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ECONOMIC RETURNS AND TECHNICAL EFFICIENCY IN CASSAVA-BASED FARMING SYSTEMS IN YEWA COMMUNITIES OF OGUN STATE, NIGERIA

***O. A. C. OLOGBON, [1]O. OYEBANJO, [2]O.P. OLUWASANYA, [3]A.R. ILORI, [3]M.O. FADIPE,**

[1]Department of Agricultural Economics and Farm Management
Faculty of Agricultural Management and Rural Development
Olabisi Onabanjo University, Ayetoro Campus, Ogun State, Nigeria
[2]Department of Cooperative Management and Rural Development
Faculty of Administration and Management Sciences
Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria
[3]Department of Agricultural Extension and Rural Development
Faculty of Agricultural Management and Rural Development
Olabisi Onabanjo University, Ayetoro Campus, Ogun State, Nigeria
*Corresponding Author: chrisologbon2017@gmail.com Tel: +2345210030

ABSTRACT

This study analyzed the economic returns and technical efficiency in cassava-based farming systems in selected communities in the Yewa axis of Ogun State. Data were collected from 120 cassava farmers in a two-stage sampling technique. The data were analyzed using descriptive statistics, budgetary technique, and the stochastic frontier model. The study showed majority of the cassava farmers in the study area to be male, ageing, less formally educated but well experienced in farming. Result of the enterprise's budgetary analysis showed that cassava sole-cropping generated a total gross margin (GM) of ₦236,051 and net farm income (NFI) of ₦233,862 as against the values of ₦474,084 and ₦470,168 respectively, for cassava intercrop program during the same production year. From the findings, sole cropping has total factor productivity (TFC) value of 0.46, producing more cassava yield from each unit of the input used than in intercrop program with a TFC value of 0.1. Land and labour inputs were critical determinants of cassava output in the study area, while the involvement of younger folks in the cassava farming enterprise and attainment of higher education will significantly improve the technical efficiency of the cassava farmers. An average technical efficiency level of 79 percent was obtain for cassava production systems, implying a 21% gap for it to reach maximum production potentials. It was recommended that the policy formulation that will enhance access of the cassava farmers to more cultivable land, improved educational opportunities (through adult literacy education) and labour saving device/technology will assist to rapidly transform the cassava production systems in the study area. This will also help them increase their profitability and efficiency level in cassava production.

Keywords: Technical efficiency, Profit level, cassava-based systems, total factor productivity

INTRODUCTION

Cassava (*Manihot esculenta crantz*) is a perennial woody shrub with an edible root, a major staple crop grown throughout the lowland tropics. Cassava products are dietary staple food in Nigeria and other countries in sub-Sahara African (SSA) nations. Nigeria is populated with over 200 million people, and 7 in every 10 Nigerians consume, at least, a product of cassava once in a day (Njoku and Muoneke, 2008). These products, which are derived from cassava roots, include cassava flakes (gari), cassava flour (pupuru and lafun), cassava paste (fufu or akpu), eaten by a vast segment of people that cut across the different geopolitical zones of Nigeria. It is a widely acceptable energy-based staple food to over 600 million consumers of cassava across the globe as it is considered food for the poor (Hershey et al, 2001; FAO, 2015), high-yielding (71 tonnes/ha), highly tolerant to erratic weather condition including a range of rainfall (El-Sharkawy, 2003), and mostly preferred for its ability to survive in less-competitive soils (Nwokoro et al., 2002). According to Kormawa and Akoroda (2003), close to 84% of domestic cassava production is available for consumption while the remaining 16% is available for industrial use in Nigeria

African countries produce over 103 million metric tonnes cassava per annum with Nigeria accounting for approximately 35 million metric tonnes per annum (FAO, 2009) to emerge the largest producer in the world; three times the production level in Brazil, and almost double that of Thailand and Indonesia (FAO, 2011). *Globally, cassava cultivation has experienced consistent growth of well above 3% annually* (FAO, 2018). The total area harvested in 2003 was 31 million hectares with average yield of about 11 tonnes per hectare (IITA, 2005), but as at 2018, Nigeria produced about 60 million tonnes (FAO, 2018; FAOSTAT, 2019). The World cassava production output stood at about 278 million tones while Africa total production was about 170 million tonnes (about 56% of world production), according to FAOSTAT (2019). A technical bulletin (IITA, 2005) attributes the large harvest in Nigeria to rapid population growth, internal market demand, availability of high yielding improved varieties of cassava tuber, and increase hectrage of farm land allocated to cassava in the country. Generally, cassava is one of the fastest expanding staple food crops in cassava consuming countries and has continued to gain prominence among farmers while the industrial demand is also rising consistently (Food and Agricultural Organisation FAO, 2018).

