PAT June, 2014; 10 (1): 74-92 ISSN: 0794-5213

Online copy available at

www.patnsukjournal.net/currentissue

Technical Efficiency of Smallholder Cassava Farmers in Selected Local Government Areas In Kogi State, Nigeria

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Abstract

The study examined the technical efficiency of 110 smallholder cassava farmers selected from two Local Government Areas in Kogi State, Nigeria. Descriptive statistics and stochastic frontier production function were used to analyze the primary data collected with the aid of a structured questionnaire. The maximum likelihood estimates showed that labour (0.5054), planting material (0.432) and land resource (0.1388) were the important production factors and directly related to cassava output. The parameters that increased technical efficiency are education, farming experience and extension contacts while age, membership of farmers' group and household size reduced technical efficiency with mean technical efficiency of 0.9489 (94.89%). The estimates indicated that the farmer have not fully utilized the variable resources as the return to scale was 1.7724. The study concluded that there were still some levels of inefficiency of 0.0511 (0.5.11%) among the cassava farmer; and that the significant production and inefficient factors should be manipulated by the farmers and policy makers to increase the technical efficiency and invariably the output. Young and educated men and women should be encouraged to take up cassava production by providing them access to credit, improved varieties, farm mechanization implements and adequate extension services.

Keywords: Smallholder, Cassava farmers, Technical efficiency, Stochastic Frontier Approach

Introduction

Although, Nigeria is the leading world producer of cassava with production of 33,379 metric tonnes in 2004; there is a shortage in supply of 60 percent; a gap needed to be filled by Nigerian farmers (Babalola, 2002; Aregheore, 2009). Cassava is a staple starch food for millions of people in tropical countries and for livestock feed. It is consumed in form of granules (gari), lafun, farina, pastes, flour, boiled, raw, chips, flakes, cubes, peelers, pellets, adhesives and its leaves consumed as vegetable to supply vitamins A and B and protein. Other uses include confectionery, pharmaceutical, beverages, chemicals, textile, and dry cell, adhesive for paper, plywood and packaging industries. Its flour is a good substitute of wheat flour in baking bread. Based on this multi-dimensional uses of cassava, it is highly demanded in international market and therefore boosts export market for Nigeria. About 40 million tonnes of cassava is produced in almost all the states of Nigeria with improved variety, but 90% of this is consumed locally (PALIP, 2004 and Iyali, 2004). In addition, cassava is a powerful poverty reduction enterprise due to its low input requirement, and low cost of food source to rural and urban dwellers. Therefore, cassava is a crop that could be exploited in finding solutions to Nigerian agricultural problem of poor performance. Nigerian agricultural sector has failed to keep pace with the demand of households and industries for farm products either as food or raw materials due to a combination of negligence due to petroleum discovery, political and civil unrest, economic stagnation, rapid population growth and erratic rainfall (Anonymous, 2004a; Oyedipe, 2001 and Umar, Audu and Waizah, 2011). This has resulted in food shortages and consequently food importation (Stock, 2009). In recent times, much has been said and done about the urgent need to promote investment in agriculture, particularly cassava production for self-sufficiency in food security for the persistently rising population, for poverty alleviation and to arrest the declining contributions of agriculture to Gross Domestic Product (GDP) in Nigeria.

