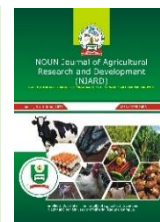




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Original Article

Economic and Yield Performance of Cucumber Production under Organic and Inorganic Manure Systems among Smallholder Farmers in Kaduna State, Nigeria

Esheya S. E¹, Kaine A. N¹., Idenyi E. O²., Obazi S. A³

¹Department of Agricultural Economics and Extension, National Open University of Nigeria

²Department of Agricultural Education, Vocational and Technical Education, Alex Ekwueme Federal University, Ndufu-Alike Ikwo

³Department of Agricultural Extension, University of Nigeria Nsukka

Corresponding author: Email: sesheya@noun.edu.ng, Phone No: 07083372428



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Abstract

Cucumber (*Cucumis sativus*) production is gaining prominence among smallholder farmers in Kaduna State, Nigeria, due to favorable agro-ecological conditions, increasing urban demand, and its short production cycle. However, rising costs of inorganic fertilizers and declining soil fertility pose serious challenges to profitability. This study examined economic and yield performance of cucumber production under organic and inorganic manure systems among smallholder farmers in Kaduna state, Nigeria. Five local government areas were purposively selected for this study using a sample size of one hundred respondents. Data on input costs, yields, and output prices were analyzed using descriptive statistics, gross margin analysis, net farm income, cost-benefit ratio (CBR), and analysis of variance. The findings reveal significant differences in production costs and profitability between manure types. The result indicates that cucumber production under inorganic manure generated higher output per hectare (21,000 kg) than production under organic manure (18,500 kg). A CBR of 11.77 for organic manure implies that every ₦1 invested generated about ₦11.77 in returns; while a CBR of 13.91 for inorganic manure indicates that every ₦1 invested yielded approximately ₦13.91 in returns. This confirms that both manure systems have $CBR > 1$, indicating profitability, but inorganic manure production was more economically efficient and generated higher returns on investment. The study recommends integrated nutrient management practices to enhance profitability and ensure sustainable cucumber production in Kaduna State, Nigeria.

Keywords: Input utilization, Farm income, Resource efficiency, Sustainable agriculture, Cost-benefit analysis

INTRODUCTION

A substantial portion of the population of Kaduna State makes their living from agriculture, which also greatly contributes to the food supply in northern Nigeria. Vegetable production is supported year-round by the state's abundant irrigation resources, including the Kubanni and Galma river systems, fertile soils, and moderate rainfall (Kaduna Agricultural Development Programme [KADP], 2021). In Kaduna State, cucumber (*Cucumis sativus*) has become a

significant vegetable crop, especially in local government areas like Zaria, Igabi, Giwa, and Chikun. The crop is preferred due to its short maturity time, high market demand in cities like Zaria and Kaduna metropolis, and its ability to generate revenue for smallholder farmers [National Agricultural Extension and Research Liaison Services [NAERLS], 2020). Despite its importance, Nigeria's average cucumber output is just 8-10 tonnes per hectare, far less than the potential yield of 25-30 tonnes per hectare under



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ideal management conditions (Food and Agriculture Organization [FAO], 2021). Numerous factors, including insect and disease infestations, inadequate irrigation, reliance on low-yielding varieties, and most importantly, declining soil fertility, are blamed for the yield difference (Olabode et al., 2019). Controlling soil fertility remains a significant challenge in cucumber farming. Farmers in Kaduna State primarily employ inorganic fertilizers due to their rapid nutrient availability and yield response. However, because of their growing cost, erratic supply, and concerns about soil damage, small-scale farmers today have less access to inorganic fertilizers (National Bureau of Statistics [NBS], 2022). This is due to the predominance of mixed crop-livestock agricultural systems in Kaduna State, which makes organic manure—such as compost, cattle dung, and poultry droppings—easily accessible. Organic manure improves soil structure, microbial activity, and long-term soil fertility. Despite these advantages, its application is restricted by bulkiness, transportation costs, and delayed nutritional release (Ojeniyi, 2018).