Engaging in cassava farming can be a powerful approach to eradicating poverty in many Nigerian rural households. The cash income from cassava proves more egalitarian than the other major staples because of its lower resource requirements to produce when compared with many other major staples. It tolerates poor soil, adverse weather and is more pest and diseases resistant than many other major staple crops. Cassava intercropped with other crops has from time immemorial been the prevalent arable cropping system in the large guinea savanna vegetation agriculture in Nigeria (FAO, 2004). Traditionally, about two to three crops are often intercropped with cassava, most importantly maize and melon. The crops are selected on the basis of differences in growth habits and soil nutrient requirements, all of which have economic implications for improved household income. Cassava as a major component of the intercrop enterprise usually contributes significantly to the total farm income among other crops (Bamire *et al*; 2004). However, crucial issue in the Nigerian cassava intercrop system is that of low productivity (Nang'ayo et al., 2007). Cassava-based farms just like many other cropping programmes in sub-Sahara Africa (SSA) are largely small-scaled with their attendant low productivity complexes. Relatively, most Africa's population lives in rural areas and characterized by subsistence farming, poor roads and other poor infrastructure, poor market information, low literacy levels and relatively high levels of poverty. Constrained by the problem of resource poverty, rural farmers use little or none of the improved inputs important for increased productivity (Chukuji *et al*, 2006). Farmers' output therefore need to be expanded with existing levels of conventional inputs and improved technology. However, according to Wambui (2005), output growth is not only achieved by new technological innovations but also through efficient use of those technologies. More than ever, farmers will have to produce more efficiently to maximise output from a given mix of inputs, or use the minimum levels of inputs for a given level of output.

The framework for this study is developed from interplay of the theory of agricultural production, agricultural programme intervention and technical efficiency in agricultural productivity. A production function is the technical relationship between inputs and outputs; that is, a function that summarizes the process of conversion of factors into a particular commodity. It shows the maximum amount of the goods that can be produced using alternative combinations of the various inputs. The importance of efficiency in increasing agricultural production has been widely recognized and investigated by researchers (Seyoum *et al*, 2000; Abay *et al*, 2004; and Chavas *et al*, 2005; and Bravo-Ureta and Pinheiro, 1993).

The concept of efficiency can be said to deal with the relative performance of the processes used in the transformation of inputs into outputs. Economic theory's discussion of efficiency distinguishes it into two types; namely, allocative efficiency and technical efficiency. Furthermore, (Farrell, 1957), one of the pioneers of efficiency studies distinguished the two types of efficiency through the use of the frontier production function (Xu and Jeffery, 1998). Technical efficiency is defined by the duo as the ability to produce a given level of output with a minimum quantity of inputs under certain technology. Allocative efficiency refers to the ability of choosing optimal input levels for given factor prices. The total efficiency otherwise called economic efficiency is the product of technical and allocative efficiency. The degree to which technical and allocative efficiency are achieved is referred to as production efficiency.

This background provides motivation for this study to examine the economic returns and technical efficiency in cassava-based production systems in selected Yewa communities of Ogun State, Nigeria. Specifically, the study objectives were to estimate the profitability of cassava-based production system, and to determine the technical efficiency in cassava-based production systems in the study area.

METHODOLOGY

This describes the area of study, sampling techniques, method of data collection and method of data analysis.

The study area

Ogun State lies within the tropics latitude 6° N and 80° N and longitude 2° E and 5° E. The State covers a land mass of 16,025 sq km with an estimated population of 3,738,570 (NPC, 2006). The geographical setting for this study is the Yewa North axis of Ogun State, with a mean annual rainfall of about 1,200mm and a mean monthly temperature of 10□ C – 24□ C during the rainy season and 30□ C – 35□ C during the dry season, adjudged to be suitable for cassava production (IITA, 2005). Many households in this local area depends on farming activities as their primary occupation.

Sampling techniques

The survey technique that was employed is two-stage sampling technique. In stage one, among several farming communities/towns in the Local Government Area, five (5) were purposively selected based on the concentration of cassava farmers in the areas. The selected towns include: Ayetoro, Igan-Okoto, Igbogila, Imasayi and Igan-Alade. Stage two involves selection of twenty four (24) respondents from each town to give a total number of one hundred and twenty (120) farmers from whom relevant data were obtained through structured questionnaires.

Methods of data analysis

Descriptive analysis, budgetary technique, productivity function and stochastic frontier analysis were used to analyze the data collected.

