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Improved Tomato Varieties and Farm Size: Major Determinants of Level of Output of Tomato Crop in Ondo State, Nigeria

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ABSTRACT

The study aimed to evaluate the economic viability and profitability of cultivating improved tomato varieties in Akure North and Ifedore Local Government Areas of Ondo State, Nigeria. Primary data were collected through a well-structured questionnaire, with a sample size of 150 farmers selected using snowball sampling through a multi-stage procedure. Data analysis involved descriptive statistics, farm budgeting techniques, and multiple regression. Findings revealed that 36.7% of farmers were within their active working age. Most farmers (71.3%) were female, and 73.3% were married, with an average household size of seven. Around 40.7% of the farmers had higher education (HND/B.Sc.), and 68.7% were members of farming associations. Economic analysis indicated a total cost of N208,374.04 and a net income of N601,625.96, yielding a return on investment (ROI) of 3.89, meaning N2.89 profit for every N1 invested. The study also highlighted that farm size, farming experience, educational level, and agrochemical applications significantly influenced tomato production. Challenges identified included unfavorable climate, theft, price instability, poor seed supply, and inadequate capital. The study recommended government support in providing subsidies and resources for farm expansion and better extension services to ensure a steady supply of improved tomato varieties.

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Introduction

Tomato farming remains crucial for food security and economic stability across many developing regions due to its nutritional benefits and role in daily food consumption (Li *et al.*, 2020). However, challenges in productivity and market stability persist, largely due to reliance on traditional practices and local seed varieties that are often low-yielding and susceptible to diseases (Kom et al., 2022). Globally, malnutrition remains a significant issue. Approximately 868 million people suffer from undernourishment, while nearly two billion experience health issues due to micronutrient deficiencies (Srivastav et al., 2022). In Nigeria, rural communities bear the brunt of these nutritional deficits, with tomatoes playing a pivotal role in combating these problems while supporting the rural economy. Again, approximately 90% of African farmers still rely on local seed varieties, often of poor quality, limiting yield and market value (Kom et al., 2022). Therefore, the introduction of improved tomato varieties offers a promising solution to increase yields, minimize post-harvest losses, and stimulate the development of processing and export industries, thereby contributing to economic growth (Maruen & Pavel, 2021; López-Sánchez et al., 2021). In response, the adoption of improved tomato varieties and advanced agricultural technologies has gained attention as a pathway to enhance yields and reduce losses (Gatahi, 2020). Studies from various countries underline the transformative effects of adopting such technologies, though adoption rates and impacts vary significantly based on farm size, socio-economic factors, and geographic conditions (Afolami, 2001; Donkoh et al., 2013; Gatahi, 2020; Adams et al., 2021).

Recent research also highlights a strong relationship between farm size and the adoption of agricultural innovations, including improved tomato varieties (Gatahi, 2020; Adams et al., 2021). Larger farms often have greater access to financial resources, making it easier for them to invest in high-quality seeds, fertilizers, and irrigation systems (Fan & Rue, 2020). For instance, a study by Awotide et al. (2016) in Nigeria found that farm size was a significant predictor of technology adoption among smallholder farmers, as larger farms typically generate higher incomes and have greater access to credit. This dynamic is emphasized in research conducted in Kenya, where Muthini et al. (2023) observed that larger farms are more likely to adopt improved tomato varieties due to better financial resilience and risk tolerance, which smaller

farms often lack. In contrast, smallholder farmers may face challenges in adopting improved varieties due to limited resources and a lack of access to agricultural extension services (Derera & Gikera, 2020). These constraints hinder the adoption of high-yielding, disease-resistant varieties, leaving smaller farms reliant on traditional, low-productivity varieties. Therefore, interventions that make technology accessible and affordable to smallholder farmers are essential for improving productivity at a broader scale.