Nigeria had always designed appropriate programmes for such investment and its strategic plans and projects are often well formulated and among the best in developing countries. Examples of such programmes designed to promote agricultural production are Nigerian Agricultural Co-operative and Bank (NACB) now Bank of Agriculture (BOA), Nigerian Agricultural and Insurance Corporation (NAIC), Agricultural Development Programme (ADP). National Accelerated Food Production Programme (NAFPP),National Agricultural Land Development Authority (NALDA), River Basin Development Authorities (RBDAs), Federal Department of Rural Development (FDRD),Commercial Agriculture Credit Scheme (CACS), Agricultural Credit Guarantee Scheme Fund (ACGSF), Interest Drawback Programme (IDP) and most recently the Nigeria Incentive-Based Risk Sharing for Agricultural Lending (NIRSAL) (CBN,2010, Agriculture today, 2011). But how far have these programmes succeeded in achieving the objectives of the schemes given her natural and human resources endowments? Little has been achieved through these projects because of government instability leading to frequent policy changes, corruption and poor implementation. In order to exploit the advantages of cassava production in terms of foreign reserve generation, self-sufficiency in food security, replacing wheat flour with cassava flour and curtailing the importation of wheat and other food items; Federal Government of Nigeria made an intervention in production of cassava in July, 2002 and set up Presidential Initiative on Cassava Production, Processing and Export (Anonymous, 2014a,b; Awoyinka, 2009) in addition to other cassava projects such as Cassava Multiplication Project (CMP) and Root and Tuber Expansion Programme (RTEP). The objectives of the presidential Initiative included to increase cassava cropped area to 5 million hectares, to obtain yield of 150 million tonnes, to earn export income of USD 5 billion and to introduce vitamin A rich cassava variety to 1.8 million farmers by 2010 (Anonymous, 2014a and Awoyinka, 2009). The strategies of this presidential initiative on cassava of 2002 to achieve these laudable objectives included production of 9.2 million bundles of breeder stock by 2007 by National Root Crop Research Institute (NRCRI), Umudike, 250 million bundles of certified stock by 2007 by Agricultural Development Programme (ADP) and 73.2 million bundles of foundation stock by Root and Tuber Expansion programme (RTEP). Cassava production has been on increase since 2009 which might due to this intervention and if well harnessed, it would be next to petroleum in GDP contribution (Awoyinka, 2009). Again, the collaborative efforts of National Root Crop Research Institute (NRCRI), umudike, International Institute of Tropical Agriculture (IITA), Ibadan, Agricultural Development Programme (ADP), Ministry of Agriculture and Natural Resources (MANR), The International Fund for Agricultural Development (IFAD) and United States Agency for International Development (USAID) have resulted in the introduction of genetically improved resistant cassava cultivars currently in use in the country. Even there was a presidential bill of compulsory inclusion of 10 per cent cassava flour in the production of bread and other flour-based foods by the present administration and it has been sent to lawmakers at the National Assembly (Adeniyi, 2012). Despite the increase in cassava production, it remained well behind the population growth rate of Africa (Awoyinka, 2009; Okigbo, 1987), but it is the only tropical root and tuber which plays some role in world trade (Jochen, 1993). Therefore, based on these programmes, initiatives, government interventions and introduction of resistant cultivars on cassava and the quest to meet the demand of the growth in the population, there is the need to examine the technical efficiency of production of this important crop to aid policy formulation, increase productivity and derive maximum benefit from its production. Also cassava has low input requirements and farmers in Nigeria are poorly endowed with farm resources and as such the available scarce inputs need to be efficiently utilized, hence the need to investigate the technical efficiency of cassava production (TE). In addition more than 3 million people eat cassava in Nigeria (PALIP, 2004), therefore, there is the need for greater TE, lower cost of production and enhance productivity (Simpa, 2014). Determination of production efficiency helps to identify source of inefficiency and this would enable public and private sectors to improve performance (Shehu, 2013) in cassava production. In view of all these, the objectives of this paper are to describe the socio-economic characteristics, determine the return to scale and examine the technical efficiency of smallholder cassava farmers in Kogi State, Nigeria.

Theoretical Framework on Technical Efficiency

Farm efficiency measurement is one of the important tools used by both researchers and policy makers in agriculture for evaluating farmers' performance. Farm production efficiency helps to identify source of inefficiency (Shehu, 2013). And efficiency is also an index to guide adjustment of resources and indicating problem areas that need further research (Olayide and Heady, 1982). Farrell (1957) conducted a pioneering study of efficiency of farms in the framework of production function. Therefore, theory of agricultural production function and technical efficiency (TE) in agricultural production are the basic concepts of this study. A production function describes the feasible technical relationship between input and output variables. It shows the process of conversion of input to output and maximum amount of a particular product that can be produced from available alternative combinations of the inputs needed.

