (P < 0.05), ^{ns} –not significant*

Number of Marketable Fruits

At harvest, the number of marketable cucumber fruits per plant was significantly influenced by fertilization treatments (P<0.01) (Table 2). Plants that received 100% of the recommended fertilizer rate (T1) produced the highest number of marketable fruits (5.00 fruits/plant), which was statistically comparable to those treated with 50% RR combined with organic amendments (T3, 4.00 fruits/plant). Treatments T2 and T4 (50% RR plus higher volumes of the fermented inputs) yielded 4.00 fruits per plant, similar to T3 but lower than T1. The lowest number of marketable fruits was recorded in T5 (organic inputs alone), with only 3.00 fruits per plant, highlighting that the amendments alone were insufficient to sustain optimal fruit set under the tested conditions.

These results indicate that integrating the organic inputs with reduced inorganic fertilizer can maintain fruit productivity close to full fertilization, thereby reducing reliance on synthetic inputs. The enhanced fruit number in integrated treatments may be attributed to improved nutrient availability and bioactive compounds in the fermented amendments, which promote reproductive growth and fruit set. Similar findings were reported by Tri Kurniastuti (2018), who observed increased fruit production in tomato with FPJ and calcium supplementation, and by Pant et al. (2012), who noted that compost teas enhance vegetable productivity through nutrient solubilization and plant growth–promoting compounds. Furthermore, Zha et al. (2024) demonstrated that sheep manure–based fertilizers improve soil fertility and microbial activity, supporting higher fruit yield.

Table 2. Number of Marketable Fruits

Treatment	**Mean**
T1 – Control (100% RRSA)	5.00^{a}
T2 – 50% RRSA + 400 ml FSM Tea + 20 ml FPJ/plant	4.00^{b}
T3 – 50% RRSA + 350 ml FSM Tea + 20 ml FPJ/plant	4.00^{ab}
T4 – 50% RRSA + 300 ml FSM Tea + 20 ml FPJ/plant	4.00^{b}
T5 – 50% RRSA + 250 ml FSM Tea + 20 ml FPJ/plant	3.00^{b}
F- Result	**
C.V (%)	9.46
$LSD_{0.01}$	0.93

Note: Means with the same letter within a column are not significant.
*** - (P < 0.01), * - (P < 0.05), ^{ns} –not significant*

Number of Nonmarketable Fruits per Plant

At 45 days after sowing, the number of non-marketable cucumber fruits per plant was significantly influenced by fertilization (P<0.05; See Table 3). Plants supplied with 100% of the recommended inorganic fertilizer (T1) produced the fewest rejected fruits (2.00), whereas those receiving 50% of the recommended rate supplemented with organic inputs (T2 and T3) had significantly higher values (3.00). Treatments T4 and T5 showed intermediate responses with no significant difference from either group. These results indicate that although fermented organic amendments supply nutrients and beneficial microbial metabolites, their partial or full substitution for inorganic fertilizer may create short-term nutrient imbalances—particularly in calcium, potassium, or nitrogen—which are essential for proper fruit set, shape formation, and cell expansion. Insufficient or uneven nutrient availability during critical stages of fruit development can lead to curvature, misshaping, or undersized fruits, thereby increasing the proportion of nonmarketable produce. Similar findings have been reported in cucumber systems where compost tea affected both yield and fruit quality under nutrient film technique conditions (Diab et al., 2012), and where the effectiveness of compost teas on yield components varied depending on nutrient composition and extraction processes.

Table 3. Number of Nonmarketable Fruits per Plant

Treatment	Mean
T1 – Control (100% RRSA)	2.00[b]
T2 – 50% RRSA + 400 ml FSM Tea + 20 ml FPJ/plant	3.00[a]
T3 – 50% RRSA + 350 ml FSM Tea + 20 ml FPJ/plant	3.00[a]
T4 – 50% RRSA + 300 ml FSM Tea + 20 ml FPJ/plant	2.00[ab]
T5 – 50% RRSA + 250 ml FSM Tea + 20 ml FPJ/plant	2.00[a]
F- Result	*
C.V (%)	12.98
$LSD_{0.05}$	0.54

Note: Means with the same letter within a column are not significant.
*** - (P < 0.01), * - (P < 0.05), ns –not significant*

Length and Diameter of Marketable Fruits

Across treatments, the average length and diameter of marketable cucumber fruits were not significantly affected by fertilization (P>0.05). Fruit length ranged from 10.60 cm (T5) to 12.61 cm (T1), while fruit diameter varied from 46.96 mm (T5) to 50.91 mm (T1), indicating that supplementing 50% of the recommended inorganic fertilizer rate (RR) with organic amendments did not produce measurable differences in fruit size. These findings suggest that fruit dimensional traits—length and diameter—are relatively stable and less responsive to variations in fertilization compared to other yield attributes such as fruit number or total yield. This stability may be attributed to genetic and physiological constraints that limit size variation once basic nutrient requirements are met. Similar patterns have been observed in previous studies, where compost teas enhanced vegetative growth but had inconsistent effects on yield components in pak choi (Pant et al., 2012), and where fruit size in greenhouse cucumber remained unaffected by differences between chemical and biofertilization (Ortiz-Romero et al., 2025).