Socio-economic characteristics of the respondents/farmers

Descriptive statistics such as tables, percentage, frequency and mean were used to describe the socio-economic characteristics of the farmers.

Profitability level of cassava-based production systems

The budgetary analysis was employed to determine profitability level in cassava-based production systems. The Gross Margin and net farm income were estimated as:

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

$$NFI = GM - TFC \quad (2)$$

where:

GM = Gross Margin, TVP = Total Value of Production, TVC = Total Variable Cost

NFI=Net Farm Income and TFC = Total Fixed Cost.

TVP = PQ

P = Unit price of output, Q = Quantity of output, TVC entails all the cost involved in the production of output that are variables e.g. cost of cassava cutting, fertilizer, other agrochemicals, among others. TFC comprises all fixed costs involved in cassava production, such as rent on land, farm tools, and farm machineries.

Productivity analysis in cassava-based production systems

The Total Factor Productivity (TFP) analysis was used to estimate the productivities of major cassava based systems in the study area. Total Factor Productivity (TFP) following Key and Mcbride (2003), can be measured as the inverse of unit variable cost. This is so since TFP is the ratio of the output to the Total Variable Cost (TVC) as shown in equation 3.

$$TFP = \frac{Y}{TVC} \quad (3)$$

Where Y = quantity of output in kilograms and TVC = Total Variable Cost in naira (₦)
Put in an alternative form,

$$TFP = \frac{Y}{\sum P_1 X_1} \quad (4)$$

Where P_i = unit price of i^{th} variable input and X_i = quantity of i^{th} variable input. This methodology ignores the role of Total Fixed Cost (TFC) as this does not affect both the profit maximization and the resource-use efficiency conditions. Besides, it is fixed and as such a constant. From cost theory.

$$AVC = \frac{TVC}{Y} \quad (5)$$

Where AVC = Average variable cost in naira (₦). Therefore,

$$TFP = \frac{Y}{TVC} = \frac{1}{AVC} \quad (6)$$

As such, TFP is the inverse of the AVC.

Technical efficiency measures in cassava -based production system

To determine the technical efficiencies, Cobb-Douglas frontier production function was estimated which is defined by:

$$Ln\ Y = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_4 lnX_4 + Vi - U_i \quad (7)$$

where:
Y = output of farmer (grain equivalent), Ln = natural logarithm, X_1 = land (hectares), X_2 = labour (mandays), X_3 = fertilizer (kg), X_4 = planting material cost (₦), X_5 = depreciation cost (₦) and $\beta_0, \beta_1, \beta_2, \beta_3,$ and β_4 are regression coefficients; Vi = random variables which are assumed to be independent of U_i, identical and normal distributed with zero mean and constant V variance N (0, Sv^2); U_i = technical efficiency effect which are the result of behavior factors which

could be controlled by an efficient management.

The inefficiency of production, U_i will be modeled in terms of the factors that are assumed to affect the efficiency of production of the farmers. Such factors are related to the socio-economic variables of the farmers. The determinants of technical efficiency are defined by the relation:

$$U = \delta_o + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 \quad (8)$$

where:
U_i = technical efficiency, Z_1 = gender, Z_2 = age, Z_3 = household size, Z_4 = education, Z_5 = farming experience and δ_0 to δ_5 are efficiency parameters.

These variables are assumed to influence technical efficiency of the farmers. The gamma ($\gamma = \delta_u^2 / \delta^2$) which is the ratio of the variance of U (δ_u^2) to the Sigma squared (δ^2) which is a summation of variances of U and V ($\delta_u^2 + \delta_v^2$) were also determined. The Maximum Likelihood Estimate Method using the computer FRONTIER version 4.1 was used to estimate the parameters of the Stochastic Frontier Production Function.

The technical efficiency of an individual firm is defined in terms of the observed output (Y_1) to the corresponding frontier output (Y_1^*) given the available technology. This could be expressed mathematically as:

$$TE = Y_1 / Y_1^* \quad (9)$$

where:
Y_1 = observed output and Y_1^* = frontier output
Equation 9 can thus be expressed as:

$$TE = Y_1 / Y_1^* = Exp\ (Xi\beta + V_i - U_i) / Exp\ (X\ \beta + V_i) = Exp\ (-U_i) \quad (10)$$

Therefore, $0 \leq TE \leq 1$.

