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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Evaluating the Total Factor Productivity of Smallholder Cassava Farmers based on Socio-economic Variables, Cost and Revenue in Southwest, Nigeria

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Abstract

The nation's low productivity in producing food crops is a reflection of inefficiency and the use of antiquated technology, which further impedes attempts to make sustainable progress in food production and availability. This study used a structured questionnaire to gather cross-sectional data from 360 cassava-based farmers who were randomly selected using a multi-stage sampling method. The goal of the questionnaire was to estimate the Total Factor Productivity (TFP) of productive resources used in cassava-based farms in South-West Nigeria. Descriptive and inferential statistics, the gross margin and the total factor productivity index were used to assess the data. The results showed that the majority (82.2%) of cassava farmers were male and they were within the active age group given a mean of 47.9years with a mean household size of 6 persons. About 87.2% of the farmers were married and had an average farming experience of 13years while about 58.3% of them had secondary education. The cassava farmers had an average farm size of 3.4ha and many (72.2%) of them had no access to credit. According to the summary statistics on total factor productivity, 66.9% of farmers produced at high levels, with their total factor productivity indices being above the optimal range. It was discovered that a number of factors significantly influenced the productivity of cassava-based farmers, including age, gender, marital status, farming experience, farm size, access to financing, availability of extension agents, membership in a cooperative association, and total household income. It was also found that cassava-based production was a profitable enterprise and that the total variable cost, total cost, gross margin, profitability ratio, efficiency ratio, income expenditure ratio and return on investment were significant in determining the level of productivity of farmers. There was a significant difference between the socio-economic characteristics of farmers who had low productivity and farmers who had high productivity. As a result, the report advises that the government give farmers with subsidized inputs such as agrochemicals and fertilizer, as well as loan facilities, to help farmers raise their scale of output and productivity.

Keywords: Cassava-based, Factor-productivity, Profitability, Small-holder farmers, Southwest

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1. Introduction

Cassava (*Manihot esculenta*) is Sub-Saharan Africa's second most important staple food crop (Katz and Weaver, 2020). Sub-Saharan Africa has the largest per capita consumption, at over 800g per person/day, and it is the principal energy source for nearly 40% of the population (Adebayo, 2023). Because of its drought tolerance and capacity to produce even in unfavorable soil conditions, cassava is vital to Nigeria's rural economy. Nigeria's unique weather characteristics make it ideal for cassava cultivation (Ikuemonisan et al., 2020). Cassava is adaptable to a variety of agro-ecological zones, making it appropriate for both rain-fed and irrigated agriculture. The country's good environment reduces the hazards connected with weather swings, hence increasing cassava cultivation's resilience (Ogbuene et al., 2024). With a tolerance for low soil fertility, resistance to drought, pests, and diseases, as well as a high resistance to weeds, it adapts to climate change remarkably well (HarvestPlus, 2016).

Nigeria is the world's largest cassava grower, with 54.8 million MT produced in 2017, accounting for 20.4% of worldwide production; nonetheless, cassava yield in the country is low (FAOSTAT, 2019). Cassava farming provides a living for the majority of Nigeria's smallholder rural households, and it has the potential for bridging the food gap, because it has been discovered from research that famine rarely exists where cassava is widely grown (Olarinde et al., 2020). Cassava not only serves as a food reserve during famines, but it also boosts Nigeria's GDP and has transitioned from a staple to a commercial crop.

Despite a constant annual growth rate of more than 3% in global cassava production, African smallholder farming systems' crop yield falls short of optimal levels (Kintché et al., 2017; FAO, 2018). The country, which has an estimated 200 million people, is unable to meet the needs of its growing population, implying that it cannot meet global demand. This has resulted in a shift toward cassava cultivation, which has given a means of survival for millions of Nigerians and is now regarded highly by the government and foreign development groups as a target crop for agro-based industrialization and food security. To ensure the lowest-cost mix of inputs and outputs, increasing cassava output per unit of input consumption is the way to go (Osun et al., 2014).