Kumshakar and Lovell (2000) defined technical efficiency(TE) as the degree to which a farmer produces maximum feasible output from a given bundle of input (an output oriented measure) or uses the minimum feasible inputs to produce a given level of output (an input oriented measure). Researchers such as Etim *et al.*, (2013), Simonyan and Obiakor (2012), Orewa and Izekor (2012), Oluwatusin (2011), Oviasogie (2011), Shehu *et al.*, (2010), Rahman and Umar (2009), Ojo *et al.*, (2009), Ekunnwe *et al*., (2008), Ojo (2007), Abay, Miran and Gunden (2004) Nmadu and Simpa (2014) has variously studied TE of agricultural production and stressed its importance in increasing production. TE is a success indicator and shows the relative performance of the processes used in the transformation of inputs into outputs (Shehu, 2013 and Awoyinka, 2009). The level to which te chnical and allocative efficiency are achieved is referred to as production efficiency (Awoyinka, 2009). Farm efficiency measurement can be approached from three ways and these are cost frontier method, profit frontier and production function (the approach of this study using stochastic frontier function).

A deterministic stochastic frontier function introduced to solve the problem of inadequacies of production function in measuring TE (Meeusen *et al. (*1977) and Ali and Flinn, (1989). Deterministic production function explains that all deviations from frontier are attributed to inefficiency whereas in stochastic production function, it is possible to discriminate between random errors and farm specific factors and it differs in efficiency. A deterministic approach did not put into account that farms' performance can be affected by factors such as bad weather, poor performance of machinery or breakdown of input supply which are all beyond the farmer's control (Forsund *et al.*, 1980). Inefficiency (deviations from the efficiency frontier) could therefore, occur from two sources namely; inefficiency in input-use (which is farm specific) or random-variations in the frontier across different farms. Efficiency estimation in deterministic model is affected by statistical noise and this lead to use of stochastic frontier production function which takes care of the sources of inefficiency in production (Etim *et al.*, 2013). The efficiency parameters are included in the stochastic frontier so that their effects on the technical efficiency of producers could be measured. When SFPF is used, any variation in output is both due to technical efficiency effects (which could be controlled with efficient management of both human and material resources) and random error which do not come under the control of efficient management. Maximum likelihood Estimation (MLE) is an improvement on stochastic frontier. This improvement of stochastic frontier model enables one to measure firm level efficiency using MLE procedures; an econometric technique. However, stochastic approach allows for statistical noise Oluwatusin (2011) and Ojo *et al.*, (2009). The inefficient farm could be made efficient by increasing its output with the same input level or using fewer inputs to produce the same level of output (Shehu, 2013). The closer a farm gets to the frontier the more technically efficient it becomes (Ogunyinka and Ajibefun 2003). By definition, stochastic frontier production function is:

$$Yi = F(Xi; \beta) \exp(Vi - Ui) i = 1, 2,., N \qquad (1)$$

Where; Yi is the output of the ith firm; Xi is the corresponding vector of inputs; β is a vector of unknown parameter to be estimated; Vi is the symmetric error component that accounts for random effects and exogenous shock; while $Ui< 0$ is a one sided error component that measures technical inefficiency.

Many researchers have in recent times used Stochastic Frontier Production Function (SFPF) for analysis of agricultural data as a result of its ability to closely marry economic concepts with modeling realities (Dawang et al., 2011). This is due to the inherent variability of agricultural production because of interplay of weather, soil, pests, diseases and environmental constraints and farms are mostly owned by families who do not keep correct and required records and accounts of farm activities, hence available data on production are subject to measurement errors (Ojo, 2007). Simpa (2014) and Nmadu and Simpa (2014) worked on TE of yam farmers in Kogi State, Nigeria and found that age, educational level, household size and farming experience decrease technical inefficiency. Orewa and Izekor (2012) and Etim *et al*, (2013) worked on efficiency of yam production in Nigeria and found that the mean technical efficiency was about 70%. Similar works were carried out by Oluwatusin (2011), Shehu *et al.* (2010), Rahman and Umar (2009) and Ojo *et al* (2009) in Nigeria. All these studies concluded that there is more room for Nigerian farmers to increase food production by adjusting policy variables that were either found to increase output and reduce inefficiency. The above studies have also that shown MLE of stochastic frontier production function model is a strong analytical tool for measurement of technical efficiency in agricultural production, because it allows joint estimation of Cobb-Douglas function and efficiency model. This study adopted MLE approach for the estimation of Stochastic Frontier Production Function Model in examining technical efficiency of cassava production among smallholding farming households in selected Local Government Areas of Kogi State, Nigeria.

