NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 52 Number 2, August 2021 Pg. 8-14
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org

TECHNICAL EFFICIENCY OF CASSAVA COOPERATIVE FARMERS IN SOUTH-SOUTH, NIGERIA: A COMPARATIVE ANALYSIS

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Abstract
This paper used the stochastic frontier production function to analyze the technical efficiency of 90 randomly selected cooperative cassava farmers in comparison to 90 non-cooperative cassava farmers in South-South, Nigeria. The result showed that labour, land preparation, planting materials, fertilizer and farm size were positively related to cassava production for cooperative farmers and at 1% level of significance, whereas, land preparation and cuttings had the same effect for their counterparts. Technical efficiency analysis revealed the presence of cost inefficiency effects in cassava production at 95 and 91% for both cooperatives and non-cooperative farmers, respectively. It showed that 36.6, 33.3 and 16.6% of the cooperative farmers were 90, 80 and 70% technology efficient, respectively, while, 11.1, 24.4 and 11.1% of the non-cooperative farmers were 90, 80 and 70% technology efficient, also. The minimum efficiency for cooperative and non-cooperative farmers was 0.63 and 0.31; the maximum was 0.92 and 0.99, and the mean 0.92 and 0.85 respectively. Coefficients of Age, experience, household size and education were positive and significant for cooperative farmers with the mean technical efficiency value of 0.724. However, experience was significant for non-cooperative farmers with the mean technical efficiency value of 0.609. The study concluded that the mean technical efficiency of cooperative cassava farmers was comparatively and significantly higher than the non-cooperative farmers. The study recommended that factors that will enhance membership into effective and viable farmers' cooperatives societies should be addressed. Such factors include a robust/focused extension education, conscious/consistent awareness of the comparative advantage of cooperative societies and creating an easy/acceptable framework for its operation.

Keywords: Cassava, Technical Efficiency, Cooperative, Production, Non-Cooperative

Introduction

The International Cooperative Alliance (ICA) describes cooperative as an autonomous association of persons united voluntarily to meet their everyday economic, social and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise (ICA, 1995). These autonomous associations of persons have collective action with a primary economic purpose of vertical integration and overcoming scale discrepancies that will generally exist between the farm sector and the upstream or downstream industries (Sexton, 1988). These autonomous associations of persons bring to the fore why certain group of persons like the farmers join cooperative. The reason is to enhance their position in the market and determine prices instead of being price-takers (Manalili *et al*., 2008), guide against service shortfalls or exorbitant prices for available services, market failures, transactions cost, discriminatory treatment from contract growers and increased monopsony in buyer's markets (Torgerson *et al*., 1997), aid in education and provision of other essential information to members (Anyaele, 2003) and improve their general quality of life and economic opportunities (Ahukannah *et al*., 2007). Globally, the cooperative sector is considered as a reliable organization contributing significantly to the world economy. For instance, the sector is valued at about $ 2.5 trillion annually, of which, agriculture and food processing contribute 32-33% (ICA, 2010 and 2017). According to Kurimoto (2004), agricultural cooperatives contribute considerably to the national economies of Japan, with an average of $50 billion annually. In recognition of its potential to support the world economy, the United Nations declared 2012 as the International Year of Cooperatives with a resilient model in times of crisis to support its members and a typical example is the 2008 financial crisis (Birchall and Ketilson, 2009; Otung and Akpaeti, 2017), while, the U.K. Co-operative Economy (2012) describes cooperatives as an alternative to austerity.

Just like the developed economies, the developing economies like Nigeria have identified cooperatives through the instrumentality of agricultural development as a vehicle for the development of agriculture, because farmers can solve agricultural challenges such as inadequate capital, inadequate access to loan and high level of illiteracy which remain significant agricultural development challenges (Kehinde *et al*., 2009). The usefulness of this organization engendered the establishment of cooperative colleges by the Nigerian Government (Adegeye and Dittoh, 1985). It is one organizational innovation that can harness the current democratization and decentralization/independent policies of the Nigerian government to give smallholders political voice, place them on a ladder of ascending financial market and manage the systemic risks that undercut their production supplies.

Empirical studies by scholars reveal the impact of cooperative societies on agriculture. Ronchi (2001) noted that inequities arising from unequal access to markets lack information, credit and risk-mitigation mechanisms can be smoothened by strengthening producer cooperatives without paying a premium in the context of existing trade rules. Abate *et al*. (2014) on the technical efficiency of Ethiopian cooperatives shows a positive and significant impact of agricultural cooperatives on members' levels of technical efficiency. They report that on average, cooperatives members were better situated to get maximum possible output from a given set of inputs used by at least 5%. Their inefficiency model suggested that inefficiency of farm households is significantly linked with the number of plots, diversification of crops, gender of household head and membership in agricultural cooperatives. They recommend that promoting agricultural cooperatives as complementary institutions to public extension services would enhance efficiency.