Adopting improved tomato varieties has proven to be economically advantageous across various contexts (Gatahi, 2020; Adams et al., 2021). A study by Tetteh Anang et al. (2020) in Ghana demonstrated that the use of improved seed varieties increased both yield and profitability, significantly enhancing farmers' incomes. The research suggested that improved varieties not only boost yield per hectare but also lead to better-quality produce that can command higher prices in the market. Also, in Ethiopia by Ali et al. (2023), where farmers using improved tomato seeds saw a notable increase in their net income due to the enhanced productivity and reduced costs associated with disease management. Furthermore, studies show that improved varieties contribute to market stability by reducing the seasonal volatility that affects tomato prices (Panno et al., 2021; Ali et al., 2023; Salazar et al., 2023). Improved varieties often have a longer shelf life, which extends market availability and reduces post-harvest losses (Panno et al., 2021). A study in India by Shinde et al. (2022) showed that with better storage and handling techniques alongside improved varieties, farmers were able to reduce wastage and maintain a steady supply to meet demand even in off-peak seasons.

Despite the benefits, the adoption of improved tomato varieties is limited by factors such as lack of access to quality seeds, limited extension services, and financial constraints (Balana & Oyeyemi, 2022). For instance, López-Sánchez et al. (2021) identified that the high cost of improved seeds and the lack of financial support are critical barriers in Latin American countries. These barriers are also prevalent in African countries, where inadequate infrastructure and limited extension services restrict farmers' ability to adopt new technologies. Similarly, Maruen and Pavel (2021) highlight that institutional support, such as government subsidies for improved seeds and training programs for farmers, can be pivotal in overcoming these barriers.

In Nigeria, tomato farming is a significant economic activity, yet it faces productivity challenges due to the limited adoption of improved technologies (Akinbola et al., 2023). Previous studies (Abdulai et al., 2018; Bidzakin et al., 2020; Akinbola et al., 2023) have emphasized the need for improved seed varieties and modern farming practices to address these challenges. The adoption of improved tomato varieties could increase yields, reduce production costs, and create opportunities for smallholder farmers to participate in higher-value markets. Addressing these barriers through targeted interventions could provide a sustainable pathway for rural economic development and improved food security. This study, therefore, seeks to conduct an economic analysis of the production of improved tomato varieties in Akure North and Ifedore Local Government Areas of Ondo State. The specific objectives include examining the socio-economic characteristics of tomato farmers, determining the profitability of improved tomato production, analyzing the factors affecting production, and identifying the key constraints faced by farmers.

Materials and Methods

This study was conducted in Akure North and Ifedore Local Government Areas (LGAs) of Ondo State, Nigeria, called the "Sunshine State." Akure North LGA includes five key groups: Iju, Ita-Ogbolu, Oba-Ile, Igoba, and Ogbese. These communities are situated between latitudes five°45' and 7°52'N, and longitudes four°20' and 6°05'E, with a populace of approximately 198,000. The vegetation is predominantly rainforest, characterized by dense bushes and grasses. Major monetary activities in Akure North include fishing and the cultivation of food and tree crops, which include cocoa, rubber, oil palm, and cashews. Farming and trading are the principal occupations of residents. Ifedore LGA, one of the 18 LGAs in Ondo State, has its headquarters in Igbara-Oke and is bounded to the north and east by Akure South LGA, to the south by Osun State, and the west via Ekiti State. The place lies inside longitude 4.89°E and latitude 6.89°N, overlaying approximately 295 km². According to the 2006 census, Ifedore had a population of 176,327. The LGA consists of essential cities with Igbara-Oke, Ijare, Ilara, Ipogun, Ibule, Isarun, Erigi, and Obo. Primary data were gathered for this research with a well-structured questionnaire. A multi-stage sampling technique was implemented. In the first stage, Akure North and Ifedore LGAs were purposively selected because of the awareness of farmers growing advanced tomato varieties. In the second stage, 5 groups were randomly selected from every one of the 2 LGAs. In the third stage, 15 tomato farmers were randomly selected from every community through the use of a snowball sampling technique, resulting in a total sample size of one hundred fifty (150) respondents. Data were analyzed using descriptive statistics, farm budgeting, and multiple regression. Descriptive statistics, such as frequency and percentage, were used to summarize the socio-economic characteristics of respondents, along with age, gender, marital popularity, and household size, as well as to pick out demanding situations faced by farmers. The budgeting method was used to determine the profitability of improved tomato production.