Growers of cucumbers in Kaduna State must contend with growing production costs, declining soil fertility, and unpredictable profit margins. Due to supply chain problems and declining subsidies, smallholder farmers are no longer able to afford the rising costs of inorganic fertilizers (NBS, 2022). Because of this, a lot of farmers either utilize unproven alternatives or underapply fertilizer, which reduces yields and profitability. Despite the fact that organic manure is readily available, especially from poultry and cattle enterprises, farmers in Kaduna State do not have enough economic knowledge about how profitable it is compared to chemical fertilizer (Adamu & Esheya, 2020). Although many agronomic studies on fertilizer response in vegetable crops in northern Nigeria have been conducted, there is little to no empirical data comparing the economic performance of organic and inorganic manure in cucumber production in Kaduna State. The impact of fertilizer application on carrot production in Samaru, Northern Nigeria, was examined in a paper published by Cambridge University Press. The study discovered that whereas potassium had little effect and phosphorus responded inconsistently, nitrogen fertilizer greatly enhanced carrot yield. The study also found that farmers in Northern Nigeria might make money from irrigated dry-season carrot

farming (Green, 2008). An investigation of the effects of poultry manure and NPK fertilizer on okra productivity was carried out in Nigeria's Northern Sudan Savanna. The results of the experiment showed that applying poultry manure and inorganic fertilizer together greatly increased plant growth, fruit yield, and overall productivity. In comparison to unfertilized plots, higher yields were achieved at moderate fertilizer rates (Muhammad et al., 2020). Garden cress's reaction to varying fertilizer rates, watering intervals, and sowing techniques was studied at Ahmadu Bello University. The results demonstrated a considerable increase in leaf production, plant height, branching, and vegetable output when NPK fertilizer was applied at a ratio of 60:60:60 kg ha⁻¹. For maximum yield, the study suggested a drilling technique and frequent irrigation in addition to fertilizer application (Mohammed et al., 2018).

Fertilizer users produced more vegetables and had larger profit margins than non-users, according to a study on the economics of fertilizer use in vegetable production. According to the study's findings, fertilizer application improved vegetable farmers' technical productivity and farm income (Ohajianya & Onu, 2004). The majority of decisions about the use of manure rely on perception rather than factual cost-benefit analysis. For example, a study of arable crop farmers in Taraba State's Jalingo Local Government Area looked at how they felt about using organic manure. The results showed that farmers thought organic manure would increase crop productivity and soil fertility. Farmers' acceptance and use of manure in crop production were positively impacted by extension contact and educational attainment (Usman et al., 2016). Once more, a study on the socioeconomics of organic manure farming in Benue State discovered that farmyard manure was widely used by farmers due to its believed capacity to preserve soil fertility and increase crop yield. The study highlighted that the degree of manure adoption in crop production systems was influenced by farmers' perceptions and understanding of manure management (Oluwatosin & Ogunkanmi, 2020). Due to a lack of location-specific economic research, farmers have been unable to make educated judgments about the usage of inputs, which has led to inefficient resource allocation. This study bridges this gap by using a comparative cost-benefit analysis to guide legislators, farmers, and



extension agents toward more sustainable and efficient nutrient management strategies. Therefore, a comparative cost-benefit analysis of the use of organic and inorganic manure in cucumber production in Kaduna state is necessary to determine the most profitable and sustainable option for farmers. The specific objectives of the study were to: calculate the gross margin and net farm income from cucumber production under different manure types; compare the yield of cucumbers obtained from applying organic and inorganic manure; estimate the cost of cucumber production per hectare under organic and inorganic manure use; analyze the cost-benefit ratio of cucumber production using organic and inorganic manure; and assess the profitability implications of manure choice among cucumber farmers in Kaduna State, Nigeria.

