PRODUCTION EFFICIENCY AND PROFITABILITY OF CASSAVA FARMING IN ILARO AGRICULTURAL ZONE, OGUN STATE, NIGERIA

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Abstract: The study was conducted to examine the technical efficiency and profitability of cassava farming in the study area. Primary data were collected with structured questionnaire from 140 respondents through a multi-stage sampling technique. The data were analysed by descriptive statistics, budgetary equations and Stochastic Production Frontier (SPF) model. The results show that average age of the studied farmers was 48 years. Majority (85.7%) were married. Average family size was 6 persons. About 60.0% of them had, at most, primary education. The average farm size of farmers was 3.9 ha with 21 years of experience. Estimates of cost and returns show that labour and fertilizer were the most expensive inputs at 69.9 and 13.15% of the total cost, respectively. The benefit-cost ratio shows that returns on total cost was 44%. The estimates of SPF model revealed that mean technical efficiency was 0.595. Farm size and labour had significant increasing effects on technical efficiency of cassava production at 1 and 10%, respectively; while fertilizer and education had negative effects each at 1% significant level. The major challenges of the farmers were inadequate fund (70.0%), attack of cattle/herdsmen (67.9%) and fluctuation in output price. The study shows that cassava production is profitable but production efficiency can be increased by 40.5%. Therefore, private and government efforts should ensure distribution of improved and adequate inputs for expansion of farm size. Government should provide well-equipped Agro-service centers to promote farm mechanization at affordable charges for increased production efficiency.

Keywords: Cassava, technical efficiency, gross margin, stochastic, farm size, constraints

Introduction

Nigeria is the world's largest producer of cassava in the tropics (FAO, 2017). The country's production volume for 2015 was 57.64 million metric tonnes, representing 37.3% of Africa's or 20.8% of the world's total production for the year. Cassava plays a particularly important role in the agriculture of developing economy like Nigeria. It is the third largest source of carbohydrate food and it gives the highest yield of food energy on poor soils even with low rainfall (Akerele *et al.*, 2018). Cassava roots are rich in starch and contain significant amount of calcium (500 mg/100g), phosphorus (400 mg/100g), and vitamin C (25 mg/100g) (Odoemenem and Otanwa, 2011). It can be processed and consumed as fufu, garri, lafun and tapioca by both rural and urban dwellers in Nigeria. It is also processed into starch, livestock feed, ethanol, adhesive for pharmaceutical industries and flour for confectioneries industries. In recent years, cassava is processed as a supplement with wheat flour for baking bread. Cassava is available all year round as staple food in Nigeria. Hence, it generates cash income for the largest number of households in comparison with other staples.

In view of the importance of cassava in the Nigerian economy, efforts have been intensified towards ensuring sufficiency level of its local production. Ojiako *et al.* (2013) and FAO (2017) confirmed that the increasing output of cassava in Nigeria was driven more by increase in land area cultivated rather than by yield growths. The national average yield of cassava was very low at about 13.63 metric tons per hectare while the potential yield is about 40.0 metric tons per hectare. More so, cassava farming is characterized by small farm holdings and it is labour intensive. Despite the leading position of Nigeria in cassava production, the country still imports significant quantities of cassava products such as starch, flour, sweeteners among others to satisfy the industrial sector (Olukunle, 2016).

Ashaye *et al.* (2018) noted that some of the constraints to cassava production in Nigeria are pest and disease related. The pest includes cassava green mite, cassava mealy bug and the variegated grasshopper while the diseases are cassava mosaic, cassava bacterial blight, cassava anthracnose and the root rot. These together with poor cultural practices lead to yield losses that may be as high as 50% in Africa. Nnadi *et al.* (2013) also noted that extension services is important in providing information on modern technologies and management of farm resources. This cannot be undermined in the pursuit of improving productivity and efficiency in agriculture (Chukwuemeka and Nzewi, 2011).

Cassava gained prominence in Nigeria in the year 2002 following the pronouncement of a Presidential initiative on Cassava production and export. The Federal Government of Nigeria promulgated a law, making it mandatory for bakers to use composite flour made up of 10% cassava and 90% wheat for bread production in Nigeria (Bamidele *et al.*, 2011). Despite this regulation, it was estimated that 88 percent of cassava produced in African countries including Nigeria is consumed as staple food in the form of *garri, fufu, akpu* among others (Kaine, 2011).