Model Specification

Budgeting techniques involved the method of calculating gross margin, profit, and Return on Investment (ROI) of improved varieties of tomato production in the study area. It is expressed as follows:

$$NR = TR - TC$$

Where:

NR = Net Revenue or Profit of Improved Varieties of Tomatoes Enterprise

TR = Total Revenue of Improved varieties of Tomatoes production

TC = Total Cost on Improved varieties of Tomatoes production

Return on Investment (ROI) = TR/TC

TC = Total Variable Cost (TVC)+Total Fixed Cost (TFC)
TR = Output (Q) x Per Unit Price (P)

Gross margin = TR - TC

The multiple regression analysis was used to identify the factors affecting improved tomato variety production in the study area. The regression model in implicit form is given as:

$Y= F(X_1, X_2, X_3, X_4, X_5 .....U)$

Where Y = Output of Improved varieties of Tomatoes (Naira)
X_1= Farm Size (ha)
X_2= Agro-Chemical (liter)
X_3= Farming experience (years)
X_4= Labor Cost (Naira)
X_5= Age of farmers (years)
X_6= Level of education (years)
U_I= Error term.

The following functional forms were estimated for the production function and the one that best satisfies the theoretical, statistical, and econometric criteria for a production function was selected as lead equation. The functional forms that were estimated were: Linear, semi-log, double log, and exponential.

Explicitly, the models were expressed as follows:

Linear function:

$$Yi = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + Ui$$

Semi-Log:

$$Yi = b_0 + b_{1\log}X_1 + b_{2\log}X_2 + b_{3\log}X_3 + b_{4\log}X_4 + b_{5\log}X_5 + b_{6\log}X_6 + Ui$$

Exponentials:

$$\text{Log } Yi = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + Ui$$

Double log

$$\text{Log } Yi = b_0 + b_{1\log}X_1 + b_{2\log}X_2 + b_{3\log}X_3 + b_{4\log}X_4 + b_{5\log}X_5 + b_{6\log}X_6 + Ui$$

Results and Discussion

Socio-Economic Characteristics of the Respondents

Gender plays a significant role in agricultural activities, with both men and women having specific responsibilities in farm labor. However, women in agriculture often face unique challenges, such as limited access to quality seeds, agricultural extension services, and credit, which can affect productivity. These roles vary by country and ecological zone. Studies in similar contexts (e.g., Oparinde et al., 2023; Olutumise et al., 2023) indicate that women may have less decision-making authority and fewer resources, impacting their ability to adopt improved farming techniques. The findings show that 28.7% of the respondents were male, while 71.3% were female. This suggests that tomato production in the study area is largely female-dominated, likely because men are more involved in cash crop farming, which is generally more lucrative. This aligns with the findings of Ajibade et al. (2021), who noted that some agricultural activities are more suited to one gender than the other, with tomato production being more commonly handled by women. The age distribution of the respondents indicated that about 36.7% of farmers were between 31 and 40 years old, while 27.3% were aged 51 and above. This suggests that most farmers are within their productive years, which is expected to result in higher output. This finding is consistent with Gbigbi (2021), who reported that most Nigerian farmers fall within the productive age range. Table 1 reveals that 17.3% of the respondents were single, 73.3% were married, and 9.3% were widowed. The high proportion of married women actively engaged in tomato farming supports Ajibade et al. (2021) findings, which suggest that married women tend to focus more on their businesses to provide for their families. The study also showed that 34.7% of respondents had a household size of 1-5 members, while 55.3% had a household size of 6-10 members. Large household size may provide a labor advantage, as suggested by Adams et al. (2021), who found that larger households tend to achieve higher profits in tomato production, helping them meet basic family needs. The education level of the respondents showed that 40.7% had an HND or B.Sc. degree, while only 4% had no formal education. This indicates a relatively high level of literacy among farmers, which could facilitate the adoption of improved farming techniques and a better understanding of agricultural inputs such as fertilizers and chemicals. The majority (80.7%) of respondents cultivated tomatoes on small plots of land, ranging from 1-5 plots (648 square meters per plot). Only 18.7% had farms of 6-10 plots. This suggests that most farmers operate on small holdings due to limited financial resources, aligning with Fan & Rue's (2020) observation that farm size significantly affects the amount of farm produce. The farming experience of respondents indicated that 44.7% had been engaged in tomato farming for 1-5 years, 32.7% for 6-10 years, and 22.7% for over 11 years. Farmers with less experience are generally more open to adopting new technologies, which can enhance productivity and efficiency in tomato farming.