The National Agricultural Development Programmes (ADPs), River Basin Development Authorities (RBDAs), the National Agricultural Land Development Authority (NALDA), the National Fadama Development Programme (NFDP), the National Agricultural Technology Support Project (NATSP), and the National Accelerated Industrial Crop Storage and Postharvest Technology Programme (NAICP) are a few of the initiatives that have been put into action. Even with ongoing government and donor financing intervention, changing strategies, and other measures, the situation of poverty has not significantly improved, and the full potential for cassava yield has not been realized (Eze and Nwobi, 2014). The trends in yield performance (output per hectare) in Nigeria remain low, as the majority of cassava farmers (approximately 95%) are smallholder farmers cultivating less than 2 ha, with just about 5% cultivating more than 5 ha. As a result, production has been low since farmers cultivate and process cassava on a subsistence basis, with no potential of commercializing the crop and competing with other cassava exporters throughout the world (Oluwafemi et al., 2019). Because it takes into account how much more can be produced with the limited and scarce resources available for production, boosting the productivity and efficiency of small farmers in rural areas is therefore essential for raising per capita income and achieving zero hunger (Bradshaw, 2006; Audu et al., 2013). To fulfill the country's growing population needs, Nigeria must improve cassava output while protecting future production variables (Sanusi et al., 2022). This demonstrates that total factor productivity must be tracked throughout time to reflect the nation's agricultural success (Thakur et al., 2014).

A number of studies on agricultural products' technical efficiency were conducted in Nigeria. Akhilomen et al., (2015); Ajayi and Olutumise (2018); Jimi et al., (2019); Oluwatayo and Taiwo (2019); Oyetunde-Usman and Olagunju (2019); Adebayo et al., (2020). Numerous studies (Audu et al., 2013; Eze and Nwibo, 2014; Oladeebo and Oluwaranti, 2014; Okebiorun et al., 2018; Okorie et al., 2021) have examined the productivity of cassava farmers in order to determine the reasons behind the differences in productivity. Many investigations (Thakur et al., 2014; Pilo, 2019; Ionescu, 2022; Nirere, 2022) have examined the yield of a range of crops grown in regions other than Africa. As a result, there is little empirical study on the profitability and total factor productivity of cassava farming in Southwest Nigeria. Due to this, the study evaluated the productivity level and the variables affecting the production level of cassava farmers in the research area. The specific objectives of this study are to

describe the socio-economic characteristics of respondents, determine the productivity of cassava farming and estimate the profitability of cassava production in the study area. The study's findings would help both farmers and policymakers understand the key variables required for increased cassava agricultural production and how to manage them. Hence, the findings will be beneficial in developing appropriate strategies to increase cassava output in the area and throughout the economy. Furthermore, the findings would be useful for future studies on cassava production.

2. Materials and Methods

2.1 Study area

Southwest Nigeria was the location of the study. Ogun, Osun, Ondo, Oyo, Lagos, and Ekiti are the six states that make up the region. According to Lawal et al. (2016), the region is situated between latitudes 6o 21' and 8o 37′ N of the Equator and longitudes 2o 31' and 6o 00′ East of the Greenwich Meridian. There are about 25.02 million people living there, spread across a total land area of 76,852 square kilometers (Adeolu, 2019). The area is renowned for having a lot of rain. The rainy season usually begins in March and lasts until mid-July. It then takes a short break in early August before returning in late August and continuing through October (Olujumoke et al., 2016). In the south of the region, annual rainfall varies from 2,000 mm to 1,150 mm. November marks the start of the dry season, which ends in February or March on average. All year long, the temperature stays between 210C and 290C with comparatively low humidity. With a high forest zone (rain forest) in the south and a sub-Savannah forest on the northern edge, the area boasts a diverse range of flora. The climate in the area is favorable for the growth of crops such as plantains, cocoa, yam, maize, millet, cassava, rice, and kola nuts (Olagunju, 2022).

2.2 Data collection

Primary data were collected for the purpose of the study with the aid of a structured questionnaire. Data were collected on their socio-economic characteristics, productivity of the respondents and cost and return of cassava production using a questionnaire with well-constructed open-ended and closed-ended questions, supported by the interview schedule. The questionnaire was designed by creating valid and reliable questions that address research objectives placing them in a useful order, and selecting an appropriate method for administration. The questionnaire was self- administered and researcher-administered in person and was presented on paper to gather specific information from the respondents.

2.3 Sampling technique and sample size

A multi-stage sampling procedure was used to choose the study participants. In the first stage, two states (Ondo and Osun) recognized for their cassava farming were specifically selected. This is because of their predominance in cassava farming in the areas. In the second stage, three Local Government Areas (LGAs) were randomly selected from each state. The third stage involved random selection of three communities from each local government area, while the last stage involved selection of twenty farmers from each community who specialized in cassava and were specifically chosen from a list provided by the Agricultural Development Program (ADP) office in each of the chosen States. This resulted in a total of 360 respondents for the study. The reference was 2021/2022 production year and all the estimates were based on the period. Ondo and Osun States are among the highest cassava producing States in Southwest, Nigeria (Ikuemonisan et al., 2020). The region (Southwest) contributes about 13.1% to the national cassava output and out of it, Ondo and Osun States account for about 4.8% (FAOSTAT, 2019).