The findings of Isitor *et al.* (2017) revealed that average farm size was low at 0.9 ha and mean technical efficiency was 51.5%. The farmers were relatively young (47.6 years) with average household size of 7 members. About half of them had primary education with 43.0% having more than 19 years of cassava farming experience. Oduntan *et al.* (2015) observed that farm size, labour quantity, agrochemicals and quantity of cassava stem cuttings were the major determinants of cassava output while level of education, farming experience, household size and age of farmers were the factors affecting cassava production efficiency.

Kingsley *et al.* (2015) employed stochastic production frontier in the analysis of the technical efficiency of small-scale cassava farming. They found that mean technical efficiency was 89.0%. Age and sex of the farmers had significant declining effect on production inefficiency. Aminu and Okeowo (2016) reported that cassava mixed cropping was more prevalent and the farmers were relatively young (41.67 years old), literate but operating small-scale farms.

The findings of Ogunleye (2018) showed that about 17.3% of the cassava farmers had access to microcredit while 82.7% of them did not obtain microcredit. Those with microcredit were more profitable and efficient among the cassava famers in the study area. Toluwase and Abdu-Raheem (2013) revealed that cassava farmers earned a gross farm income of about N68, 662.50 per ha. The benefit-cost ratio indicated that returns for every one naira invested on cassava production is N2.19. Similarly, Nandi *et al.* (2011) found that cassava farming is profitable with returns to scale value of 1.69. This indicates an increasing return to scale but the farmers are not producing maximum output. The study of Muhammad-Lawal *et al.* (2012) showed that improved cassava varieties generated a higher Gross Farm Income (N167,733) than the local varieties (N114,569) while farm size, age of the farmer and household size were the significant variables explaining the variation in cassava output.

Ogunleye *et al*. (2017) also confirmed that government-assisted cassava farmers were more efficient and they earned higher profit than the non-beneficiaries. Meanwhile, Ettah and Kuye (2017) pointed out that profit efficiency in cassava production was between 0.14 - 0.91 with mean of 0.65. Thus, the farmers can increase their profit efficiency by additional 35%. The study showed that age (0.37), education (0.67) and household size (0.58) had positive and significant effect on the profit efficiency.

Nzeh and Ugwu (2014) reported that cassava production and marketing was greatly hampered by poor finance since the farmers could not meet up with the basic requirements to sustain effective production and marketing. According to Eze and Nwibo (2014), policy intervention by government or individuals should be implemented with the goal of achieving specific outcomes in the productivity of the domestic agricultural sector.

Against the above background problems, the specific objectives of this study are to examine the profitability of cassava farming and analyse the technical efficiency of the farmers in the study area. The findings of the study would help both farmers and policy makers to understand the important variables required for improved productivity of cassava farming and how to manage them. Hence, the results would provide useful guides in the formulation of appropriate policies towards the expansion of cassava production in the area as well as in the economy, at large. Furthermore, the findings would provide relevant information for further studies on cassava production.

Materials and Methods

The study area

The study area is Ilaro Agricultural Zone in Ogun State. The State was created in 1976 in the Southwest region of Nigeria. Other States in the region include; Lagos, Oyo, Ondo, Ekiti and Osun State. Ogun State has a boundary with Lagos State to the south, Oyo and Osun states to the north, Ondo to the east and the Republic of Benin to the west. It is popularly known as Gateway State with Abeokuta as the State capital and the largest city. The total population in Ogun State was 3,751,140 (NPC, 2007). There are four Agricultural zones in Ogun State namely; Ijebu, Ikenne, Abeokuta and Ilaro Agricultural zones as designated by the Ogun State Agricultural Development Programme (OGADEP). The Headquarters of the Ilaro Agricultural Zone is Sawonjo where the Agricultural Extension officers converge for their fortnight meetings.

Farming is the major occupation of the people in the study area and it a predominant area for food crop and livestock production. The Ilaro Agricultural zone has in many years been regarded as the food-basket of the State. Ilaro Agricultural zone is blessed with climate and soil structure conducive for production of diverse range of crops, all classes of livestock. The climate has two distinct seasons namely wet and dry seasons, characterized by minimum rainfall of 1211 mm and a maximum of 1264 mm, mean temperature of 27^0C and daily sunshine powers of 4.4 in August to February. The average monthly temperature ranges from 18^0-24^0C during the rainy season and 30^0-35^0C during the dry season. As a result it is a predominant area for the production of cassava, yam, maize, pepper, tomato and many other crops including melon, fruits and leafy vegetables.