Improved Tomatoes Varieties in the Study Area

Table 2 reveals that 12.7% of the respondents were involved in the production of cherry, 3.3% in beefsteak, 14.0% in grape, 11.3% in plum, 4.7% in patio, 0.7% in Campari, and 1.3% in Brandywine tomato. Notably, the largest group, accounting for 52.0% of respondents, focused on UTC tomato production. This indicates that UTC tomatoes are the most popular variety among growers in the study area. The preference for UTC tomatoes may stem from their high yield and their extended shelf life, as they resist decay and souring for prolonged periods after harvest. Additionally, UTC tomatoes are ideal for making tomato paste due to their firm, fleshy texture, reddish hue with yellow stripes, and low water content.

Costs and Returns

The costs associated with producing improved tomato varieties included both fixed and variable expenses. Fixed costs comprised spending on tools such as hoes, cutlasses, knapsacks, wheelbarrows, and land rent. On the other hand, variable costs covered labor, transportation, herbicides, fertilizers, and seeds. In the study area, the average income from improved tomato variety production was estimated at N625,446.43.

Table 1. Socio-economic Characteristics of the Respondents

Variable	Frequency	Percentage	Mean
Gender			
Male	43	28.7	
Female	107	71.3	
Marital Status			
Single	26	17.3	
Married	110	73.3	
Widowed	14	9.3	
Age			
20-30	21	14.0	
31-40	55	36.7	39.4
41-50	33	22.0	
51-60	41	27.3	
Educational Status			
No formal	6	4.0	
Primary	51	34.0	
Secondary	20	13.3	
HND/B.SC	61	40.7	
Postgraduate	12	8.0	
Household Size			
1-5	52	34.7	
6-10	83	55.3	6.9
11-15	15	10.0	
Experience (years)			
1-5	67	44.7	
6-10	49	32.7	6.1
11 years and above	34	22.7	
Farm Size (plots)			
1-5	121	80.7	
6-10	28	18.7	1.5
11-15	1	7	

Source: Field Survey, 2023

Table 2. Popular Types of Improved Tomatoes Varieties in the Study Area

Tomatoes	Frequency	Percentage (%)
Cherry Tomatoes	19	12.7
Beefsteak tomatoes	5	3.3
Grape tomatoes	21	14.0
Plum tomatoes	17	11.3
Patio tomatoes	7	4.7
Campari tomatoes	1	.7
Brandywine tomatoes	2	1.3
UTC	78	52.0

Source: field survey 2023

Table 3. Cost Structure and Returns of Improve Tomatoes Varieties Production

Items	Average	Percentage (%)
Fixed Cost	Value in (N)	
Land	13,333.33	11.5
Hoe	2,500	0.3
Cutlass	3,857.14	0.3
Knapsack	1,133.33	1.9
Wheelbarrow	2,146.67	2.0
Basket	850	0.3
Total Fixed Cost (TFC)	23,820.47	15.4
Labour		
Planting, Harvesting, Weeding	30,125	17.5
Variable Cost		
Transportation	75,000	24.5
Herbicides	16,071.43	10.5
Fertilizer	42,857.14	20.1
Seed	20,500	12.0
Total Variable Cost	184,553.57	84.6
Total cost TFC+TVC	208,374.04	100.0
Total Revenue= Qty*price	810,000	
Gross Margin=TR-TVC	625,446.43	
Net Farm Income NFI=(TR-TC)	601,625.96	
Return on investment=TR/TC	3.89	