The population size that was used for the study was 4000. Only 2,265 cassava farmers are registered with the Ondo State Agricultural Development programme and 1,735 cassava farmers are registered with the Osun State Agricultural Development programme from which the respondents (360) were selected.

Using the Yamane's formula to calculate the sample size,

$$n = \frac{N}{1+N(e)^2} \quad \text{(Eq.1).}$$

The variables in this formula are:

n = the sample size

N = the population of the study

e = the margin error in the calculation

Let's assume a desired margin of error of 5%

n = 4000/(1+4000*0.05^2) = 363.63

n = 364

2.4 Method of data analysis

The acquired data were examined using descriptive statistics such as frequency distribution and percentages. Profitability and financial ratios, gross margin ratio, income expenditure and return on investment were computed and discussed for the cassava farming businesses. Total factor productivity index was used in the categorization of the farmers into different groupings. Specifically, total factor productivity (TFP) indices were used to categorize the farmers into three levels of productivity of high, low and optimal. For a high productivity level farmer, the index was TFP >1. A TFP < 1 score indicated low productivity farmer while optimally producing farmer had a TFP equal to one (Sadiq et al., 2019). In similar vein, the second level of categorization was done using TFP indices based on socioeconomic characteristics. Eleven socio-economic characteristics computed for the analysis were age, gender, marital status, household size, level of education, farm size, access to credit, access to extension agents, access to healthcare, membership of cooperative association and total household income of the farmers. Each socioeconomic characteristic that had a TFP > 1 was rated high, TFP < 1 rated low, and TFP equal 1 was rated optimal. The last categorization of the farmers was done based on cost and returns of the cassava farmers. The variables of the cost and returns used included cost of labour, cost of cassava, cost of fertilizer, cost of agrochemicals, cost of depreciated fixed asset and cost of rent.

2.4.1 Total factor productivity (TFP)

This was used to calculate the productivity of cassava farmers. TFP can be expressed as the inverse of unit variable cost. This is because TFP is the ratio of the production to the total variable cost (TVC), as illustrated below.

$$TFP = \frac{Y}{\sum P_i X_i} \quad \text{(Eq. 2).}$$

Where Y is the quantity of cassava in kilograms, P is the unit price of the ith variable input, and X is the quantity of that variable input.

2.4.2 Gross margin (GM)

Gross Margin analysis was utilized to determine the costs and returns of cassava-based production in the research area (objective II).

$$GM = TR - TVC \quad \text{(Eq. 3).}$$

Where, GM = Gross Margin, TR = Total value of cassava output in/ ha, TVC = Total Variable Cost of cassava production/ ha. Ratios that were used included Profitability Ratio (GM/TVC), Efficiency Ratio (TR/TVC), Gross Margin Ratio (GM/TR), Income Expenditure Ratio (TR/TC), Return on Investment Ratio (Net Profit/Total Investment) (ROI) and Profitability Ratio (GM/TVC)

3. Results and Discussion

3.1 Socio-economic characteristics of the respondents

The descriptive analysis of the socio-economic characteristic of the respondents showed that most of the respondents were within the age bracket of 41-50 years with a mean age of 47.9 years (*Table 1*). This implies that majority of the cassava farmers were in their active age. The result showed that majority (82.2%) were male while 17.8% were female. This revealed that male gender dominated cassava production in the study area. About 87.2 percent of the respondents were married and most (58.3%) of the respondents had secondary school