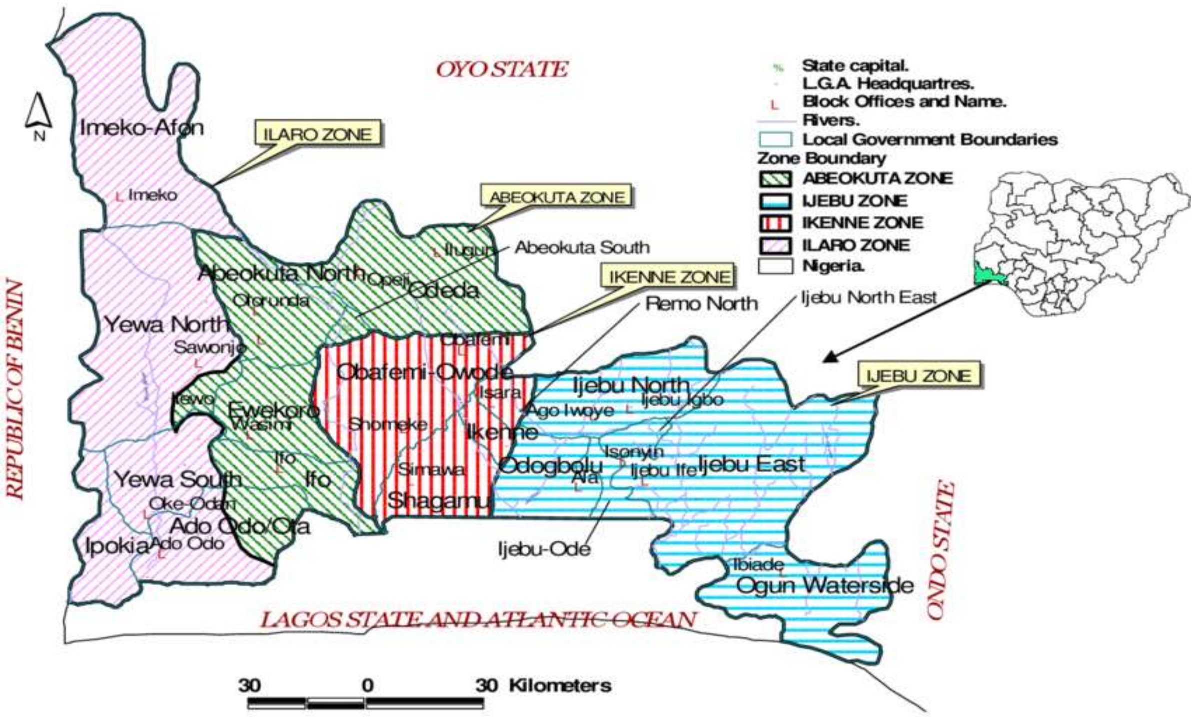

Fig. 1: Map of Ogun State agricultural development programme zones showing the study area

Method of data collection and sampling techniques

Primary data were collected using a well-structured questionnaire which were administered through personal contact and interview schedule with the cassava farmers. Multistage sampling technique was used in selecting the sample size for the study. In the first stage, the two (2) Agricultural blocks (Sawonjo and Imeko) were selected out of the four (4) designated Agricultural blocks in Ilaro Agricultural zone. In the second stage, 50% of existing cells in each block was selected. In the subsequent stages, 30% of the 80 contact farmers in each cell were selected randomly for interview. A snowball approach was used in reaching the target farmers. Thus, a total of one hundred and sixty eight (168) cassava farmers were interviewed while the data analysis was based on one hundred and forty (140) respondents after data screening.

Method of data analysis

The socio-economic variables of the respondents and the farming constraints were analysed using descriptive statistical tools such as frequency, percentages and mean, among others. Profitability of cassava farming in the area was estimated using the budgetary equations to estimate the cost and returns as follows;

$$GM = TR - TVC \quad (1)$$

$$NFI = TR - TC \quad (2)$$

Where: GM: Gross Margin (₦); NFI = Net Farm Income (₦); TR = Total revenue (Price (₦) x Quantity of output); TVC = Total variable cost (₦); TC = Total cost (₦) (i.e. Total Variable Cost +Fixed Cost)