Methodology

Kogi State is located between latitude 6°30′N and 8°30'N of equator and longitude 5°51′ E and 8°00'E of Greenwich Meridian. Kogi state is located in the Guinea forest-savanna ecological zone of Nigeria (KADP, 1995). The population of the state was 3,314,043 in 2006 (NPC, 2006), it could now be estimated to 4,063,845.

A multi- stage random sampling procedure was used for selection of the respondents. At the first stage, two Local Government Areas were randomly selected from twenty-one Loal Government Areas in the state and these Local Government Areas were Okehi and Adavi. At the second stage, two villages each were selected randomly from each of the selected Local Government Areas (LGAs). The villages were Uboro and Ohu-epee and Osara and Aku from Okehi and Adavi LGAs respectively. The cassava farmers of the selected villages were enumerated to obtain the sampling frame of each of the villages as par Table 1. At third stage, 10% of the cassava farmers were randomly selected from each of the villages for response giving a sample size of 110. The data was collected using structured questionnaires administered by the researcher and trained assistants. The field survey was carried out in December 2013. The data collected was for 2012/2013 cropping season.

Table 1: Selected Local Government Areas, sample frame and size

Sampled LGA	Sampled Villages	Sampling frame	Sample size 10%
Okehi	Uboro	200	20
	Ohu-epee	280	28
Adavi	Osara	320	32
	Aku	300	30
Total		**1,100**	**110**

Source: Field survey, 2013

Analytical model

Descriptive statistics was used to describe the socio economic characteristics of the cassava farmers. The Stochastic Frontier Production function using the Cobb –Douglas functional form was used to analyze the technical efficiency of cassava of the farmers. This function has been employed in other studies to determine technical efficiency of agricultural production (Simpa, 2014, Nmadu and Simpa, 2014. The production function model is explicitly specified as:

$$InY = In\ \beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_5 + \beta_6 InX_6 + \varepsilon_i \quad (2)$$

where, ln = Natural logarithm, Y = Quantity of cassava produced (Kg/ha), X_1 = Farm Size (Ha), X_2 = Labour (Man days/ha), X_3 = Cuttings (Nos/ha), X_4 = Quantity of Agro Chemicals used (Litres/ha), X_5 = Quantity of Fertilizer used (Kg/ha) and X_6 = Land resources (ha).

$\beta_{0,}$ β_1-β_7 = vectors of technology parameters to be estimated (Regression coefficients).

εi= Composite error term defined as Vi – Ui

V_i= Random variables which are assumed to be independent of Ui, identical and normally distributed with zero mean and constant variance N (0, Sv2).

Ui = Non–negative random variables which are assumed to account for the technical inefficiency in production and are often assumed to be independent of Vi such that Ui is the non-negative truncated normal distribution.

The inefficiency of production, Ui is modeled in terms of the factors that are assumed to affect the efficiency of production of the farmers. The factors are the socio-economic characteristics of the farmers. The determinant of technical inefficiency is defined by:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \varepsilon_i \quad (3)$$

Where;

Ui = technical inefficiency, Z_1 = Age (Years), Z_2 = Gender (1= male, 2= female), Z_3 = Marital status(married=1, divorced=2, others=3), Z_4 = Educational Level (Years), Z_5 = Farming experience (Years), Z_6 = Farmers' group (No of group joined), Z_7 = Extension contacts (No of visits) and Z_8 = Household size (number). ε_i= Error term and δ_o – δ_8 = parameters to be estimated

The parameters of the Stochastic Frontier Production Function (SFPF) were obtained using the computer programme Frontier 4.1 by Coelli (1994).

