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Develop sustainable coffee-based farming model using cash crops production

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ABSTRACT

The study was conducted February 2022 to March 9, 2023, to determine effects of levels of vermicompost on peanut intercropped in coffee plants. The study aimed to determine the best treatment using the following parameters: growth, yield performance, and Cost and Return Analysis (ROI). The different treatment in the study was: T1- Farmers Practice, T2- RR+700kg of vermicompost/ha, T3- RR+750kg of vermicompost/ha, T4- RR+800kg of vermicompost/ha. and layout in Randomized Complete Block Design (RCBD). Significant results were shown 30 days after planting (DAP) on the height of peanut plants. The number of peanut root nodules at 20, 40 and 60 DAP, T4- RR+800kg of vermicompost/ha obtained highest mean of 25.80 cm, 36.58 cm, and 53.65 cm respectively. While T4- RR+800kg of vermicompost/ha obtained highest number of leaves, and T1- Farmers Practice obtained lowest. The to weight of pods, developed pods, and number of seeds per pod shows that T4- RR+800kg of vermicompost/ha obtained the highest mean. T1- Farmers Practice obtained the lowest number of undeveloped pods with a mean of 10.15g. Moreover, T4- RR+800kg of vermicompost/ha remained the highest yield/ha with a mean of 1,543 kilograms. The application of T4- RR+800kg of vermicompost/ha obtained the highest ROI gaining 259.13%. The study revealed that NSIC Pn 09 applied with different levels of vermicompost as organic fertilizer influenced the plant height, root nodules, leaves, developed and undeveloped pods, seed number and pod weight. While, T4- RR+800kg of vermicompost/ha obtained highest plant height, root nodules, leaves, developed pods, seeds per pod, yield/ ha and ROI.

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INTRODUCTION

The Philippines is home to a diverse range of coffee types, each with their own unique flavor profiles and characteristics. One of the most popular Philippine coffee types is Robusta, which is around 80% of the country's coffee production (Masa, 2023). Coffee contributes more antioxidants to the daily diet than tea, fruit, and veggies combined. After evaluating the popular beverages for bioactive non-nutrient content, the instant coffee was found to have the highest overall biophenol concentration. In two more investigations by Samoggia *et al.* (2019), coffee was shown the highest antioxidant capacity compared to other beverages such as green, black tea, and herbal infusions. The cup of coffee biochemical properties is determined by the degree of roasting, the kind of bean, type of coffee, brewing technique, and grind type (Samoggia *et al.*, 2019).

Coffee was ubiquitous, this ancient product as a medium for a new generation of peaceful conversation, as a symbol of peace. But for this to work, the coffee must be delicious. The procedure of manufacturing high-quality coffee must take place. Such a method may reflect the hard work and patience required to develop excellence in people's lives. A sustainable existence in coffee might provide hope—spiritually, physically, and financially. Coffee has the potential to jolt us awake to the possibility of optimism. However, it takes 2-3 years before the coffee plants bear fruit thus, intercropping systems is essential to farmers in the low-input and environment, where intercropping coffee with legumes have the contribute in addressing problems in climate change and degradation of soil fertility. The main reasons for small farmers to intercrop with legumes were flexibility, increase profit, minimizing risks, soil conservation and soil fertility improvement, pests and disease management, and balanced nutrition (Lusembo *et al.*, 2019). The practice of cover cropping protects the soil surface of the coffee plants to prevent weeds' occurrence, formation of soil layers to prevent soil erosion. It helps improve the soil fertility through organic matter and nutrients from managing vegetation (Alcantara *et al.*, 2009).

The cultivation of perennial legumes in cropping systems, this serves as a green manuring (Favero *et al.*, 2001), tolerate drought (Pacheco *et al.*, 2008), and capable of regenerating, unlike with other crops (Espindola *et al.*, 2006).

The peanuts are nuts and categorized under the legume family. It originates in South America known as *Arachis hypogea* L. other terms such as ground nuts, earth nuts, and goobers. It is an important food crop around the world due to its economic importance such as oil, flour, peanut butter, roasted whole peanuts and source of magnesium, folate, vitamin E, copper, and arginine (Atli Arnarson, 2023). It was recorded as the top important commodity in the world in terms of oil, and protein sources (Taru *et al.*, 2008; Sorrensen *et al.*, 2004).