MATERIAL AND MEHODS

The study was carried out in Kaduna State, Nigeria, which is situated between latitudes 9°02'N and 11°32'N and longitudes 6°15'E and 8°38'E. The state has a tropical continental climate with distinct wet and dry seasons, an average annual rainfall of 1,000 to 1,500 mm, and mean temperatures between 25°C and 35°C. Kaduna State is a highly diverse population that is administratively divided into 23 Local Government Areas (LGAs): Kaduna North, Kaduna South, Zaria, Sabon Gari, Kafanchan, Zangon Kataf, Ikara, Giwa, Soba, Birnin Gwari, among others. With undulating plains, highlands, and river valleys, Kaduna State shares borders with the following states: Kano and Katsina States to the north, Zamfara State to the northwest, Niger State to the west, Federal Capital Territory (Abuja) to the southwest, Nasarawa State to the southeast, and Plateau State to the east. The state has a tropical continental climate with two distinct seasons: Rainy season: April to October Dry season: November to March Rainfall decreases from the southern part of the state (KADP, 2021). Wide savannah grasslands can be found in Kaduna's northern regions, whereas more vegetation can be found in its southern regions. The most important river draining Kaduna State is the River Kaduna, a major tributary of the River Niger. Other rivers that support agriculture and household water use are the Galma, Gurara, and Wonderful rivers (Adamu et al., 2023). Five Local Government Areas (LGAs) with irrigation systems and a reputation for intensive vegetable

production were the focus of the investigation. These LGAs include Zaria, Igabi, Giwa, Chikun, and Sabon Gari. These areas were picked due to their abundance of cucumber producers, proximity to urban markets, and availability of both organic and inorganic manure. The study used on-farm productivity data in conjunction with a cross-sectional survey design.

Cucumber producers utilizing various types of manure during the same production season may provide quantifiable data on input use, output levels, and expenses thanks to this approach. The design is appropriate for comparing the profitability of various manure treatments and conducting economic analyses. The study's participants were all cucumber growers in the Zaria, Igabi, Giwa, Chikun, and Sabon Gari LGAs of Kaduna State. Most of these farmers are smallholder farmers who use rain-fed agriculture and irrigation during the dry season.

For the investigation, a multi-stage sampling technique was used: Stage I: Based on their predominance in cucumber production, five LGAs (Zaria, Igabi, Giwa, Chikun, and Sabon Gari) were specifically chosen. Stage II: Two cucumber-producing communities were randomly chosen from each of the selected L.G.A to obtain a total of ten communities. Stage III: Ten cucumber producers were chosen at random from each neighborhood, yielding a sample size of 100 respondents. For statistical testing and comparative cost-benefit analysis, this sample size was deemed sufficient.

Model specification: Data collected were analyzed using the following techniques:

- **Descriptive statistics** such as frequencies, means, and percentages were used to describe the socio-economic characteristics of respondents and input-use patterns.
- **Gross Margin Analysis**
[GM = TR - TVC]
- **Net Farm Income (NFI)**
[NFI = TR - TC]
- **Cost-Benefit Ratio (CBR)**
[CBR = TR/TC]
- **Analysis of Variance (ANOVA)**
ANOVA was used to test for significant differences in yield and profitability between manure types across the five LGAs at the 5% level of significance.



- The implicit economic model for profitability analysis is expressed as:
 - $[P_i = f(M, L, C, Y)]$
- Where:
- (P_i) = Profit per hectare
 (M) = Manure type (organic or inorganic)
 (L) = Labour input
 (C) = Cost of inputs
 (Y) = Yield of cucumber

Table 1: Mapping of Objectives to Analytical Tools

S/N	Specific Objective	Variable	Analytical Tool
1	Determine cost of cucumber production per hectare under organic and inorganic manure	Cost of inputs, labour, manure	Descriptive statistics
2	Compare yield of cucumber under different manure types	Yield (kg/ha)	Descriptive statistics, ANOVA
3	Estimate gross margin and net farm income	Revenue, variable & total cost	Gross margin & NFI analysis
4.	Analyze cost–benefit ratio	Total revenue, total cost	Cost–Benefit Ratio

RESULTS AND DISCUSSIONS

The results and analysis of the study "an assessment of the profitability of cucumber production by smallholder farmers using different manures in Kaduna state, Nigeria" are presented in this chapter. Data gathered from 100 respondents selected from the study area served as the basis for the analysis. In keeping with the goals of the study, descriptive and inferential statistics were used to show the findings.