The model was tested for full efficiency hypotheses by carrying out a generalized likelihood ratio (LR) test for significance (Oluwatusin, 2011). The test statistic is defined as follows:

$$LR\ (\lambda) = 2[\ln(L(H_o))-\ln(L(H_a))] \quad (4)$$

Where; $L(H_o)$ is the value of the log-likelihood functions of the production functions as specified by null hypotheses and $L(H_a)$ are the values of the likelihood function of the frontier of the model. The test statistic LR(λ) is distributed approximately as a chi-square with degrees of freedom equal to the difference in the number of parameters in the null and alternative hypotheses (Oluwatusin, 2011). The decision rules was that the null hypothesis is rejected when the test statistic (λ) is greater than the critical (χ^2) values for full technical efficiency hypothesis tests at 5% alpha level. The critical value of full technical efficiency was obtained from the table developed by Neave (1979).

Results and Discussion

Socio-economic Characteristics of Smallholder Cassava farmers in Kogi State

Table 2 shows the socio-economic variables of smallholder cassava farmers in the study area. There is a gender balanced involvement of smallholder cassava farmers in the study area, with male and female scoring 54.4% and 45.6% respectively. This might be as a result of easy production process and less input requirements (PALIP, 2004). This supports the finding of an Anonymous, (?2004)[a] that, it is half-truth to say that cassava is men or women crop, because in Ihiala, Anambra State, Nigeria, both men and women produce cassava and that men are increasingly involved in cassava production, processing and marketing as transformation unfolds. The age of the smallholder cassava farmers ranged between 31 and 69 years with a mean of 52.3. Majority of the cassava farmers were within the age bracket of 51 -69 years and this indicates that the smallholder cassava farmers were aging. This finding is in collaboration with the result of Ekunme *et al.,* (2008) and Orewa and Izekor (2012), who stated that small scale farmers in Nigeria were aging with mean of 53 and 51 respectively. This Table 2 shows that only 63.63% of the farmers were married and this compares favourably with the finding of Simpa (2014) that scored 70.6 for married root crop farmers in his study area. Majority of the farmers were fairly educated with 45.46%, 18.18% and 9.09% having primary, secondary and tertiary education respectively. Only 20% had no any form of education. This means that the farmers had minimum level of education that could enable them to adopt modern agricultural technology and participate in cassava transformation agenda despite the fact that they are aging. This result is in agreement with Ojo ., (2009). The range and mean of farming experience of the smallholder cassava farmers was between 5 and 23 years and 19.95 respectively, with majority (95.45) having more than ten years of experience. This conforms to Nmadu and Simpa (2014) and Musa et al., (2011), who had 89.4% and 78.4% for farming experience of than ten years respectively. The many years of farming experience shows that the farmers are relatively experienced and there is some level of specialization and this would help in cost minimization and achieving greater efficiency. Farmers' group could be formal or informal and almost every farmer belongs to one group or another. A farmer is likely to belong to more than one group especially informal groups and the more group they joined the less efficient they become, because of conflicting ideas and suggestions to a particular problem or process. For example, in this study, 58.73% of the farmers belonged to three or more groups and only 4.54% had no group. This might be the reason why the parameter (farmers' group) is a significant source of inefficiency in the model as shown in Table 3. The range of extension contact is between 0 and 4 with a mean of 1.45 and majority (63.63%) had extension contact of 0 to 1. Only 10.92% had more than 3 contacts. This implies poor extension services and absence of information on new innovation in cassava production despite the current policy of the

Federal Government on cassava development. This complements the finding that extension-delivery to farmers is poor in cassava transformation, because United Agricultural Extension System (UAES) which ensure a single line of command in dissemination of technologies to farmers has not been implemented due to logistic problem (Anonymous, 2004a). As regards household size, 56.36% had less than 5 persons per household. The average household size was 4.93 persons per household. This shows that majority of the farmers had relatively low household size which might be good economically in terms of the households welfare as there would be less pressure on farmers' output and invariably income. This justifies Orewa and Izekor (2011). But in the study small household size reduces TE and might be in term of inadequate supply of family labour.