This crop is commercially for oil production that contains many functional compounds like proteins, fibers, polyphenols, antioxidants, vitamins, and minerals that are added into processed foods. Recently, peanuts revealed as a source of compounds such as resveratrol, phenolic acids, flavonoids, and phytosterols which block the absorption of cholesterol from the diet. Additionally, it is a good source of co-enzyme Q10 which contains 20 amino acids, and with the highest amount of arginine. These bioactive compounds are recognized for having disease-preventive properties and promoting longevity. The processing methods of peanuts are through roasting and boiling could achieve higher amount of bioactive compounds Arya *et al.* (2015).

The country of China and India is recorded as the largest consumers and exporters of peanuts in the world, with a 36.0% of the global consumption. As a result, peanut consumption increased in Senegal at the rate of 12.0% during 2016-2018 (industry-reports/peanuts-market 2019). Meanwhile, peanut production in the Philippines as of 2019 is equivalent to 29,300.78 metric tons (PSA, 2020). However, the country is importing dependent with 75%. Therefore, Philippines is 25% self-sufficient, indicating that there is inadequate supply of production to meet the demand of the population.

The peanuts market is projected to register a CAGR (compound annual growth rate) of 4.5% during the 2021-2026 forecast period. Due to COVID-19 pandemic, the peanut exporting countries have encountered difficulties meeting the demand with the decline in importing countries amid the lockdown. However, the peanut demand has returned to pre-COVID-19 levels and is expected to increase during the forecast period, as exporters are experiencing demand from Southeast Asian countries and the European region.

Organic fertilizers application derives different benefits for the soil, which includes healthier soil, increase soil fertility, reduce soil acidity, prevent leaching, improve soil structure, circulation of air, and increase the population of beneficial microorganisms that help release nutrients to the soil (Culbreath, 2004). Vermicompost is the product of decomposing with worms, usually red wigglers, white worms, african night crawler, and other earthworms, which decompose plant residue, food waste, bedding materials, and vermicast (https://www.wikipedia.org/).

Peanut growers wanted to harness the benefits of vermicompost as organic fertilizer, but levels of its application are uncertain. Thus, the study had conducted to evaluate the efficacy of using vermicompost on peanut (NSIC Pn 9) based on different levels of application intercropped in coffee production. Generally, the study was conducted to evaluate the different levels of vermicompost on the peanut's growth and yield performance intercropped in the coffee plants. Specifically, it aimed to determine the following: (a) the plant height of peanut at 30, 60, and 90 days after planting; (b) the number of root nodules at 20, 40, and 60 days after planting; (c) number of leaves at 30, 60, and 90 days after planting; (d) number of developed pods; (e) number of undeveloped pods; (f) number of seeds per pod; and (g) Cost and Return Analysis (ROI).

MATERIALS AND METHODS

The peanut seed (NSIC Pn 09) was secured at Cagayan Valley Research Center, Ilagan, Isabela. The liberica and excelsa coffee seeds were purchased at the National Coffee Research Development and Extension Center (NCRDEC), Cavite State University, Cavite.

Experimental design and treatments

The data was investigated through Analysis of Variance (ANOVA) of the Randomized Complete Block Design, with the Statistical Tool for Agricultural Research (STAR) Software.

Treatments:

T_1- Farmers practice

T_2- RR+700 kg of vermicompost per hectare

T_3-RR+750 kg of vermicompost per hectare

T_4-RR+800 kg of vermicompost per hectare

Soil sampling and analysis

Soil samples were collected at the four (4) sides and center of the experimental area. After which, the collected soil is pulverized, the inert matter was removed, and air-dried. Then one (1) kilogram of composite soil sample was submitted to the Department of Agriculture (CVIAL) for analysis.

Soil media preparation for coffee seedlings

The soil medium used in the propagation of coffee is a 1:1:1 ratio (garden soil, compost, and manure) using a polyethylene bag measuring 3×3×12 with 1 kg of soil per pot.

Land preparation

The areas for the establishment of coffee as well as the study were initially plowed and harrowed using a rotavator and an animal-drawn plow. The area was rest for two (2) weeks to allow weeds to germinate and decay before the final harrowing. Final harrowing were done by using the animal-drawn plow, this was implemented prior planting until the soil had been thoroughly pulverized. Staking and layout were employed to ensure the population density and the desired planting distance of 4 × 4 meters between hill and rows.