Table 2: Average Cost of Cucumber Production per Hectare by Manure Type (₦)

Cost Items	Organic Manure Quantity	Organic Manure Unit Cost (₦)	Organic Manure Total Cost (₦)	Inorganic Manure Quantity	Inorganic Manure Unit Cost (₦)	Inorganic Manure Total Cost (₦)
Seeds	20 kg	950	19,000	20 kg	950	19,000
Manure/Fertilizer	50 bags	650	32,500	10 bags	5,500	55,000
Labour	17 man-days	5,000	85,000	15 man-days	5,000	75,000
Agrochemicals	11 litres	2,000	22,000	11 litres	2,000	22,000
Transportation	6 trips	3,000	18,000	5 trips	3,000	15,000
Miscellaneous	5 units	2,000	10,000	5 units	2,000	10,000
Total Cost (TC)	—	—	185,500	—	—	195,000

Source: Field Survey, 2025.

Cost of Cucumber Production per Hectare

A comparison of the costs associated with using organic and inorganic manure in cucumber production is shown in Table 2. Quantities used, unit costs, and overall production costs under each treatment are the basis for the comparison. According to the results, the organic manure treatment had a total production cost of ₦185,500, whereas the inorganic manure treatment had a slightly higher total cost of ₦195,000. This suggests that using organic manure for production was comparatively less expensive than using inorganic manure. Both treatments used the same amount of seeds (20 kg)

at the same unit cost of ₦950 per kilogram, for a total seed cost of ₦19,000. This implies that the difference in overall production costs between the two treatments was not caused by seed input. The manure/fertilizer component showed a significant difference. At a cost of ₦650 per bag, the organic manure treatment required 50 bags, totaling ₦32,500. The inorganic manure treatment, on the other hand, only required 10 bags, but each bag cost ₦5,500, making the total cost of fertilizer ₦55,000. This suggests that inorganic fertilizer is more costly even if less is needed, probably because chemical fertilizers have higher market prices and manufacturing expenses. Additionally, the organic manure



treatment had a greater labor cost (₦85,000) than the inorganic manure treatment (₦75,000). Because organic materials are large and take more work to handle, transport, and apply in the field, applying organic manure may involve more labor. For both treatments, the cost of agrochemicals stayed around ₦22,000, indicating similar usage levels and management strategies for weed and pest control. In a similar vein, miscellaneous costs were ₦10,000 for both treatments. Compared to the inorganic manure treatment (₦15,000), the organic manure treatment had a higher transportation cost (₦18,000). This could be because organic manure is bulkier and has a higher volume, necessitating

additional handling and transportation trips. These results imply that the total production cost of organic manure is cheaper than that of inorganic manure, despite the fact that it requires more labor and transportation inputs. Therefore, the outcome suggests that organic manure might be a more economical option for farmers, particularly in areas where organic materials are readily available and labor is reasonably priced. Additionally, whereas synthetic fertilizers offer rapid nutrient release at a comparatively greater cost, the application of organic manure can increase soil health and environmental sustainability.

Table 3: Average Cucumber Yield per Hectare by Manure Type

Variables	Organic Manure	Inorganic Manure
Quantity Produced per Hectare (kg)	18,500	21,000
Price per kg (₦)	2,500	2,500
Total Revenue (TR) (₦)	46,250,000	52,500,000

Source: Field Survey, 2025.