Table 2: Socio-Economic Characteristics of the cassava farmers

Variable	Frequency	Percentage	Variable	Frequency	Percentage
Gender			**Farmers' Group**		
			No of groups		
Male	60	54.4			
Female	50	45.6	Zero	5	4.54
Total	110	100	1	20	18.18
			2	27	24.55
Age			3 and above	58	52.73
31 – 40	10	9.09	**Total**	110	100
41 – 50	45	40.91	**Mean**	2.1	
51 – 60	25	22.73			
61 and Above	30	27.27	**Extension Contacts (Visits)**		
Total	110	100	0 – 1	78	63.63
Mean	52.3		2 – 3	28	25.45
			Above 3	12	10.92
Marital Status			**Total**	110	100
Married	70	63.63	**Mean**	1.45	
Divorced	15	13.64			
Others	25	22.73	**Household Size (No)**		
Total	110	100	Less 5	62	56.36
			6 – 10	31	28.18
			More than 10	17	15.46

Educational Level					
No school	22	20	**Total**	110	100
Primary	50	45.46	**Mean**	4.93	
Secondary	20	18.18			
Tertiary	10	9.09			
Others	8	7.27			
Total	110	100			
Mean	6.65				
Farming Experience					
Below 10	5	4.55			
11 – 15	10	9.09			
16 – 20	30	27.27			
21 and above	65	59.09			
Total	110	100			
Mean	19.95				

Source: Field Survey, 2013

Determinants of Production Function

The MLE of the production function parameters of small-scale cassava production in Kogi State is presented in Table 3. The generalized likelihood ratio test shows that the computed chi-Squared ($\chi2$) was 30.52 were significantly different from zero at 1% level of probability. This finding suggested that ordinary least square (OLS) could not have been an adequate for the data. This conforms to the findings of Oluwatusin (2011), Ojo *et al.*, (2009). The sigma-squared (σ^2) value of 0.191 was significant at 1% alpha level, this shows a good fit of the model and correctness of the distributional assumption specified. The gamma (γ) value which is the variance ratio and measures the effects of technical inefficiency on the obtained output was 0.9213. This implies that 92.13% of the variation in output of cassava in the study area was due to technical inefficiency. Table 3 also showed maximum likelihood estimate of labour (0.5054), planting material (0.432 and land resource of (0.1388) and they are all positively signed and statistically significant at 1% level of probability. This implies that more output of cassava; equivalent to the value of their coefficients would be obtained from using 1% additional unit of these production variables, ceteris paribus. Conversely, the reduction in the use of these inputs would result in a negative impact on the output of cassava production.

The positive coefficients of these variables show their importance in cassava production. This result is in agreement with the findings of Simpa (2014), Musa et al., (2010) and Shehu et al., (2010) that had positive coefficients for labour, planting material and land resources and they were significant and directly affect farm output in their various study areas. The estimate of farm size, herbicides and fertilizer were positive, but not significantly significant, therefore, had no significant influence on cassava output.