Table 1. Distribution of respondents by socio-economic characteristics

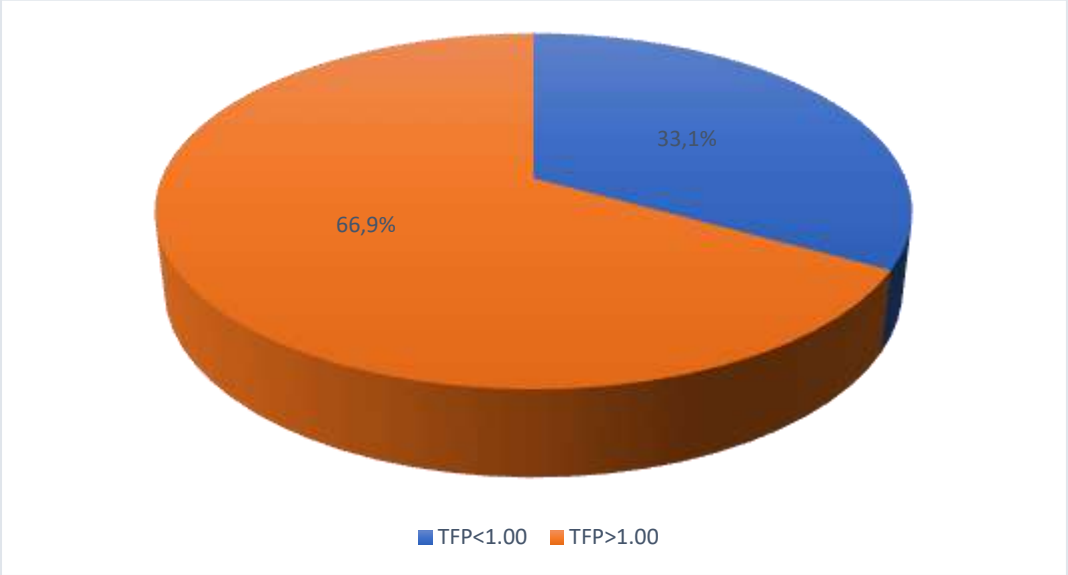
Variables	Frequency	Percentage
Age		
Mean = 47.9		
≤30	26	7.2
31-40	86	23.9
41-50	104	28.9
51-60	74	20.6
>60	70	19.4
Gender		
Male	296	82.2
Female	64	17.8
Marital status		
Single	18	5.0
Married	314	87.2
Widowed	18	5.0
Separated	10	2.8
Household size		
Mean = 5.6		
1-5	178	49.4
6-10	180	50.0
11-15	2	0.6
Level of Education		
No formal education	8	2.2
Adult education	34	9.5
Primary school	36	10.0
Secondary	210	58.3
Tertiary	72	20.0
Years of Farming Experience		
Mean = 12.7		
1-5	100	27.8
6-10	73	20.3
11-15	55	15.2
16-20	78	21.7
>20	54	15.0
Farm size		
Mean = 3.4		
1-5	324	90.0
6-10	32	8.9
>10	4	1.1
Credit Access		
Yes	100	27.8
No	260	72.2
Access to Extension Services		
Yes	88	24.4
No	272	75.6
Membership of Cooperative Society		
Yes	189	52.5
No	171	47.5

Source: Computed from Field Survey, 2022

education. The mean household size of the respondents was six persons. Oluwatoba et al. (2021) classified small scale farmers in terms of the size of their farm holdings. Small scale farms are farms under 6 hectares. Medium scale farms range between 6 and 9.99 hectares while large-scale farms are 10 hectares and above. The result indicated that majority (90%) of the respondents had farm size between 1-5 ha with a mean of 3.4 ha thereby, classifying them as small-scale farmers. This supports the assertion of Gbigbi (2021) that Nigerian farmers were small-scale farmers. The results further showed that the average farming experience of the farmers was 12.73 years. This indicates that cassava production is an age-long venture among the respondents, and farmers are equipped with the required skills. The result also revealed that 72.2% of respondents did not access credit while only 27.8% accessed credit. This could lower their level of investment in agricultural production as capital is an important factor in agricultural production activities (Mukaila et al., 2021; Falola et al., 2022). The result revealed that majority (75.6%) of respondents had no interaction with extension workers. This could affect the use of better cassava production technologies. According to membership of association, about 47.5% did not belong to any organization. This is likely to impact negatively on their level of their efficiencies.

3.2 Distribution of respondents by level of productivity

The summary statistics of total factor productivity in Figure 1 revealed that the majority of farmers (66.9%) had high levels of productivity because their total factor productivity indices were above the optimal scale, indicating good input mix allocation in the production process, while 33.1% had low levels of productivity because their total factor productivity indices were below the optimal scale. This means that more than half of the sampled population made effective use of their input resources. This is congruent with the findings of Sadiq et al. (2019), who discovered that more than half of the sampled farmers were productive in their utilization of input resources in the study area.