Table 4. Results Showing the Factors Affecting the Production of Improved Tomato Varieties Production

Variable	Coefficient	Standard error	p-value
Constant	18.259	3.015	.009
farm size	0.391**	0.015	.000
Agrochemicals	0.341***	0.092	.005
farming experience	0.500**	0.242	.040
labor cost	-0.500	0.432	.239
Age of farmers	-0.206	0.406	.647
level of education	0.287***	0.036	.000
R	.949[a]		
R square	0.9		
Adjusted R square	0.867		

Source: Data analysis, 2023

The total average variable cost amounted to N184,533.57, while fixed costs totaled N23,820.47, with depreciation calculated using the straight-line method. This resulted in an average total cost of N208,374.04 and a net income of N601,625.96. The return on investment (ROI) of 3.89 indicates that for every N1 invested in tomato production, there is an additional income of N3.80k. This demonstrates the profitability of tomato farming in the study area.

Factors that Affect the Production of Improved Tomato Varieties in the Study Area

Table 4 presents the results of a regression analysis on factors affecting the production of improved tomato varieties in the study area. Based on the R-squared value, F-ratio, and the number and signs of significant variables, the double-log functional form was chosen as the lead equation. The model's constant is statistically significant with a coefficient of 18.259 and a p-value of 0.009, indicating the baseline level of production when all other variables are held constant. Farm size is positively correlated with tomato production, with a coefficient of 0.391 and a p-value of 0.014, suggesting that larger farm sizes significantly contribute to higher production. Similarly, the use of agrochemicals has a strong positive effect on production, as indicated by a coefficient of 0.341 and a highly significant p-value of 0.005.

Farming experience also shows a positive impact on production, with a coefficient of 0.500 and a p-value of 0.040, implying that farmers with more years of experience tend to achieve better yields in tomato production. However, labor costs and the age of farmers do not significantly affect production, as reflected by their respective p-values of 0.239 and 0.647, showing no meaningful statistical relationship with production. It means that a unit increase in man-day and age of the farmers will cause a decrease in the output of tomato production by 0.50% and 0.21%, respectively. The probable reason for the insignificant labor variable in affecting tomato production which may be due to the predominant use of family labor or cooperative labor-sharing among farmers, reducing reliance on paid labor. This finding contrasts with studies in more labor-intensive crops or commercial farming contexts, where labor costs are often significant. For example, Akinbola et al. (2023), Oladoyin et al. (2024) and Olubunmi-Ajayi et al. (2024) observed labor as a crucial factor in larger, commercial farms, while studies in similar smallholder settings often show minimal impact of labor costs on production outcomes. Educational level, however, plays a crucial role, with a coefficient of 0.287 and a p-value of 0.000, indicating that higher educational attainment significantly boosts tomato production, likely due to better understanding and adoption of improved farming techniques. The model's R-value of 0.949 suggests a very strong correlation between the independent variables and tomato production. The R-squared value of 0.949 means that 94.9% of the variation in tomato production is explained by the model, and the adjusted R-squared value of 0.867 confirms the model's high predictive power even when adjusted for the number of predictors.

Constraint Militating Improved Tomato Variety Production in The Study Area

Table 5 presents the various challenges faced by farmers in the study area, which were identified and ranked based on their significance. The findings indicate that the most significant challenge was unfavorable climatic conditions, followed by issues related to pilfering and theft. This suggests that a more favorable climate would significantly improve tomato production in the region. Tomato production in the area is particularly challenged by environmental factors, including high humidity and seasonal rainfall fluctuations, which can promote fungal diseases and complicate pest management. These climatic conditions can lead to increased post-harvest losses and variable yields, especially in the absence of adequate irrigation or pest control resources. Price instability was ranked third, while the poor availability of quality tomato seeds emerged as the fourth major constraint. These results highlight the importance of access to improved tomato seed varieties, which is critical for boosting crop yields. As a recommendation, subsidized improved seed varieties should be made accessible to farmers to enhance production levels. Inadequate capital, largely due to difficulties in accessing credit, was identified as the fifth most pressing issue. Additionally, the lack of market information, insufficient storage facilities, and the prevalence of pests and diseases were ranked sixth, seventh, and eighth, respectively.