Determinants of Technical Inefficiency

Table 3 presents the result of the regression analysis of the determinants of technical inefficiency of small scale cassava production in Kogi State. The coefficients of the inefficiency model explain the difference among the efficiency levels of the individual farms. The dependent variable, $U_{i,}$ in inefficiency function represents inefficiency in level on the TE; therefore a positively signed independent variable of the inefficiency function increases U_i (the inefficiency factor) and as such reduces TE. Conversely, a negatively signed coefficient of independent variable of inefficiency function reduces inefficiency value and increases TE. The coefficients of education, farming experience and extension contacts which are inefficiency parameters are negatively signed and as such they reduce inefficiency. These imply that farmers with higher educational level, more years of farming experience and had more extension contacts would be more technically efficient than farmers that had less of these factors in small-scale cassava production in the study area. As the levels of education, years of farming experience and number of extension contacts increase, inefficiency decreases and TE increases. The positive coefficients of age, membership of farmers' group and household size imply that as age, number of farmers' group joined by the farmer and household size increase, the inefficiency level of the farmer rises and TE decreases. This shows that older farmers, farmers that belong to more than one farmers' group and farmers with large household size are more technically inefficient than young farmers with small household size and joined many farmers' group in small-scale cassava production in the study area. Other variables; gender and marital status were not significant and therefore, had no effects on inefficiency level among small-scale cassava farmers. The results of this inefficiency regression analysis of cassava production in Kogi State compares favourably with the findings of Ojo *et al.,* (2009), Oluwatusin (2011) and Orewa and Izekor, (2012).

Table 3: Maximum Likelihood Estimates of Parameters of the Cobb-Douglas Frontier Function for Small Scale Cassava Farmers in Kogi State

Production factors	Parameters	Co-efficient	t-ratio	Standard errors
Constant	β_0	2.1305***	7.3659	0.2893
Farm size	β_1	0.6768	10.9870	0.0616
Labour	β_2	0.5054***	5.6343	0.0897
Planting material	β_3	0.432***	5.1063	0.0846
Herbicides	β_4	0.019	0.6551	0.029
Fertilizer	β_5	0.0004	0.0118	0.0337
Land resource	β_6	0.1388***	2.6899	0.0516
Diagnostic statistic				
Sigma-square (σ^2)		0.191***	0.0048	
Gamma (γ)		0.9213***	0.0419	
Log likelihood		67.95		
Likelihood ratio (LR)		30.52		
Number of observation		110		
Determinants of Inefficiency				
Constant	β_0	-0.9063	2.1344	0.4246
Age	β_1	0.0144***	0.1722	0.059
Gender	β_2	0.0751^{NS}	1.0884	0.0836
Marital status	β_3	0.0618^{NS}	0.5965	0.1036
Educational level	β_4	-0.2313**	39.2033	0.0059
Farming experience	β_5	-0.0388*	1.9795	0.0196
Farmers' group	β_6	0.0063**	8.9096	0.7071
Extension contact	β_7	-0.1661***	2.7454	0.0605
Household size	β_8	0.3346*	2.0047	0.1668

Source: Field Survey/MLE Results, 2013,
* Significant at 10% level; **significant at 5% level; *** significant at 1% level

Elasticity of Production and Return to Scale

Elasticity measures the degree of response of output to proportional change in input level used. The elasticity of production as shown in Table 4 summed up to 1.7724 and it indicates an increasing return to scale. Therefore cassava production in the study area was in stage I of production function. This implies that a unit increase in inputs used would result in a greater quantity of the output, though; this surface is an irrational stage. This result confirms the finding of Ojo et al., (2009) that had 1.686 for RTS for another root crop.

Table 4: Elasticity of production factors and Return to Scale (RTS)

Production factors	Elasticity
Farm size	0.6768
Labour	0.5054
Planting materials	0.432
Herbicides	0.019
Fertilizer	0.0004
Capital	0.1388
Total (RTS)	**1.7724**