Computed from Field Survey, 2022

Figure 1: Distribution of Respondents by their Total Factor Productivity

3.3 Total factor productivity based on socio-economic variables

Table 2 shows that age, gender status, marital status, farming experience, farm size, access to credit, access to extension agents, membership in a cooperative association, and total household income had a significant impact on farmers' productivity at 1% or 5% level. These variables have given favorable results, implying that an increase in any of these factors could boost overall factor production in the study area. However, there is a substantial gap between farmers with low and high production in terms of socioeconomic factors. The average age of farmers who had high productivity was higher than that of farmers who had low productivity, implying that middle age farmers are more productive, possibly due to better experience that they have gained over the years in managing farming practices and utilizing productive resources. This is consistent with Adebayo et al. (2023) study, which found that middle age farmers were more productive. The majority of farmers who had high

levels of productivity were male. This may be due to gender differences in access to inputs, productive resources and services. Also, the majority of the farmers who had high levels of productivity were married, implying that marriage contributed to their output, which could have been owing to access to family labor. Farmers who had a high level of productivity had more years of farming experience, farm size, access to financing, access to extension agents, and total family income, which is consistent with the prior hypothesis that farmers with more of these would be more productive. This finding is congruent with that of Sadiq et al. (2019), who found that gender, farming experience, medicine, and income all had a favorable effect on the total factor productivity of broiler farmers in Niger State, Nigeria. This is also in line with the results of Gbigbi (2021), which stated that farm size had positive effect on efficiency among farmers in Delta State, Nigeria.

Table 2. Total factor productivity: The distribution of respondents based on socio-economic variables

Socio-economic Variables	Low Productivity (TFP<1.00) (Mean)	Std. Dev.	High Productivity (TFP>1.00) (Mean)	Std. Dev.	Mean Diff.	t-value
Age	42.50	10.88	50.69	13.07	-8.19	-5.90***
Gender	1.11	0.31	1.21	0.41	-.102	-2.40**
Male (freq.)	.891	.313	.788	.409	.102	2.40**
Female (freq.)	.109	.313	.212	.409	-.102	-2.40**
Marital Status	1.94	0.27	2.11	0.52	-.171	-3.39***
Single (freq.)	.067	.251	.041	.199	.026	1.05
Married (freq.)	.924	.266	.846	.361	.078	2.09**
Widowed (freq.)	.008	.092	.071	.257	-.062	-2.56**
Separated (freq.)	0	0	.041	.199	-.041	-2.26**
Household size	5.64	2.02	5.54	1.56	.095	0.49
Level of Education	3.93	0.66	3.80	1.03	.131	1.27
No formal education (freq.)	.008	.092	.029	.168	-.021	-1.25
Adult education (freq.)	.042	.201	.120	.326	-.078	-2.40**
Primary school education(freq.)	.076	.266	.112	.316	-.036	-1.08
Secondary school education (freq.)	.756	.431	.498	.501	.258	4.81***
Tertiary education (freq.)	.118	.324	.241	.428	-.123	-2.77***
Farming experience	9.69	6.71	14.24	9.30	-4.552	-4.76***
Farm size	3.10	2.12	3.57	2.15	-.472	-1.96**
Access to credits	0.12	0.32	0.38	0.54	-.264	-4.95***
Access to extension agents	0.11	0.31	0.31	0.46	-.202	-4.29***
Access to healthcare	0.77	0.42	0.87	0.34	-.094	-2.28**
Membership of cooperative association	0.49	0.50	0.54	0.49	-.044	-0.78
Total household income	302941.2	141872.2	455,020.7	184,535.7	-152079.6	-7.91***

Computed from Field Survey, 2022

** Significant at 5% level; *** Significant at 1% level

3.4 Total factor productivity based on cost and revenue

Results in *Table 3* showed that variable inputs such as labour, cassava stem and agrochemicals were significant in determining the level of productivity of farmers at 1% and 5% level respectively. Farmers who had high level of productivity incurred higher cost on labour and agrochemicals while farmers who had low

Table 3. Total factor productivity distribution of respondents based on cost and revenue: summary statistics for income of farmers