Establishment of the 3 coffee types

After 8 months of the coffee seedling age, manual transplanting was done on the three coffee types,

namely robusta, excelsa, and liberica, following the 4x4 distance of 0.6 hectare and subdivided into 3 parts per coffee type in the newly established area.

Planting of peanut

Planting of peanut in the robusta coffee. The seeds were planted in the furrows at twenty-five (25) cm between hills and fifty (50) cm between rows. Manual planting using the drill method with four (4) seeds per hill, and thinning one (1) week after seed emergence, leaving two (2) plants per hill in the first location, which is the robusta coffee type.

Fertilizer application

Inorganic fertilizer applications is based on the recommended rate of the soil analysis (25-20-0 NPK). The vermicompost and inorganic fertilizer application based on the imposed treatments: T_1-Farmers practice; T_2: RR + 700 kg of vermicompost per ha; T_3: RR + 750 kg of vermicompost per ha; T_4: RR + 800 kg of vermicompost per ha) applied evenly along the furrows as basal.

Plant care and management

Hilling-up at 18 days after planting to prevent the plants from excessive moisture and to control weeds. The occurrence of insect pests is controlled by spraying biopesticide. And regular watering of the plants through manual procedure.

Harvesting

Sample plants were harvested manually by using a shovel. Caring of the plants to avoid dropping pods.

Post-production practices

The newly harvested peanut was aerated and dried in the field by handpick or strip/thresh pods from the vine by beating. Picking was done in such a way that the peduncle does not go with the pod. The harvested peanuts were shelled manually to avoid scratching, splitting, and rupturing of the seed coat, breaking of the cotyledon, or separating one or both of the cotyledons from the embryonic axis. After shelling, the peanut was cleaned and sorted manually.

Data gathered

NPK content of the soil before planting

A composite soil sample was randomly collected before land preparation and after harvesting peanut plants. A kilogram of soil sample is submitted to the Regional Soil Laboratory, Tuguegarao City, Cagayan (DA-CVIAL) for analysis.

Growth and yield parameters

a. Plant height NSIC Pn 09 at 30, 60, and 90 days after planting of peanut intercropped in robusta coffee plant: The plant height of the ten randomly selected plants was measured from the base of the plant up to the tip of the meristem by using a meter stick at 30, 60, and 90 days after planting.

b. Number of root nodules NSIC Pn 09 at 20, 40, and 60 Days after Planting of peanut intercropped in robusta coffee plant: Three (3) sample plants each plot was carefully dug, and roots are washed through a fine sieve with water to remove soil particles and organic debris. Nodules were counted manually.

c. Number of leaves NSIC Pn 09 per plant at 30, 60, and 90 days after planting intercropped in robusta coffee plant: The leaves of three (3) sample plants were counted and recorded at 30, 60, and 90 days after planting.

d. Number of developed and undeveloped pods NSIC Pn 09 intercropped in robusta coffee plant: After harvesting the developed and undeveloped pods per plant are counted and recorded.

e. Number of NSIC Pn 09 seeds intercropped in robusta coffee plant: The sample pods were randomly selected and manually recorded the number of seeds per pod.

f. Pod of NSIC Pn 09 Yield per Hectare intercropped in robusta coffee: The yield per hectare is computed based on the formula below:

Yield per hectare= [{Pod yield/Sampling area (kg)}/{Sampling area (m^2)}]×10,000 m^2

g. Cost and return analysis: This were computed by dividing net income with cost of production multiplied by 100.

ROI (%)=(Net income/Total costs of production)×100

RESULTS AND DISCUSSION

Plant height (cm) at 30, 60, and 90 days after planting (DAP) peanuts intercropped in robusta coffee plant

Table 1 shows the plant height at 30, 60, and 90 days after planting peanut intercropped with robusta coffee. The data showed that there was a **s**ignificant difference obtained at plant height 30 days after planting of peanuts. Based on the analysis of variance, T4-RR+800 kg of vermicompost per hectare obtained the highest means of 19.02 cm. However, T3-RR+750 kg of vermicompost per hectare and T2-RR+700 kg of vermicompost per hectare had a comparable result to T1-Farmers Practice (No fertilizer application). Insignificant results were obtained at 60 and 90 days after planting, wherein T4-RR+800 kg of vermicompost per hectare had the highest mean of 27.92 cm and T1-Farmers Practice (No fertilizer application) obtained the lowest means of 25.27 cm. As to the 90 days after planting, T4-RR+800 kg of vermicompost per hectare obtained the highest mean of 29.82, followed by T3-RR+750 kg of vermicompost per hectare, T2-RR+700 kg of vermicompost per hectare, and T1-Farmers Practice (No fertilizer application) with a mean of 28.45 cm, 28.25 cm, and 27.65 cm, respectively.