Source: Field Survey/MLE Results, 2013

Distribution of Technical Efficiency among the respondents

The estimates presented in Table 5 shows the levels of TE among smallholder cassava farmers in the study area. The indices reveal that all farmers were operating below the maximum frontier of the production function (less than 100%). This implies that all the smallholder cassava farmers are not fully efficient. The range of TE of the cassava farmers was 0.500 to 0.999 for worst and best practiced farmers respectively. The mean TE was 0.9489 (94.89%). These imply that worst, best and average farmers have efficiency gain of 0.4396 (43.96%), 0.0105 (1.05%) and 0.0511 (5.11%) respectively at the given mix of production input levels to get to the frontier (maximum output). The efficiency gain represents the gap between the maximum or potential output (100%) and actual or obtained output. The results showed that most of the farmers were generally and relatively technically efficient; but there were still some levels of inefficiency. There still exists a room to increase production capacity at the given input mix. According to Grabowseki, Kraft, Pasurka and Aly (1990), a farm is considered technically inefficient even if the farm has a technical efficiency index of 82%. If we go by this postulation, about 77.27% of the smallholder cassava farmers in the study can be considered to be technically efficient while 22.73 inefficient. This result supports the finding of Olayide (1980) that stated, small-scale farmers are very efficient in utilization of productive resources available to them at their level of technology, but full potential of farm inputs are yet to be fully harnessed for optimum cassava production. And these resources needed to be harnessed fully to raise productivity to a significant level and produce enough food (cassava) in quantity and quality to feed the teeming population of the nation. Fully harnessed potential of farm resources would lead to reduction in food importation in Nigeria that was once an exporter of food items.

Table 5: Distribution of Technical Efficiency of Cassava farmers in the Study area

Technical Efficiency Class Index	Frequency	Percentage
0.100 – 0.199	0	0
0.200 – 0.299	0	0
0.300 – 0.399	0	0
0.400 – 0.499	0	0
0.500 – 0.599	5	4.55
0.600 – 0.699	10	9.09
0.700 – 0.799	3	2.73
0.800 – 0.899	7	6.36
0.900 – 0.999	85	77.27
Total	110	100
Mean	0.9489 (94.89%)	
Mean efficiency gain	0.0511 (5.11%)	
Maximum	0.9895 (98.95%)	
Maximum efficiency gain	0.0105 (1.05%)	
Minimum	0.5604 (56.04%)	
Minimum efficiency gain	0.4396 (43.96%)	
Technically efficient farmers	77.27%	
Technically inefficient farmers	22.73%	

Source: Field Survey/MLE Results, 2013

Generalized Likelihood Ratio (LR) Hypothesis test of Full Efficiency

The results in Table 5 show the hypothesis test of full efficiency. The generalized likelihood ratio test is defined by the chi-Squared (χ^2) distribution. The analysis indicates that the computed chi-Squared (χ^2) was 30.52 and critical value was 2.167. This shows that the χ^2_{cal} value was greater than the $\chi^2_{critical}$ value. Therefore, the null hypotheses (Ho: $\gamma = 0$) which states that there is no inefficiency effects in Stochastic Frontier production function is hereby rejected. These further confirm the value of gamma which was significant. These findings suggested that traditional response function of estimating ordinary least square (OLS) could not have been an adequate representation of the data and this conforms to the findings of Oluwatusin (20111).

Table 5: Generalized likelihood ratio test for parameters of SFPF for smallholder cassava farmers in Kogi State

Null hypothesis	Log likelihood	No. of restriction	χ^2 Statistic	Critical value	Decision
Ho: $\gamma = 0$	67.95	7	30.52	2.167	Ho Rejected

Source: derived from diagnostic test/MLE/ field survey, 2013 and the critical value obtained from Neave (1979) at 5% level of probability

Conclusion

Cassava production was characterized by gender balanced participation, aging and well experienced farmers. The farmers were relatively technically efficient, but there were still some levels of inefficiency among farmers considering the average technical efficiency index. The important production factors that could be manipulated to increased cassava production are labour, planting material and land resource and significant negative inefficiency factors that increase technical efficiency are farming experience, educational level and extension contact while age, farmers' group and household size increase technical inefficiency.

Recommendations

- The important production parameters for example; labour, planting materials and land resource should be enhanced to increase cassava output.
- For labour supply, young and educated men and women should be encouraged to take up cassava production as the present corps of farmers is aging. This could be achieved by providing the young farmers with access to credit, improved varieties, farm mechanization implements and adequate extension services. By doing these, significant factors that reduce inefficiency such as education and extension contact would be improved and problem of aging that reduces technical efficiency would be resolved.

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