(A)Variable Cost	**Low Productivity (TFP<1.00) Mean**	**Std. Dev.**	**High Productivity (TFP>1.00) (Mean)**	**Std. Dev.**	**Mean Diff.**	**t-value**
Cost of labour	34848.74	56343.10	75663.90	89022.71	-40815.16	-4.57***
Cost of cassava stem	5362.19	4956.28	3541.08	1757.20	1821.11	5.09***
Cost of fertilizer	3331.09	2870.06	3427.80	2359.70	-96.71	-0.34
Cost of agrochemicals	4750.42	7389.38	6675.10	7170.25	-1924.68	-2.37**
Cost of transportation	18399.16	9995.89	19186.72	25680.75	-787.56	-0.32
Total Variable Cost (TVC)	66691.60	63916.77	108494.60	101202.20	-41803.01	-4.12***
(B) Fixed Cost						
Depreciated fixed assets	4107.42	626.71	4004.98	1637.61	102.44	0.66
Cost of rent	15126.05	156030.60	2626.56	6933.73	12499.49	1.24
Total Fixed Cost (TFC)	19233.47	156112.3	6631.54	7187.04	12601.93	1.25
Total Cost (TC)	85925.07	174680.80	115126.10	102032.90	-29201.08	-1.99**
Total Revenue (TR)	224369.80	168782.50	624045.60	291024.60	-399675.9	-13.87***
Gross Margin (GM) (TR-TVC)	157678.20	171151.30	515551	304552.20	-357872.9	-11.92***
Profitability Ratio (GM/TVC)	3.11	3.51	7.18	5.01	-4.07	-7.96***
Efficiency Ratio (TR/TVC)	4.11	3.51	8.18	5.01	-4.07	-7.96***
Gross Margin Ratio (GM/TR)	0.70	1.01	0.83	1.05	-0.13	0.86
Income Expenditure Ratio (TR/TC)	3.72	3.19	7.53	4.61	-3.81	-8.11***
Return on Investment Ratio (Net Profit/Total Investment) (ROI)	2.72	3.19	6.53	4.61	-3.81	-8.11***

Computed from Field Survey, 2022
** Significant at 5% level; *** Significant at 1% level

productivity incurred higher cost on cassava stem, fixed assets, and rent. However, farmers who had high productivity incurred higher cost on the input utilized and realized higher revenue than farmers who had low productivity.

Results further showed that the total variable cost, total cost, gross margin, profitability ratio, efficiency ratio, income expenditure ratio and return on investment were significant in determining the level of productivity of farmers at either 1% or 5% level. Farmers who had high level of productivity had a higher value in all these

ratios than farmers who had low productivity. Based on the return on investment, cassava production is a profitable enterprise and the farmers who had high productivity had higher profit than the farmers who had low productivity. This result is congruent with Mukaila et al. (2022). This is also consistent with a prior expectation that high productivity should translate into more profitability.

4. Conclusions

The summary statistics of total factor productivity revealed that more than half of the sampled population was productive in their use of input resources. However, a significant proportion of them performed below the ideal scale. Farmers with more years of farming experience, larger farm sizes, access to credit, extension agents, and total household income were more productive than their counterparts. Age, gender status, marital status, farming experience, farm size, access to credit, access to extension agents, membership in a cooperative association, and total household income were significant in determining the level of productivity of smallholder cassava farmers. Most of the farmers who had high level of productivity were male, mostly married and middle age. Results further showed that variable inputs such as labour, cassava stem and agrochemicals were significant in determining the level of productivity of farmers. Farmers who had high level of productivity incurred higher cost on labour and agrochemicals while farmers who had low productivity incurred higher cost on cassava stem, fixed assets, and rent. Farmers who had high production, on the other hand, paid a greater cost for their inputs and earned a bigger profit than those with poor productivity. The results also revealed that the total variable cost, total cost, gross margin, profitability ratio, efficiency ratio, income expenditure ratio, and return on investment all play an important role in influencing farmer productivity. Based on the return on investment, farmers who had high productivity had higher profitability than farmers who had poor productivity. The study therefore recommends that;

- Subsidies for agrochemicals and fertilizer should be provided by the government to farmers, as their high cost can impair profitability and production.
- The government should provide finance to farmers to boost production and productivity.
- The government should do better in empowering and equipping the extension agents to perform better in farmers' education, dissemination of relevant information and mobilization of farmers for training when the need arises.
- Encouraging and educating farmers to join cooperatives can help them form networks and generate beneficial relationships, which can benefit their operation.
- Farmers should be encouraged to engage rigorously in non-farm activities that can give them income. This income could be used to purchase all necessary farm inputs and increase their scale of production.

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Ethical Statement

There is no need to obtain permission from the ethics committee for this study.

Conflicts of Interest

I declare that there is no conflict of interest as the article author.

Authorship Contribution Statement

Concept: O. O.; Design: O. O.; Data Collection or Processing: O. O.; Statistical Analyses; O. O.; Literature Search: O. O.; Writing, Review and Editing: O. O.

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