Computation

For Organic Manure:

$$[TR = 18,500 \times 2,500]$$

$$TR = 46,250,000$$

For Inorganic Manure:

$$[TR = 21,000 \times 2,500]$$

$$TR = 52,500,000$$

Yield of Cucumber Per Hectare

According to the results, cucumber cultivation using inorganic manure produced more per hectare (21,000 kg) than production using organic manure (18,500 kg). As a result, the total revenue from applying inorganic manure was ₦52,500,000 as opposed to ₦46,250,000 from applying organic manure. The quicker crop response and nutrient availability linked to chemical fertilizers may be the cause of the increased yield observed under inorganic manure. Inorganic fertilizers offer easily soluble nutrients that improve fruit development, flowering, and vegetative growth, increasing marketable yield. Despite having a comparatively lower output, the organic manure treatment nevertheless brought in a sizable sum of money. Long-term soil fertility,

microbial activity, water retention, and soil structure are all enhanced by organic manure, which may eventually maintain production. Additionally, because consumers are becoming more interested in eco-friendly and chemical-free goods, organic cucumber production may command higher prices in niche markets. According to this study, cucumber yields under optimal agronomic methods ranged from 15 to 21 tonnes per hectare in Kaduna State. Depending on the season and market conditions, cucumber prices in the study region currently range from ₦2,190 to ₦3,066 per kilogram. A modest farm-gate price of ₦2,500 per kilogram was used for Kaduna State in this analysis. Therefore, the results imply that while organic manure gives sustainability and soil conservation benefits that can boost long-term agricultural productivity, inorganic manure may offer higher short-term economic returns in cucumber production. This result is consistent with that of Palm et al. (2001), who investigated the combined use of organic and inorganic fertilizer sources for soil fertility management and replenishment. They found that employing organic manure increased output.



Table 4: ANOVA Test for Yield Difference

Source of Variation	SS	df	MS	F-value	Sig.
Between Groups	4,520,000	1	4,520,000.00	12.73	0.001
Within Groups	34,800,000	98	355,102.04		
Total	39,320,000	99			

Source: Field Survey, 2025.

Test for Yield Difference

To ascertain if cucumber production outcomes under organic and inorganic manure systems differed significantly, the Analysis of Variance (ANOVA) results were utilized. The results showed that the productivity and profitability of cucumber production among the farmers in the sample were significantly impacted by the type of manure. The mean profitability of cucumber production under organic and inorganic manure systems differs statistically significantly at the 1% level of significance, according to the calculated F-value of 12.73 with a significance level of 0.001. The null hypothesis that there is no significant difference is rejected since the p-value (0.001) is less than 0.05. This implies that the type of manure had a major impact on the profitability and results of cucumber production. The Sum of Squares Between Groups (SSB) was 4,520,000 with one degree of freedom, according to the ANOVA table. This figure shows how the two forms of manure—organic and inorganic—differ in terms of profitability. The comparatively large between-group variation suggests that variations in cucumber production performance were significantly influenced by the type of manure utilized.

With 98 degrees of freedom, the Sum of Squares Within Groups (SSW) was 34,800,000. This component quantifies the variation that exists within each group and cannot be accounted for by the type of manure alone. Differences in farm size, farmer experience, soil conditions, irrigation techniques, pest control, labor efficiency, input accessibility, and other socioeconomic and environmental factors influencing productivity could have contributed to this discrepancy. The variation attributed to manure type remained statistically significant even though there was discernible variation among farmers within each manure group. The Mean Square Within Groups (MSW) was 355,102.04 while the Mean Square Between Groups (MSB) was 4,520,000. An F-value of 12.73 was obtained by dividing these two

mean squares. The F-value in ANOVA analysis quantifies how much group means vary in relation to within-group variation. Generally speaking, a high F-value suggests that the observed differences between groups are unlikely to have happened by accident. The calculated F-value had a significance probability (p-value) of 0.001. The null hypothesis, which states that there is no significant difference between cucumber production under organic and inorganic manure systems, was rejected because this result is significantly below the traditional significance level of 0.05. This suggests that the variations in productivity and profitability between the two manure systems were not the result of chance but rather were statistically significant. This research implies that the type of manure has a significant impact on the performance of cucumber production.