The financial performance of the farms were determined by following indices;

$$\text{Rate of Return on investment (RRI)} = \frac{NFI}{TC} \times 100 \quad (3)$$

$$\text{Profitability Index} = \frac{NFI}{TR} \quad (4)$$

$$\text{Benefit-cost ratio} = \frac{TR}{TC} \quad (5)$$

The stochastic production frontier model

The concept of efficiency was distinguished between three types namely; technical efficiency (TE), allocative or price efficiency (AE) and economic efficiency (EE). However, technical efficiency was conceptualized in this study and measured by the stochastic production frontier model proposed by Meeusen and Vanden Broeck (1977) and extended by Jondrow *et al.* (1982). This was adopted by Fasasi (2007), Kingsley *et al.* (2015), Oduntan *et al.* (2017) and many other recent authors. It allows for the estimation of individual firm efficiency level with both time variations and cross-sectional data. The stochastic efficiency frontier production function is defined by:

$$Y_i = F(X_i, \beta)\exp(V_i - U_i) i = 1,2,..., N \quad (6)$$

Where: Y_i = Output of i^{th} farm; X_i = Corresponding (M x Z) vector of inputs; β = Vector of unknown parameter to be estimated; V_i = Symmetric error component that accounts for random effects and exogenous shock; $Ui< 0$ = a one - sided error component that measures technical inefficiency; V is accomplished by estimating the mean of conditional distribution of U.

V can be expressed as:

$$\frac{U}{e} = \mu_i + \sigma * \left(f * \frac{-\mu_i}{\sigma *} \right) \left[1 - F\left(\frac{\mu_i}{\sigma *} \right) \right] \quad (7)$$

Where:

$$\sigma* = \frac{(\sigma^2 v \sigma^2 u)^{1/2}}{\sigma^2} \quad \mu = \frac{(-\sigma^2 ueui)}{\sigma^2} \quad (8)$$

f = standard density function, F = standard distribution function

The technical efficiency is done by means of maximum likelihood estimation (MLE), which involves the estimation of population parameters such that the probability density for obtaining the actual sample observation that have been obtained from the population is greater than the probability density obtainable with any other assumed values (estimations) of the population parameter. The MLE method provides estimators that are asymptotically consistent and efficient. The parameters of the stochastic frontier function model are estimated by the method of maximum likelihood, using the computer program FRONTIER version 4.1 (Coelli, 1994).

The explicit Cobb Douglas functional form of the model for the study data is specified as;

$$InY = In\beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_5 + e_i \quad (9)$$

Where: In = Natural logarithm; Y = Quantity of cassava output (kg); X_1 = Farm size (ha)

X_2 = Quantity of labour used (mandays); X_3:= Cassava stem cuttings (kg); X_4 = Quantity of agro chemicals used (litre); X_5 = Quantity of fertilizer used (Kg)

The inefficiency model U is defined by;

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta 3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + e_i \quad (10)$$

Where:

Z_1 = Age (years); Z_2 = Gender (male = 1; otherwise = 0); Z_3 = Marital status (married = 1;otherwise = 0); Z_4 = Educational level (years); Z_5 = Farming experience (years); Z_6 = Household size (number); Z_7 = Variety of Cassava (TME 419 = 1; otherwise = 0); Z_8 = Number of Extension visit per year.

Results and Discussion

Results of socio-economic characteristics of the respondents

The socio-economic characteristics of the respondents were described in Table 1. The result shows that 66.4% of the farmers were younger than 50 years while 33.6% were, at least, 60 years old. The relative age of a farmer was 48 years implying that majority of them are youths. The male farmers were 92.9% while 7.1% were female. This may be as a result of active involvement of women in cassava processing and marketing activities. Majority (85.7%) of the farmers were married while 14.3% were either single, divorced or widowed. The average household size was 6 persons. The high proportion of married status suggests that they have dependents, some of whom may provide family labour to the farm. The results revealed that 38.6% of the respondents had no formal education, 21.4% had primary school education while 40.0% of them were educated beyond primary school. Hence, the farmers require more extension education and innovations.

A farmer cultivated an average of 3.9 ha indicating that they are predominantly small-scale farmers. About 21.4% of them cultivated above 4.0 ha. An average respondent had been cultivating cassava since 21 years ago. Thus, he has adequate understanding of his farm settings. About 55.0% of the cassava farmers were members of cooperative societies while 45.0% did not subscribe to cooperative group. This could determine their accessibility to investment fund or loan.