Similarly, Zamani *et al*. (2019) indicated that the average efficiency scores of cooperative farms in Iran are significantly higher than non-cooperative farms with the high economy of scale among the cooperative farms. They conclude that the performance of sugar beet cooperatives is substantially better than the non-cooperatives and suggested the support of cooperatives to improve efficiency. Ma *et al*. (2018) employed selectivity-corrected stochastic production frontier model with propensity score matching to address possible self-selection biases stemming from both observable and unobservable factors in China. The results show that technical efficiency for cooperative members ranged from 79 - 86% as compared to 74 -84 % for non-members, depending on how biases are controlled. Ahn *et al.* (2012) in their comparative studies of cooperative and private farms' technical efficiency in El Salvador reports more outstanding shortfalls in efficiency between cooperatives and private farms, and among cooperatives, for coffee - a crop requiring numerous steps in its cultivation, than for maize and sugar, which require fewer steps. They conclude that the under supply of effort in cooperatives may be less than differences in productivity, and this suggests that cooperative agriculture is most likely to be successful and productive where sequential steps in production are minimal.

In Nigeria, Ibezim *et al*. (2010) reported significant differences in the income and output of cooperative farmers compared to their non-cooperative counterparts and that income and output of the cooperative farmers are higher also. This legion of scholar's research gives credit to both agricultural and non-agricultural cooperatives for efficient use of available resources. The outcome has snowballed to increased income and economic well-being – a fulfilled reason for the formation of cooperative societies. Equally, a range of cash and staple crops have been used, but studies on the comparative technical efficiency of agricultural cooperatives on cassava – a staple for virtually all Nigerian households is lacking. The technical efficiency for cassava as a staple for an agricultural-based country like Nigeria is critical because staple markets, according to World Bank (2008) accounts for significant shares of household expenditure and Gross Domestic Product (GDP) in agricultural-based countries.

This research is not only set to fill this literature gap but to give a voice for the achievement of large-scale and sustainable smallholder – based cassava productivity revolution for Nigeria and indeed the sub-Saharan agriculture, with emphasis on assisting subsistence farmers through cooperative membership to enter the market and foster effective, efficient and sustainable resource management. The study assessed the technical efficiency of cassava cooperative farmers in South-South, Nigeria in comparative terms. The study aims at comparing technical efficiencies and their determinants among Cooperative and Non-Cooperative Cassava Farming Households in South-South, Nigeria using data from Akwa Ibom State.

Methodology

Area of Study

The study was conducted in Akwa Ibom State, one of the six states in the South-South Region of Nigeria. The sampling was carried out in Etinan Agricultural Zone, Akwa Ibom State, Nigeria. Etinan Agricultural Zone is made up of four (4) Local Government Areas which include; Nsit Ibom, Nsit Ubium, Nsit Atai and Etinan, which is the Headquarters. The area lies in tropical rain forest belt and has two distinct seasons- the rainy and dry seasons. The vegetation is evergreen and has large deposits of mineral resources such as clay, glass, sand and sharp sand. Agricultural resources include; palm produce, cassava and yam.

Sampling Procedures and Sample Size

The multi-stage sampling method was adopted in selecting the respondents for this study. The first stage was the purposive selection of three (3) of the four (4) Local Government Areas (LGA) in Etinan Agricultural zone that is known for their involvement in cooperatives using the bureau of cooperatives. The four (4) LGAs that makes up Etinan Agricultural Zone are; Nsit Ibom, Nsit Ubium, Nsit Atai and Etinan, while the three (3) selected LGAs are; Nsit Ibom, Nsit Ubium, and Etinan. The second stage was the selection of villages for in-depth study. Four (4) groups of villages were chosen from the three selected LGAs to give twelve (I2) villages. The first six (6) groups of villages were known cassava cooperative villages from the bureau of cooperatives which are: Ikot Ntan Nsit and Oboetuk in Nsit Ibom LGA, Edem Idim Okpot and Ikot Edibon in Nsit Ubium LGA; Ikot Ebiyak and Ikot Ebo in Etinan LGA. While, the second group was a random selection of six (6) non-cassava cooperative Villages which are; Afaha Offiong and Edebom one in Nsit Ibom LGA, Ikot Imoh and Ekpene Ukim in Nsit Ubium LGA, Ikot Ibok/Ikot Nte and Etinan in Etinan LGA. The third stage was the random selection of fifteen (15) cassava farmers in each of the Twelve (12) villages. These gave a total sample size of One Hundred and Eighty (180) respondents.