In comparison to organic manure, inorganic manure produced higher yields, higher total revenue, larger gross margins, and higher net farm income, according to the previous profitability research. By demonstrating that the superiority of inorganic manure in terms of economic performance was significant, the ANOVA result statistically justifies these observed differences. The quick release and instant availability of nutrients needed for cucumber growth may account for the improved performance linked to inorganic manure. Chemical fertilizers usually provide nutrients in concentrated, easily absorbed forms that improve fruit output, flowering, and vegetative growth. As a result, farmers who used inorganic manure were able to increase their output and earnings. However, organic manure nonetheless showed strong economic viability despite inorganic manure's considerable short-term profitability advantage. Improved soil structure, moisture retention, increased microbial activity, and long-term soil fertility sustainability are all facilitated by organic manure. Consequently, excessive reliance on inorganic manure without organic replenishment may eventually result in soil deterioration, nutritional



imbalance, and diminishing soil health, even though it may offer immediate productivity advantages.

Table 5: Gross Margin and Net Farm Income per Hectare (₦)

Item	Organic Manure	Inorganic Manure
Average Yield (kg/ha)	18,200	22,600
Price per kg (₦)	120	120
Total Revenue (TR)	₦2,184,000	₦2,712,000
Total Variable Cost (TVC)	₦165,500	₦175,000
Gross Margin (GM)	₦2,018,500	₦2,537,000
Total Cost (TC)	₦185,500	₦195,000
Net Farm Income (NFI)	₦1,998,500	₦2,517,000

Source: Field Survey, 2025.

Computation Details Using the formulae:

- Total Revenue (TR) = Average Yield × Price per kg
- Gross Margin (GM) = TR – Total Variable Cost

Net Farm Income (NFI) = TR – Total Cost

Organic Manure

- TR = 18,200 × 120 = ₦2,184,000
- GM = 2,184,000 – 165,500 = ₦2,018,500
- NFI = 2,184,000 – 185,500 = **₦1,998,500**

Inorganic Manure

- TR = 22,600 × 120 = ₦2,712,000
- GM = 2,712,000 – 175,000 = ₦2,537,000
- NFI = 2,712,000 – 195,000 = **₦2,517,000**

Gross Margin and Net Farm Income

The profitability analysis of cucumber production using inorganic and organic manure methods shows that smallholder farmers' yield performance, income generation, and profitability differ significantly. Although both production systems were profitable, the data show that using inorganic manure yielded better economic results than using organic manure. Farmers utilizing inorganic manure reported a higher production of 22,600 kg/ha, compared to an average of 18,200 kg/ha under the organic manure method. This discrepancy implies that inorganic manure improved crop yield and growth more successfully. The quick availability of minerals like nitrogen, phosphorus, and potassium—which are necessary for vegetative growth, blooming, and fruit formation in cucumber production—may be the reason for the increased yield from

inorganic manure. Even though organic manure improves soil structure and long-term fertility, it frequently releases nutrients slowly, which may limit crop responsiveness right away. The higher output under inorganic manure translated into a higher Total Revenue (TR) of ₦2,712,000 per hectare compared to ₦2,184,000 per hectare under organic manure at a consistent market price of ₦120 per kilogram. This suggests that compared to farmers using organic manure, those using inorganic manure were able to produce an extra ₦528,000 per hectare. Since higher output immediately increases revenue while prices stay the same, the result shows the significant correlation between crop yield and farm income.