Table 1: Socio-economic characteristics of the respondents

Variable	Frequency	%	Mean
Age (years)			
40 and below	16	11.4	
41 - 50	77	55.0	48 years
51 - 60	36	25.7	
61 and Above	11	7.9	
Sex			
Male	130	92.9	
Female	10	7.1	
Marital status			
Single	7	5.0	
Married	120	85.7	
Divorced	8	5.7	
Widow	5	3.6	
Household size (number)			
1 – 4	27	19.3	
5 – 8	100	71.4	6 members
> 8	13	9.3	
Educational level (years)			
No formal education	54	38.6	
Primary education	30	21.4	
Secondary education	40	28.6	
Tertiary education	16	11.4	
Farm size (ha)			
Below 2.0	54	38.6	
2.0 - <4.0	56	40.0	3.9 ha
4.0 - <6.0	13	9.3	
6.0 and above	17	12.1	
Farming experience (years)			
Below 10	47	33.6	
10 - < 20	28	20.0	
20 - < 30	40	28.6	21 years
30 and above	25	17.9	
Membership of cooperative			
Yes	77	55.0	
No	63	45.0	
Total	**140**	**100.0**	

Source: Field survey, 2019

Table 2: Costs and returns structure of cassava farming per hectare in the study area

Item	Mean (₦)	% of Total Cost
Sources of Revenue		
Sales of tubers	241,151.43	
Sales of stem cuttings	1,048.05	
Total Revenue (TR)	**242,199.48**	
Cost of Variable Inputs		
Purchase of stem cuttings	1,123.14	0.67
Cost of farm labour	115,916.24	68.97
Fertilizers -0.31	22,094.46	13.15
Herbicides	3,497.37	2.08
Insecticides	2,750.37	1.64
Tractor services	10,364.29	6.17
Total Variable Cost (TVC)	**155,745.87**	**92.67**
Cost of Fixed Inputs		
Rent on land	11082.75	
Farm shield	1231.42	
Total Fixed Cost (TFC)	**12,314.17**	**7.33**
Total Cost (TC)	168,060.04	100.00
Gross Margin (GM)	86,453.61	
Net Farm Income (NFI)	74,139.44	
Rate of Return on Investment (RRI=NFI/TC)	0.44	
Profitability Index (NFI/TR)	0.31	
Benefit-Cost Ratio (TR/TC)	1.44	

Source: Field survey, 2019

Cost and returns structure of the sampled cassava farms

The cost and returns structure of cassava farming in the study area was estimated by budgetary equations. The results of the estimation in Table 2 shows that man-days of labour was the most expensive variable input in cassava farming and it constituted 69.9% of total cost of production followed by fertilizer (13.15%). The cheapest variable input was stem cuttings at 0.67%. This is possibly due to harvesting and recirculation of stem cuttings from previous planting.

The average total cost of production was ₦168,060.04 per hectare while the total revenue was ₦242,199.48 per hectare. Thus, the gross margin was ₦86,453.61 per hectare showing that cassava farming is a profitable venture in the study area. The profitability index was 31% while benefit-cost ratio was 1.44. However, rate of return on investment of 0.44 implies that the studied cassava farmers made an average net profit of ₦44 over every ₦100 expended as total cost of production. This shows an appreciable proportional return on farm investment despite that the farmers basically employed traditional method of production.

Technical efficiency of the cassava farms

The results of the technical efficiency of the cassava farms analysed by the stochastic production frontier (SPF) model is presented in Table 3. The results reveal that the variance parameter sigma square (δ) was significant (5%). This indicates a good fit of the model to the data and correctness of the distributional form of assumption for the composite error term. The gamma (γ) which measures the proportion of deviation from the frontier due to inefficiency is 0.8838 and significant (1%). This means that more than 88.38% of the variation in the technical efficiency of the cassava farms is explained by the independent variables while the remaining 11.62% variation could be due to some uncontrollable factors such as weather, climatic and edaphic conditions.

The coefficient of farm size was positive and significant (at 1%) showing that increased farm size contributed to higher technical efficiency among the cassava farms. Perhaps, increased farm size promoted the use of modern technologies leading to higher efficiency gains. The coefficient of labour was positive and significant (at 10%) indicating that increased labour usage contributed to increased production efficiency on expanded farm size. This implies that the larger the farm, the higher the technical efficiency of cassava production in the area.

Fertilizer was negative and significant (at 1%) meaning that fertilizer application contributed to a decline in the efficiency of cassava production perhaps due to wrong application. Thus, the extension agents need to educate the farmers about the use of fertilizer in cassava production.

The results shows that, among the inefficiency variables, educational level had a negative coefficient which was significant at 1%) meaning that education had a declining effect on inefficiency of cassava production. In other words, the higher the farmer's level of education, the lower his level of inefficiency in farm production. Thus, extension programmes should be used to fill the gaps in education among the farmers.