Conclusion

The study on tomato production in Akure North and Ifedore Local Government Areas of Ondo State, Nigeria, has demonstrated that cultivating improved tomato varieties is a highly profitable enterprise. With a return on investment (ROI) of 3.89 and a net farm income of ₦601,625.96, the economic viability of tomato farming in the region is evident.

Table 5. Constraints militating improved varieties of tomatoes production

S/N	Constraint	Very serious		Serious		Mild		Not at all		Mean	Rank
		F	%	F	%	F	%	F	%		
1	Unfavorable climatic condition	57	38.0	53	35.3	27	18.0	13	8.7	1.97	1st
2	Incidence of pilfering and theft	61	40.7	49	32.0	26	17.3	14	9.3	1.95	2nd
3	Instability of price	62	41.3	53	35.3	25	16.7	10	6.7	1.89	3rd
4	Poor supply of tomato seeds	60	40.0	54	36.0	28	18.7	8	5.3	1.89	3rd
5	Inadequate capital	66	44	52	34.7	24	16.0	8	5.3	1.83	5th
6	Inadequate market information	71	47.3	48	32.0	21	14.0	10	6.7	1.80	6th
7	Storage facility	77	51.3	44	29.3	19	12.7	10	6.7	1.75	7th
8	Incidence of pest and disease	77	51.3	50	33.3	11	7.3	12	8.0	1.72	8th

Source: Computed from Field survey, 2023.

Key factors contributing to increased tomato production include farm size, use of agrochemicals, farming experience, and educational level. However, the study also highlighted significant challenges faced by farmers, such as unfavorable climatic conditions, price instability, inadequate capital, and poor access to quality seeds. Based on the findings, the following recommendations are proposed to improve tomato production in the study area:

- The government should provide farmers with access to affordable loans and grants to expand their farm sizes, as farm size is a key determinant of output.
- Efforts should be made by the government to ensure a steady supply of improved tomato seeds at subsidized rates, which would help increase productivity and reduce reliance on low-quality local varieties. The government can collaborate with private seed companies and agricultural research institutions to increase the production of high-quality, disease-resistant tomato seeds.
- Given that unfavorable climatic conditions were identified as a major challenge, farmers should be trained by the extension workers on climate-resilient agricultural practices to mitigate the effects of climate variability.
- Again, strengthening agricultural extension services is crucial. These services should focus on educating farmers about the latest agrochemical applications and improved farming techniques, leveraging the relatively high educational level among farmers.
- To address the challenges of price instability and post-harvest losses, investments should be made in market information systems and storage facilities. Investing in market information systems and storage facilities offers a dual benefit: it stabilizes prices and minimizes post-harvest losses, directly increasing farmers' incomes and ensuring a steady food supply, while creating a profitable, scalable opportunity that aligns with global sustainability goals and reducing economic risks tied to market volatility. This would help stabilize prices and extend the shelf life of tomatoes, reducing wastage and increasing profitability.

Limitation of the Study

The use of snowball sampling, while practical for reaching tomato farmers in the study area, may introduce sampling bias due to reliance on existing networks. This could limit the diversity of the sample and affect the generalizability of the findings to broader populations. Additionally, measurement errors could arise from self-reported data, especially regarding production costs and yields, as these rely on farmers' recall and record-keeping practices, which may vary.

Declarations

This study was presented at the 7th International Anatolian Agriculture, Food, Environment and Biology Congress, (Kastamonu, TARGID 2024)

Ethical Approval Certificate

The research project was approved by the Faculty of Agriculture's IRB committee, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria in accordance with the law and the national ethical guidelines of Nigeria. (Approval date: 20 July 2023 and number: AD/FATAAUA/IRB/23/132).

Author Contribution Statement

OPO: The author carried out the conceptualization, Methodology, Resources, Investigation, writing review and editing

Fund Statement

No funding was received to conduct the research

Conflict of Interest

The author declares no conflict of interest.

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