The total variable cost (TVC) for producing inorganic manure was ₦175,000, which was somewhat more than the ₦165,500 for producing organic manure. The comparatively high cost of chemical fertilizer purchases, shipping costs, and labor involved in fertilizer application could be the cause of the greater variable cost under inorganic manure. On the other hand, organic manure might have been obtained locally from compost or animal waste, lowering the cost of purchased inputs. The significant output differential favored the production of inorganic manure despite the reduced variable cost under organic manure. For both inorganic and organic manure, the gross margin (GM), which calculates the returns left over after deducting variable costs, was ₦2,537,000 and ₦2,018,500, respectively. This suggests that after covering operating costs, cucumber growers that used inorganic manure kept more money. Stronger short-term profitability and improved operational efficiency are suggested by the larger gross margin with inorganic manure. The ₦518,500 difference between the two systems further demonstrates that



the extra income from greater yields more than offset the higher production costs brought on by the usage of inorganic fertilizer. In a similar vein, the total cost (TC), which include both fixed and variable costs, was ₦185,500 for organic manure and ₦195,000 for inorganic manure.

Even though the total expenses of producing inorganic manure were somewhat higher, the Net Farm Income (NFI) was still much higher. Farmers who used organic manure made ₦1,998,500 per hectare, whereas those who used inorganic manure made ₦2,517,000. This indicates that the production of inorganic manure made almost ₦518,500 more profit per hectare than the production of organic manure. Because the net farm incomes are positive and significantly high, the results imply that cucumber cultivation is profitable under both manure methods. However, because of its larger yield and increased revenue creation, inorganic manure seems to be

more financially advantageous in the near term. However, if improperly managed, relying exclusively on inorganic manure may have long-term effects on soil health, such as acidity, nutrient imbalance, and decreasing organic matter content. Conversely, organic manure enhances soil fertility, microbial activity, soil structure, and moisture retention, all of which are critical for long-term agricultural sustainability. These results suggest that careful integration of both organic and inorganic manure systems may help smallholder cucumber farmers become more profitable. The rapid yield-boosting effect of inorganic fertilizers and the soil-conditioning advantages of organic manure could be combined in an integrated nutrient management strategy. Farmers may be able to increase productivity, maintain soil fertility, lower production costs over time, and preserve environmental sustainability with the use of such a technique.

Table 6: Cost-Benefit Ratio of Cucumber Production

Manure Type	Total Revenue (₦)	Total Cost (₦)	CBR
Organic Manure	2,184,000	185,500	11.77
Inorganic Manure	2,712,000	195,000	13.91

Source: Field Survey 2025.

Cost-Benefit Ratio Analysis

Important information on the profitability and economic efficiency of cucumber production under the two manure systems is provided by the Cost-Benefit Ratio (CBR) analysis. Because their cost-benefit ratios were significantly higher than one, the findings demonstrate that both organic and inorganic manure techniques were lucrative. In contrast to organic manure, inorganic manure showed better economic efficiency and produced larger returns per unit of investment. According to the data, cucumber growers that used organic manure made ₦2,184,000 per hectare in Total Revenue (TR) and ₦185,500 per hectare in Total Cost (TC). As a result, the Cost-Benefit Ratio (CBR) was 11.77. The implication is that the farmer made about ₦11.77 for every ₦1 invested in cucumber production using organic manure. Given that the returns were far more than the manufacturing costs, this suggests a very profitable industrial enterprise. The outcome shows that lucrative cucumber production can be supported by organic manure, which may also enhance soil fertility and promote environmental sustainability. On the other hand, although paying a little higher Total Cost of ₦195,000 per hectare, farmers who used inorganic manure produced a

greater Total Revenue of ₦2,712,000 per hectare. The resulting CBR of 13.91 shows that every ₦1 invested in the production of cucumbers using inorganic manure yielded returns of about ₦13.91. Under the inorganic manure system, this larger ratio indicates improved financial performance and increased economic efficiency.