RESULTS AND DISCUSSION

Socio-economic characteristics of cassava farmers

Socio-economic characteristics usually refer to components of economic and social status that distinguish and characterize people. Cassava farming engagement in the study area is dominated by married (about 91%), adult (mean age 52 years), male (about 83%) farmers with mean educational attainment of the farmers of 12 years (Table 1). These have implications for future productivity decline in the cassava farming industry in the study area following the assertion by Ajibefun (2015) that the age and sex of farmers largely determine their ability to perform physical, hard labour while the agility that comes with youthfulness could improve farm productivity. The low educational attainment of farmers would also impede the decision making capacity of the farmers, with respect to adoption of appropriate farming technology, reducing their farm productivity (Epeju, 2010).

Being mainly married, mean household size of 6 persons per household in the study area underscores the likelihood of high dependence on household labour for major farm operations, with the likely option of complementing with hired labour rather than mechanical power as earlier foreclosed by their low education. The large household size also has implications for farm labour supply (adopted by 47.5% of the farmers), labour income source/composition, share of home consumption in own farm outputs, as well as mean per capita output (Okpara, 2010). The mean years of farming experience (about 16 years) is also expected to impact significantly on the profitability and productivity rating of the intercropped cassava-based farms. Findings from the study (Table 1) also showed that about 69% of the smallholder farmers cultivated not more than 2 hectares (with mean farm size of 1.1 hectare) on land parcels accessed mainly (about 68%) through communal arrangement, which has serious implications for future farmland expansion and the propensity of the smallholder farmers to grow commercial to enjoy scale economy in cassava farming.

Table 1. Socio-economic characteristics of cassava farmers (n = 120)

Variable	Frequency	Percentage	Mean
Age			
20-40	48	40.0	
41-60	54	45.0	52
>60	18	15.0	
Gender			
Male	100	83.3	
Female	20	16.7	
Education			
0-6	18	15	
7-12	58	48.3	12.02
13-16	44	36.7	
Marital status			
Single	11	9.2	
Married	109	90.8	
Household size			
1-3	18	15	
4-6	40	33.3	6.0
7-9	51	42.5	
10-12	11	9.2	
Farming experience			
0-10	28	23.3	
11-20	60	50.0	16.28
21-30	32	26.7	
Type of labour used			
Family labour	57	47.5	
Hired labour	50	41.7	
Rotational labour	13	10.8	
Mode of land acquisition			
Communal arrangement	81	67.5	
Inheritance	39	32.5	
Farm size			
0-2.0	83	69.2	1.1
>2.0	37	30.8	

Source: Computed from field survey data, 2017

Profitability of cassava-based/intercrop farming

Cassava-based farms like many other inter-cropped enterprises in the study area, have some fixed and variable costs items spread across the various crops in the intercrop program. These shared costs include asset depreciation, weeding and fertilizer application costs, and transportation, among others. Other aspects of the variable costs can be directly attached to particular crops in the program. These include mainly the cost of seeds and stem cuttings. The shared fixed and variable costs were apportioned as a percentage of the sales revenue from the output realized from each crop in the intercrop program. The cost-revenue outlay for the cassava-based intercrop in comparison with cassava sole-cropping is presented in Table 2.

From Table 2, the net farm income (NFI) generated from the intercrop program (₦470,168) supersedes that of the sole-cropping (₦233,862). On the other hand, the average Total Factor Productivity (TFP) of the intercrop (0.11) is lower than that of sole-cropping (0.46), implying that other exogenous factors outside the mean variable cost may have contributed immensely to the NFI for the cassava intercrop enterprise. This could be as a result of the higher price per ton for the output of each output in the intercrop as compared to that of the sole crop (cassava) output. By implication, the higher NFI recorded from the intercrop program is not necessarily as a result of higher cost efficiency but due to market value of crop output from the intercrop. However, the cassava sole-cropping has a higher total productivity factor (TFC) value (0.46), indicating that more yield is obtained from each unit of the input used in sole cropping cassava production compared to the intercrop program.

Table 2. Profitability and factor productivity analysis in cassava-based production systems

SD = Standard Deviation

S/N	Variables	Sole-cropping		Intercrops		All Farms	
		Mean (₦)	SD	Mean (₦)	SD	Mean (₦)	SD
1	Output in tones	27.35	11.73	50.1	2.2		
2	Revenue	295,651	239,854	522,219	374,878	817,871	504.329
3	Variable cost	59,599	26,009	48,134	25,067	57,358	22,758
4	Fixed cost	2,189	795	3,916	1,302	6,105	1,874
5	Total cost	71,475	58,062	44,905	34,451	116,380	79,743
6	Gross Margin	236,051	224,843	474,084	361,075	710,136	474,408
7	Net Farm Income	233,862	224,649	470,168	360,864	704,031	474,408
8	Total Factor Productivity (TFP)	0.46		0.11		0.28	0.04