Table 3: Determinants of technical efficiency of the cassava farms

Variables	Coefficient	Standard-error	t-ratio
Constant	8.2134***	0.9970	8.648
ln Farm size	2.2289***	0.4528	5.056
ln Labour	0.4928*	0.2943	1.674
ln Cassava stem cuttings	-0.0793	0.1751	-0.453
In Agro chemicals	0.1014	0.4140	0.245
In Fertilizer	-0.4457***	0.0883	-5.050
Inefficiency			
Constant	0.6104	1.1014	0.602
Age	-0.4588	0.6485	-0.706
Gender	-0.7586	1.0688	-0.710
Marital status	0.4140	1.6713	0.248
Educational level	-4.3218***	0.3101	-13.937
Farming experience	0.1349	0.7357	0.183
Household size	-1.3722	0.9204	-1.491
Extension visit	-0.1904	0.1300	-1.464
Sigma-squared	1.5991***	0.1103	14.493
Gamma	0.8838***	0.0612	14.450

Source: Field survey, 2019
Significant at 5%, * Significant at 1%

Table 4: Frequency distribution of technical efficiency of cassava farmers

Variables	Freq.	%	Min.	Mean	Max.
Below 0.20	2	1.4	0.0998		
0.20 - <0.40	31	22.1			
0.40 - <0.60	41	29.3		0.5950	
0.60 -<0.80	38	27.1			
0.80 and above	28	20.0			0.9637
Total	**140**	**100.0**			

Source: Field survey, 2019

Technical efficiency of individual farm

Table 4 shows the distribution of individual farms by their level of technical efficiency. The efficiency range is between 0.099 – 0.964. The technical efficiency of an average cassava farm was 0.595 showing that the performance of a farm was slightly above average. This indicates that the farmers need to increase their efficiency by additional 40.5% to attain maximum level of production. At least, 23.5% of the farms performed below the mean technical efficiency while a minimum of 47.2% were efficient above the average level.

The challenges of cassava farming in the study area

The challenges of the farmers are presented in Table 5. Each constraint was evaluated based on total sample of 140 respondents since a farmer could be confronted with two or more problems. The results show that majority (70.0%) were confronted by inadequate fund and limited access to agricultural loan. This could be as a result of low participation in cooperative society or low savings among the respondents. Besides, 67.9% of them complained about the attack of cattle and herdsmen on their cassava farm leading to high crop losses. It was also reported that rodents attack contributed to reduced output while disease attack was not evident during the production season.

Table 5: Distribution of the respondents by constraints against cassava farming (n = 140)

Constraints	Freq.	%	Rank
Inadequate fund/ access to loan	98	70.0	1st
High cost/ scarcity of farm labour	77	55.0	4th
Fluctuation/ low farm gate price for tubers	79	56.4	3rd
Attack of cattle/ herdsmen	95	67.9	2nd
High cost of modern inputs/ fertilizer	67	47.9	5th

Source: Field survey, 2019; Each constraint (%) = (frequency divided by sample size) x100.

Low farm gate price of tubers was reported by 56.4% of the farmers. The complaint was that the market price was unstable and the merchants dictated the price perhaps as a result of market forces i.e. demand and supply. About 55.0% of the respondents identified scarcity and high cost of hired labour. They explained that many of the youths preferred transportation business i.e. motorcycle (Okada) riding than farm labour. The lowest ranked problem which is high cost of modern farm inputs e.g. fertilizer, tractors services was identified by 47.9% of the farmers.

Conclusion

The findings of the study revealed that the technical efficiency of the cassava farmers was slightly above average at an average of 59.5%. The farmers can increase their production efficiency by another 40.5% to obtain maximum output. Despite this average performance, the estimates show that cassava farming was profitable with a Net Farm Income of ₦74,139.44 per hectare. The returns on investment was 44% above the cost of production. The study concluded that there is need for private and government efforts to ensure policies that would promote expansion of cultivated cassava farm such as input subsidies, adequate credit facilities for group farming, guaranteed market and price for cassava output among others, in order to increase the production efficiency of the farmers.

Farm size and labour had significant increasing effects on technical efficiency of cassava production. Therefore, private and government efforts should ensure adequate distribution of improved inputs such as fertilizer, chemicals, improved stem cuttings and tractor services at affordable cost to enhance expansion of farm size and labour production efficiency in cassava farming. The farmers should be enlightened to participate in cooperative societies andexplore them as major source of funds for farm investments while government should provide financial assistance in form of credit or soft loan through the farmers' associations at affordable interest rate.

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Conflict of Interest

Authors declare that there is no conflict of interest reported in this work.

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