The increased cucumber production from the quick nutrient availability linked to chemical fertilizers may be the reason for the better CBR seen for inorganic manure. Crops typically have easier access to nutrients provided by inorganic fertilizers, which promotes quicker growth, more fruit production, and eventually more commercial output. When comparing the two manure systems, it is evident that inorganic manure produced more income and had a higher return on investment than organic manure. The significant increase in productivity and overall revenue made the somewhat higher production expenses associated with the inorganic manure system worthwhile. The difference between the CBR values of 13.91 and 11.77 indicates that, in the short run, inorganic manure offered a more effective use of production resources. This suggests that because inorganic fertilizers have a higher potential for profit, farmers looking for quick financial benefits might



favor using them. However, one should not undervalue the profitability of producing organic manure. Cucumber production with organic manure is still economically feasible, as seen by a CBR of 11.77, which still shows a very profitable business. Improved soil structure, higher microbial activity, better water retention capacity, and progressive nutrient release are just a few of the long-term agronomic and environmental advantages of organic manure. These benefits support sustainable soil management and could eventually lessen reliance on artificial fertilizers. Organic manure may also assist farmers in reducing production risks related to variable fertilizer prices and restricted access to chemical inputs. According to the results, both manure systems are economically advantageous for the production of cucumbers in the research region. But while organic manure offers sustainability benefits that could boost long-term agricultural productivity, inorganic manure seems to offer higher economic efficiency and greater short-term profitability. Therefore, the best course of action might be an integrated nutrient management strategy that incorporates both organic and inorganic manure. In addition to preserving soil health and environmental sustainability, such integration can assist farmers in achieving high yields and profitability.

CONCLUSION

This study evaluated the economic and yield performance of cucumber production among smallholder farmers in Kaduna State, Nigeria, using both organic and inorganic manure systems. When compared to unfertilized growing methods, the results showed that both manure systems considerably increased cucumber productivity. Nonetheless, there were variations in the amount of yield attained, production expenses expended, and farmers' profitability. According to the study, farmers that used inorganic manure typically produced more cucumbers because the nutrients were readily available, encouraging quick plant development and fruit production. However, production costs were significantly impacted by the rising cost of inorganic fertilizers. Conversely, consumers of organic manure profited from reduced input costs, better soil health, and long-term nutrient control, although yield levels were relatively lower in the short term. Cucumber production was economically feasible under both manure systems, according to profitability analysis, with favorable benefit-cost ratios and positive gross margins. Thus, farmers' output goals, resource availability, and long-term sustainability

considerations all play a role in the decision between organic and inorganic manure systems. Organic manure improves the ecosystem and helps to maintain soil fertility over time; however inorganic manure may offer greater immediate rewards through improved yields. For smallholder farmers in Kaduna State, growing cucumbers is still a lucrative business. Productivity, profitability, and sustainability can be further increased by incorporating suitable nutrient management techniques. Therefore, agricultural extension agents should receive more training on effective composting and application methods for using organic manure to produce profitable cucumbers in the study area.

RECOMMENDATIONS

1. To increase production and profitability while preserving soil fertility, smallholder cucumber producers in the research area should implement suitable manure application techniques.
2. Using an integrated nutrient management strategy, which combines the yield benefits of inorganic fertilizers with the soil health benefits of organic manure, farmers should be encouraged to combine sources of organic and inorganic manure.
3. Through subsidies, credit plans, and farmer support programs, government organizations and agricultural development programs should make it easier for people to obtain inexpensive fertilizers and organic manure inputs.
4. To optimize cucumber yield and financial gains, agricultural extension services should increase farmer education and training on appropriate manure application rates, timing, handling, and soil fertility management techniques.
5. To improve smallholder farmers' access to and use of high-quality organic manure, community-based composting initiatives should be encouraged.

CONFLICT OF INTEREST

The authors declared no conflict of interest for this study.

AUTHORS' CONTRIBUTIONS

The research was started by the lead author, who also set the precise goals. With the co-authors' help, he traveled to the field to gather and compile data. The co-authors collected data while the lead author undertook data coding, analysis, and result interpretation. As the result of the authors' peaceful and fruitful academic collaboration, we reviewed and approved the final work.



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