Table 1. Plant height (cm) of NSIC Pn 09 at 30, 60, and 90 days after planting (DAP) of peanuts intercropped in robusta coffee plant applied with different levels of vermicompost as organic fertilizer

Treatments	Plant height (cm)		
	30 DAP	60 DAP	90 DAP
T1	12.18c	25.27	27.65
T2	16.05b	25.72	28.25
T3	17.07ab	26.10	28.45
T4	19.02a	26.10	28.45
Statistical inference	Significant	Not sig.	Not sig.
CV (%)	10.28	7.61	6.71

Note: T1= Farmers' practice; T2= RR + 700 kg vermicompost ha^{-1}; T3= RR + 750 kg vermicompost ha^{-1}; T4= RR + 800 kg vermicompost ha^{-1}.

Number of root nodules 20, 40, and 60 days after planting (DAP) of peanuts intercropped in robusta coffee plant

Table 2 shows the number of root nodules at 20, 40, and 60 days after planting of peanut intercropped in robusta coffee plant. The data discovered that a were significant differences in the root nodules at 20, 40, and 60 days after planting (DAP) of peanuts intercropped in robusta coffee plant. In 20 days after planting (DAP), T_4-RR of the soil analysis + 800 kg of vermicompost/ha obtained the highest number or root nodules with a mean of 25.80 cm; however, T_3-RR of the soil analysis + 750 kg of vermicompost/ha had comparable effects to T2-RR of the soil analysis + 700 kg of vermicompost/ha with a mean of 23.98 cm and 19.43 cm, and T2-RR of the soil analysis + 700 kg of vermicompost/ha had comparable effects to T1-Farmers Practice with a mean of 13.95 cm, respectively.

Table 2. Number of root nodules NSIC Pn 09 20, 40, and 60 days after planting intercropped in robusta coffee plant applied with different levels of vermicompost as organic fertilizer

Treatments	Root nodules (cm)		
	30 DAP	60 DAP	90 DAP
T1	13.95d	20.95b	39.10b
T2	19.43c	25.07b	41.47b
T3	23.98b	35.17a	49.04a
T4	25.80a	36.58a	53.65a
Statistical inference	Significant	Significant	Significant
CV (%)	2.52	15.74	10.05

Note: T1= Farmers' practice; T2= RR + 700 kg vermicompost ha^{-1}; T3= RR + 750 kg vermicompost ha^{-1}; T4= RR + 800 kg vermicompost ha^{-1}.

At 40 days after planting, T4-RR+800 kg of vermicompost obtained highest number of root nodules with mean of 36.58 cm, followed by T3-RR+750 kg of vermicompost per hectare with a mean of 36.17 cm, T2-RR+700 kg of vermicompost per hectare with a mean of 25.07 cm, and T1-Farmers Practice with a mean of 20.95 cm as the lowest. And on the 60 days after planting, T4-RR+800 kg of vermicompost remained highest number root nodules with mean of 53.65 cm, and T1-Farmers Practice obtained the lowest number of root nodules with a

mean of 39.10 cm. Analysis of Variance (ANOVA) showed significant results on 20, 40, and 60 days after planting.

According to a research study titled "Effects of vermicompost on growth and yield of groundnut," the highest nodule number of groundnut/peanut was observed in 200 g of vermicompost application when compared to control as well as with other treatments (Mathivanan *et al.*, 2012). The rhizobia and vermicompost that were applied to peanut plants have a significant role, a development of root nodules that fixed nitrogen to the soil (Fernandez, 2020).

Number of leaves at 30, 60, and 90 days of planting of peanuts intercropped with robusta coffee plant

Table 3 shows the number of leaves at 30, 60, and 90 days of planting peanuts intercropped in robusta coffee plant. Based on analysis of variance, it revealed a significant difference at 30, 60, and 90 days after planting (DAP) of peanuts intercropped in robusta coffee plant, as presented below. As shown on Table 3, T_4-RR of the soil analysis + 800 kg Vermicompost/ha obtained most number of leaves with a mean of 33.93 cm. However, it was comparable to T_3-RR+750 kg of vermicompost per hectare, T_2-RR+700 kg of vermicompost per hectare, and T1-Farmers Practice with a mean of 30.73 cm, 25.90 cm, and 24.77 cm, correspondingly. Highly significant results were obtained 60 days after planting. Wherein T_4-RR of the soil analysis + 800 kg Vermicompost/ha obtained the highest number of leaves with a mean 72.28 cm, followed by T_3-RR+750 kg of vermicompost per hectare, T_2-RR+700 kg of vermicompost per hectare, and T_1-Farmers Practice with a 48.5 cm.