Table 4. Length (cm) and Diameter (mm) of Marketable Fruits

Treatment	Mean	
T1 – Control (100% RRSA)	12.61	50.91
T2 – 50% RRSA + 400 ml FSM Tea + 20 ml FPJ/plant	11.58	48.88
T3 – 50% RRSA + 350 ml FSM Tea + 20 ml FPJ/plant	11.68	49.31
T4 – 50% RRSA + 300 ml FSM Tea + 20 ml FPJ/plant	11.73	48.79
T5 – 50% RRSA + 250 ml FSM Tea + 20 ml FPJ/plant	10.60	46.96
F- Result	ns	ns
C.V (%)	8.27	4.72

Weight of Marketable Fruits (g)

Average fruit weight per plant was significantly influenced by fertilization treatments (P<0.01). Plants supplied with 100% of the recommended inorganic fertilizer rate (T1) produced the heaviest fruits (892.07 g), significantly exceeding all other treatments. In contrast, plants receiving only the organic amendments (T5) produced the lightest fruits (583.47 g). Intermediate treatments (T2–T4), which combined 50% of the recommended rate with varying volumes of fermented inputs, yielded comparable results (~699–708 g) but were still significantly lighter than the full inorganic control. These observations suggest that while organic amendments provide beneficial nutrients and bioactive compounds, they cannot fully match the nutrient supply of complete mineral fertilization in terms of fruit weight. Similar patterns have been reported in cucumber, where compost tea applied under nutrient film technique improved fruit yields compared with untreated controls, but maximum fruit weight was achieved only with mineral fertilization (El-Kassas et al., 2012). Likewise, Pant et al. (2012) demonstrated that compost teas enhanced vegetable growth through improved nutrient availability, although effects on fruit yield components such as weight were less consistent.

Table 5. Weight of Marketable Fruits (g)

Treatment	Mean
T1 – Control (100% RRSA)	892.07[a]
T2 – 50% RRSA + 400 ml FSM Tea + 20 ml FPJ/plant	698.97[b]
T3 – 50% RRSA + 350 ml FSM Tea + 20 ml FPJ/plant	707.63[b]
T4 – 50% RRSA + 300 ml FSM Tea + 20 ml FPJ/plant	698.73[b]
T5 – 50% RRSA + 250 ml FSM Tea + 20 ml FPJ/plant	583.47[c]
F- Result	**
C.V (%)	5.57
$LSD_{0.01}$	109.32

Note: Means with the same letter within a column are not significant.
*** - (P < 0.01), * - (P < 0.05), [ns] –not significant*

Yield per Plot in Kilograms

Yield per plot was significantly influenced by fertilization treatments (P<0.01). The control treatment (T1), which received 100% of the recommended inorganic fertilizer rate, produced the highest yield (21.49 kg), significantly exceeding T2, T4, and T5. Notably, the yield of T3 (18.35 kg) was statistically comparable to the control, indicating that supplementing 50% of the recommended rate with organic amendments can partially substitute for full mineral fertilization without drastically reducing yield. T3 outperformed T2 and T4 despite a lower volume of FSM tea, which can be attributed to a more optimal nutrient balance and timing of application that improved nutrient uptake efficiency and plant growth. Conversely, plants receiving only the fermented inputs (T5) exhibited the lowest yield (11.82 kg), highlighting the limited capacity of organic amendments alone to sustain maximum productivity.

Although soil physicochemical parameters were not directly measured, the observed differences in yield suggest that combined inorganic–organic fertilization could positively influence soil health. Organic amendments such as fermented sheep manure tea (FSMT) and fermented plant juice (FPJ) are known to enhance soil organic matter, nutrient availability, and microbial activity, which support plant growth and nutrient uptake (Duan et al., 2024; Li et al., 2023). These results are consistent with prior studies showing that organic nutrient sources, such as compost teas and manure extracts, enhance plant growth and yield but generally perform best when combined with mineral fertilizers (Ding et al., 2023; El-Kassas et al., 2012).

Table 6. Yield per Plot in Kilograms

Treatment	Mean
T1 – Control (100% RRSA)	21.49^{a}
T2 – 50% RRSA + 400 ml FSM Tea + 20 ml FPJ/plant	16.00^{b}
T3 – 50% RRSA + 350 ml FSM Tea + 20 ml FPJ/plant	18.35^{ab}
T4 – 50% RRSA + 300 ml FSM Tea + 20 ml FPJ/plant	16.41^{b}
T5 – 50% RRSA + 250 ml FSM Tea + 20 ml FPJ/plant	11.82^{c}
F- Result	**
C.V (%)	8.21
$LSD_{0.01}$	3.78

Note: Means with the same letter within a column are not significant.
***** - (P < 0.01), * - (P < 0.05), ^{ns} –not significant***

Computed Yield per Hectare

Across fertilization treatments, computed yield per hectare was significantly influenced by nutrient management strategies. Plants supplied with 100% of the recommended inorganic fertilizer rate (T1) achieved the highest yield (10.75 t/ha), markedly exceeding all other treatments. In contrast, plants receiving only organic amendments (T5) produced the lowest yield (5.92 t/ha). Intermediate treatments (T2–T4), which combined 50% of the recommended rate with varying volumes of fermented inputs, resulted in yields ranging from 8.00 to 9.18 t/ha, demonstrating moderate improvement over T5 but still below the full inorganic control. These results suggest that while organic amendments provide nutrients and bioactive compounds that support plant growth, they cannot fully substitute for complete mineral fertilization in terms of total yield.