Source: Computed from field survey, 2017

Maximum Likelihood Estimates (MLE) of the cassava-based production systems

The variance parameters for sigma- square (δ^2) and gamma (γ) were 0.011 and 0.96 and are significant at 1 percent respectively (Table 3). The sigma-square attests to the goodness of fit and correctness of the functional form assumed for the composite error term while the gamma indicates the systematic influences that are unexplained by the production function and the dominant sources of random errors. This implies that about 96% of the variation in output of the farmers is due to the differences in their technical inefficiency. The slope coefficients of all productive inputs are significant at 1% probability level except for the coefficient of labour which is significant at 10% level and that of 'other costs' which is not significant. Land ($p<0.01$; 0.1368) and labour ($p<0.1$; 0.1186) are critical inputs in the production of cassava in the study area (Table 3). Therefore, if farmers increase their cultivated land and labour by 1 per cent, there will be a marginal increase in cassava output by 0.1368 and 0.1186 per cent, respectively. However, fertilizer ($p<0.01$; 0.0072) and planting cultivars ($p<0.01$; 0.0098) though significant to the output level of cassava, percentage increase in these inputs will have no impact on the level of output. This finding is in consonance with the report of Akerele et al. (2019) on smallholder cassava farmers in a related study also carried out in Ogun State.

The contribution of socio-economic variables to technical efficiency shows that age (0.0184), household size (-0.0022) and level of education (-0.0037) are significant at 1%, 5% and 1% level respectively (Table 3). The finding indicates that involvement of younger folks in cassava production will improve output and increase farming efficiency. Likewise, increase in the size of farmer's household and level of education increases inefficiency or improves efficiency in cassava farming, confirming the assertion of Ajibefun and Abdulkadri (2004) that educational is key to innovative technology adoption in cassava farming, while larger households will afford more family labour for cassava production. The mean technical efficiency of 79% indicates that cassava farmers have potential to increase their output by 21%. By implication, the cassava farmers have not attained the maximum possible output level.

Table 3. MLE Estimates of the cassava-based output in the production function

Variables	Coefficient	T-ratio
Production Function		
Constant	-1.2309*** (0.1143)	10.76
Land (X_1)	0.1368*** (0.008)	17.1
Labour (X_2)	0.1186* (0.069)	0.006
Fertilizer (X_3)	0.0072*** (0.002)	3.60
Planting material (cultivars) (X_4)	0.0098*** (0.003)	3.27
Other cost inputs (X_5)	0.0006 (0.093)	1.72
Inefficiency Model		
Constant	-0.079*** (0.015)	5.27
Gender	-0.0017 (0.002)	-0.85
Age	0.0184*** (0.001)	18.40
Household size	-0.0022** (0.001)	-2.20
Education	-0.0037*** (-0.001)	-3.70
Farming experience	0.0001 (0.0001)	1.000
Diagnosis Statistics		
Sigma squared (σ^2)	0.011*** (0.0019)	5.66
Gamma (γ)	0.96*** (0.09)	10.67
Log Likelihood Function	107.59	
LR test	74.55	
Mean Technical efficiency	0.79	

*****, **,*** imply significant at p values of .01, .05 and .10, respectively

Figures in parentheses are the standard errors.

Source: *Computed from field survey data, 2017*

CONCLUSION

Despite the enormous importance of the cassava growing sub-sector in closing the food insecurity gaps and serving as a major income source in the study area, its production is gradually becoming an activity left in the hands of the non-literate and the aged unless something drastic is immediately done to address this trend. As expansion of cassava output in the study area is largely determined by increases in the units of land and labour employed, the cassava farmers engage more into cassava-intercrop program than mere sole cropping so as to increase their profit and by direct implication, their level of household income. Market value of crop output from the intercrop program plays a significant role in increasing the net farm income for cassava-based production system but overall, total productivity factor value is higher in the cassava sole-cropping than in the intercrop making the former to have higher yield potentials that the latter.

RECOMMENDATIONS

Based on the results from the findings, the following recommendations were made to improve on the profitability and production efficiency of cassava-based farming systems in the study area:

Policies that will improve on the level of formal education and attract more youth into the cassava farming sub-sector should be pursued vigorously in order to ensure ease of technology adoption in the industry; Access of smallholder farmers to more farm land should be a major concern so as to achieve the much needed expansion in cassava production in the study area.

Since employment of labour input will guarantee more cassava production, access of farmers to, and training them in the adoption of labour-saving devises/technology, will ensure faster commercialization of the cassava production industry in the study area.

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