Analysis of variance showed significant results from 30 to 90 days after planting. According to Suthar *et al.* (2005), Mathivanan *et al.* (2012), and Getnet and Raja (2013), application of vermicompost increases growth and productivity of plants due to higher nutrient value, while increasing soil microbial activity and organic carbon to the soil.

In accordance with the study of Fernandez, 2020, where the recommended rate combined with the application rate of vermicompost influenced a lot the numbers of leaves to the plants.

Table 3. Number of leaves NSIC Pn 09 30, 60, and 90 DAP intercropped with robusta coffee plant applied with different levels of vermicompost as organic fertilizer

Treatments	Number of leaves (cm)		
	30 DAP	60 DAP	90 DAP
T1	24.77b	48.54c	53.70c
T2	25.90b	51.23c	55.95b
T3	30.73a	58.35b	56.95b
T4	33.93a	72.28a	64.53a
Statistical inference	Significant	Significant	Significant
CV (%)	8.33	6.04	2.11

Note: T1 = Farmers' practice; T2 = RR + 700 kg vermicompost ha^{-1}; T3 = RR + 750 kg vermicompost ha^{-1}; T4 = RR + 800 kg vermicompost ha^{-1}.

Number of developed and undeveloped pods per treatment of peanut intercropped in robusta coffee plant

Table 4 shows the number of developed and undeveloped pods per treatment of peanut intercropped in robusta coffee plant. Based on the gathered data, there are no significant differences to number of developed pods per treatment. Based on Analysis of Variance (ANOVA), T_4-RR of the soil analysis + 800 kg of vermicompost/ha had the highest number in terms of the developed pods with a mean of 42.58 g. T_3-RR of the soil analysis + 750 kg of vermicompost/ha with a mean of 61.23 g had 41.58, T_2-RR of the soil analysis +700 kg of vermicompost/ha obtained with a mean of 41.18 g, and T_1-Farmers Practice obtained the lowest mean of 40.23 g, respectively.

The number of undeveloped pods, the result revealed insignificant differences among treatments. It showed that T_1-farmers practice had the highest mean of 8.30 g, followed by T_4-RR of the soil analysis + 800 kg of vermicompost/ha with a mean of 7.47 g, T_2-RR of the soil analysis + 700 kg of vermicompost/ha 6.72 g, and T_3-RR of the soil analysis + 750 kg of vermicompost/ha obtained the lowest with a mean of 5.92 g, respectively.

Table 4. Number of developed and undeveloped pods NSIC Pn 09 after harvesting, applied with different levels of vermicompost as organic fertilizer

Treatments	Number develop pods	Number undeveloped pods
T1	40.23	8.30
T2	41.18	6.72
T3	41.58	5.92
T4	42.58	7.47
Statistical inference	Not sig.	Not sig.
CV (%)	11.41	22.63

Note: T1= Farmers' practice; T2= RR + 700 kg vermicompost ha^{-1}; T3= RR + 750 kg vermicompost ha^{-1}; T4= RR + 800 kg vermicompost ha^{-1}.

Average number of seeds per treatment

Table 5 shows the average seeds per treatment. Based on analysis of variance, showed a significant difference on the number of seeds per treatment. The most numbered seeds were obtained at T_4- RR +750 kg of vermicompost/ha with mean of 68.70 g, followed by T_3-RR +750 kg of vermicompost/ha, T2-RR +700 kg of vermicompost/ha, and T_1-Farmers Practice with means of 65.80 g, 63.55 g, and 61. 75g respectively. The study conforms to the study of Fernandez, 2020, that proper fertilization really affects the number of seeds per sample plant to get a higher number of seeds.