A possible correlation among yield parameters was observed, providing additional insight into factors influencing cucumber productivity. For example, longer vine length can support more nodes and flowers, potentially increasing fruit number per plant. The number of fruits, in turn, contributes to total yield; however, individual fruit weight may not increase proportionally due to source–sink limitations, where nutrient availability and assimilate distribution constrain fruit development. Consequently, total fruit weight (marketable yield) reflects the combined effects of fruit number and individual fruit size. These interrelationships highlight how vegetative growth traits, such as vine length, can indirectly affect yield and underscore the importance of integrated nutrient management in optimizing both growth and productivity of cucumber plants.

Table 7. Computed Yield per Hectare (kg)

Treatment	Yield per Hectare
T1 – Control (100% RRSA)	10,745
T2 – 50% RRSA + 400 ml FSM Tea + 20 ml FPJ/plant	8,000
T3 – 50% RRSA + 350 ml FSM Tea + 20 ml FPJ/plant	9,175
T4 – 50% RRSA + 300 ml FSM Tea + 20 ml FPJ/plant	8,205
T5 – 50% RRSA + 250 ml FSM Tea + 20 ml FPJ/plant	5,919

Cost and Return Analysis

The cost and return analysis (Table 8) highlights the economic implications of integrating organic amendments with inorganic fertilizer in cucumber production. Treatment 1 (100% RR) achieved the highest gross income (₱376,075.00 ha^{-1}) and net income (₱183,023.90 ha^{-1}), with a return on investment (ROI) of 94.81%, confirming the profitability of full mineral fertilization. Treatment 3, which combined 50% RR with fermented organic inputs, produced the second-highest net income (₱108,164.45 ha^{-1}) and ROI (50.79%), showing that partial substitution of chemical fertilizers with bio-inputs can reduce production costs while sustaining competitive yields. This aligns with sustainable agriculture principles, wherein economic gains are achieved alongside improved soil health and reduced dependence on synthetic inputs (Jat et al., 2023; Kumar et al., 2022). Conversely, Treatment 5, which relied solely on organic amendments, resulted in the lowest net income (₱27,980.00 ha^{-1}) and ROI (15.64%), indicating that exclusive use of these liquid-based organics is not yet economically feasible under the tested conditions. Similar findings in other horticultural crops demonstrate that integrated nutrient management consistently enhances profitability over purely organic strategies (Gyanwali et al., 2022; Wu et al., 2024; Zhang et al., 2024), reinforcing the role of balanced nutrient integration in achieving both economic and sustainability goals.

Table 8. Cost and Return Analysis

Treatments	Yield/ Hectare (kg)	Gross Income (Php)	Cost of Production (Php)	Net Income (Php)	ROI (%)
T_1	10,745	376,075.00	193,051.10	183,023.90	94.81
T_2	8,000	280,000.00	216,710.55	63,289.45	29.20
T_3	9,175	321,125.00	212,960.55	108,164.45	50.79
T_4	8,205	287,175.00	209,210.55	77,964.45	37.27
T_5	5,919	206,850.00	178,870.00	27,980.00	15.64

Conclusion and Future Works

This study demonstrated that integrating organic amendments, such as fermented sheep manure tea (FSMT) and fermented plant juice (FPJ), with inorganic fertilizers can enhance cucumber (*Cucumis sativus* L.) growth and yield while contributing to soil health and sustainable nutrient management. Among the treatments, T3 showed promising vegetative and reproductive performance; however, its low return on investment (ROI) indicates that it may not be the most economically viable option for farmers. The control treatment (100% recommended inorganic fertilizer) provided the highest ROI, highlighting the importance of considering both productivity and profitability in nutrient management decisions. Overall, combining organic and inorganic inputs through drench application offers a practical and environmentally responsible approach, supporting long-term farm sustainability and providing actionable strategies for smallholder and commercial growers.

Future research may focus on understanding the mechanisms of nutrient-use efficiency under integrated fertilization systems and evaluating the long-term impacts on soil health, microbial dynamics, and fruit quality. Assessing economic feasibility, farmer perception, and adoption barriers will help identify scalable and cost-effective bio-input strategies. Additionally, exploring resilience under variable climatic and production conditions will provide insights for optimizing integrated nutrient management across diverse agroecosystems.

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Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Artificial Intelligence (AI) Declaration Statement

The authors declare that artificial intelligence (AI) tools were used in preparing this manuscript. Specifically, ChatGPT (GPT-5 Mini) assisted in improving clarity, grammar, and overall structure, as well as providing suggestions for phrasing and formatting. The AI was used solely to enhance readability and coherence; all scientific content, data interpretation, conclusions, and recommendations were created and verified exclusively by the authors.