Table 5. Average number of seeds NSIC Pn 09 per plant after harvesting

Treatments	Average number of seeds per treatment
T1	61. 75b
T2	63.55b
T3	65.80ab
T4	68.70a
Statistical inference	Significant
CV (%)	4.39

Note: T1= Farmers' practice; T2= RR + 700 kg vermicompost ha^{-1}; T3= RR + 750 kg vermicompost ha^{-1}; T4= RR + 800 kg vermicompost ha^{-1}.

Yield per hectare (kg)

Table 6 shows the yield per hectare (kg) NSIC Pn 09 intercropped in robusta coffee plant as influenced by the different levels of vermicompost as organic fertilizer. The yield of NSIC Pn9 per treatment is organized in a descending order: T_4-RR +750 kg of vermicompost/ha with 1,543 kg (1.5 tons), T_3-RR +7 50 kg of vermicompost/ha with 1,222 kilograms (1.2 tons), T_2-RR+700 kg of vermicompost/ha with 1,136 kilograms (1.1 tons), and T_1- Farmers Practice with 906 kg (0.9 tons). While, T_4- RR+800kg of vermicompost/ha had the highest yield per hectare because of the effect of a higher level of application of vermicompost as organic fertilizer in the peanut plants.

Table 6. Yield per hectare NSIC Pn 09 as influenced by different levels of vermicompost as organic fertilizer intercropped in coffee plant

Treatment	Yield per hectare	
	(kg)	Tons
T1	906	.09
T2	1,136	1.13
T3	1,222	1.22
T4	1,543	1.29

Note: T1= Farmers' practice; T2= RR + 700 kg vermicompost ha^{-1}; T3= RR + 750 kg vermicompost ha^{-1}; T4= RR + 800 kg vermicompost ha^{-1}.

Cost and return analysis (ROI)

The Table 7, shows the Return on Investment (ROI) of peanut per treatment. Based on the analysis T_4 – RR+800kg of vermicompost/ha obtained the highest ROI with 259.13%, followed by T_1 – No fertilizer application with 210.88%, T_3 – RR of the soil analysis +750kg of vermicompost/ha with 190.95%, and T_2 – RR+700kg of vermicompost/ha obtained the least ROI with 175.15% respectively.

Table 7. Cost and Return Analysis NSIC Pn 09 as influenced by different levels of vermicompost as organic fertilizer.

Treatments	Yield /Ha	Cost of production	Net income	ROI
T1	906	20,400	43,50620	210.88
T2	1136	28,900	50,620	175.15
T3	1222	29,400	56	190.95
T4	1543	29,900	56,140	259.13

Note: T1= Farmers' practice; T2= RR + 700 kg vermicompost ha^{-1}; T3= RR + 750 kg vermicompost ha^{-1}; T4= RR + 800 kg vermicompost ha^{-1}.

The application of vermicompost in T_4– RR+800kg of vermicompost/ha obtained the highest return on investment due to the effect of higher level of application of vermicompost as organic fertilizer in peanut plants. This simply means that in every peso inverted in the project, there was a

corresponding return of two (2) pesos and fifthy nine (59) centavos.

CONCLUSION

The study evaluated the effects of different levels of vermicompost as an organic fertilizer on the growth, yield, and profitability of peanut (NSIC Pn 09) intercropped in coffee production under Cagayan State University conditions. The results clearly demonstrated that vermicompost application significantly influenced several agronomic and yield-related parameters of peanut plants.

Although plant height at 60 and 90 days after planting (DAP) did not show significant differences among treatments, the application of vermicompost notably improved root nodulation, leaf production, and yield components. The highest number of root nodules was consistently recorded in Treatment 4 (RR + 800 kg vermicompost/ha), while the farmers' practice produced the lowest. Similarly, Treatment 4 resulted in the highest number of leaves, developed pods, pod weight, average number of seeds, and overall yield per hectare. In contrast, the farmers' practice showed the highest number of undeveloped pods.

Among all treatments, RR + 800 kg vermicompost per hectare (Treatment 4) produced the highest yield, reaching 1,543 kg ha^{-1} (1.5 tons), and achieved the greatest economic return with a return on investment (ROI) of 259.13%. These results indicate that higher rates of vermicompost application enhanced soil conditions, promoted better nutrient uptake, and improved overall crop performance.

Based on the findings, the application of RR + 800 kg vermicompost per hectare is highly recommended for NSIC Pn 09 peanut production when intercropped with coffee. Furthermore, future studies are recommended to validate these results using other NSIC peanut varieties and under different agroecological conditions to further strengthen recommendations for sustainable peanut–coffee intercropping systems.

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