Conceptual framework

The stochastic frontier approach is at variance with parametric frontier in that it allows for stochastic errors arising from statistical noise or measurement errors. It decomposes the error term into a two-sided random error that captures the random effects outside the control of the firm (the decision making unit) and the one-sided efficiency component. The specification of the stochastic parametric frontier recognizes component error term as a significant source of deviation from the production frontier. The stochastic frontier production function is given as:

$Y_{i=}F(X_i; \beta) \exp(V_i - U_i) = i = 1, 2 \ldots n$ ……………….(1)

Where, Y_i is the output of ith farm; X_i, is the corresponding (M×2) vector of inputs; β is a vector of the unknown parameter to be estimated; F denotes an appropriate functional form, $V_{i,}$ is the symmetric error component that accounts for random effects and exogenous shock, while $U_i \leq 0$ is a one-sided error component that measures technical inefficiency. The principal interest in efficiency study that specifies stochastic frontier is the decomposition of the component error terms ($V_i - U_i$) into mutually exclusive events. This is usually accomplished by estimating the mean of the conditional distribution of U given V expressed as:

$E(V/ei) = \mu i = \sigma^* \{f^*(-\mu i/\sigma^*)[1 - F(Ui/\sigma^*)]^{-1}\}$ ……. (2)

Where,

$\sigma^* = (\sigma v^2 \sigma u^2/\sigma^2)$

σ^* = The standard density function

F = The standard distributional assumptions

The values of unknown coefficients in (1) and (2) can be estimated jointly by using the maximum likelihood (ML) method. This requires the estimation of population parameters such that the probability densities for obtaining the actual sample observations that have been gotten from the population which is greater than the probability density obtainable with any other assumed estimates of the population parameters (Udoh, 2005; Akpaeti *et al*., 2014). The ML method provides estimators that are asymptotically consistent and efficient. This study, however, uses a production approach to estimate technical inefficiency effects at farm levels by assuming a stochastic nature of production.

Analytical Technique

The study utilizes multiple regressions based on the stochastic production frontier to determine technical efficiencies and their determinants. Douglas functional form is given as: measuring technical efficiencies and their determinants (the response of output to the input of the respondents) was analyzed Using technical efficiency formula.

$Y_i = \ln\partial_0 + \ln\partial_j + X_{ij} + V_i + U_i$ …………….. (3)

Base on the theoretical underpinnings, Cobb-Douglas production functional form is therefore used. Hence, the empirical model is specified thus:

$\text{In } COP_i = \partial_0 + \partial_1 \text{In } FAS_i + \partial_2 \text{In } CAP_i + \partial_3 \text{In } LAB_i + \partial_4 \text{In } FER_i + \partial_5 \text{Ln } PMS_i + V_i - U_i$ … (4)

Where,

COP_i= Cassava Output (in kg)

FAS_i = Farm size (Hectare)

CAP_i= Capital (Naira)

LAB_i= Labour (Mandays)

FER_i= Fertilizer (Naira)

PMS_i= Planting Materials (Naira)

$\partial_{0,}\ \partial_1 \ldots \partial_5$ = parameters to be estimated

V_i =Normal random errors which are assumed to be independent and identically distributed having zero mean and constant variance. They are not under the control of the farmer, e.g. Weather, disease, misfortune.

U_i =Non-negative random variables associated with the technical efficiency of the enterprise(s) involved. It accounts for efficiency and under the control of the farmer.

With $V_{i=}N(0, \sigma v^2)$ and $e^{-vi} = \alpha_0 + \alpha_1(AGE) + \alpha_2(HHS) + \alpha_3(FAR.EXP) + \alpha_4(EDU) + Z_i$

Where α_0 = Technical Inefficiency effect of the fifth farm; AG. = Age of the farmers (in years); HHS = Household size (number of persons); FAR. EXP. = Farming Experience (in Years); EDU=Years of Education (in years); $\alpha_{1=}$ Parameter to be estimated, and Z_i is an error term assumed to be randomly and normally distributed. The value of the unknown coefficients in equations (3) and (4) are jointly estimated.

Diagnostic statistics Parameters in the Efficiency Model

Log-likelihood Function: It allows for the test of hypotheses and standard error measurement. The parameters of the frontier and density functions of V_i

and U_i would be estimated by maximizing this function.

LR-Test: It is used to test for the one-sided error term (U_i). That is U_i=N (0, σu^2), It is based on the assumption that the Ui follow the half-normal distribution. The likelihood ratio test is used to test the appropriateness of stochastic frontier production/profit functions about the standard production/profit functions.

Gamma (y): it represents the ratio of the variance of inefficiencies error term to the total variance of the two error terms Vi and Ui. The value of gamma (y) range between 0 and 1. It explains the percentage of the total variation in the farm output concerning the sampled farms. It measures the effect of technical inefficiency in the variation of observed output.

Sigma-squared (σ^2) $\sigma u^2 + \sigma v^2$ is used to indicate good fit and the correction of the specified distributional assumptions of the composite error term.

Lambda (**λ**) = this is the ratio of the standard error of (σ_u) to the standard error of v (σ_v)
σ = standard deviation of the total error term.

Results and Discussion

Response of Output to Input use among the Cooperative and Non-cooperative Farmers

The farm-level efficiency among the farmers in the study area is presented in Table 1. The maximum likelihood estimates of the parametric stochastic frontier analysis reveal that among cooperative farmers, all the independent variables conform to the *a priori* expectations. It is because all the estimated coefficients (cost of labour, land preparation, planting materials, fertilizer and farm size) show positive coefficients. This implies that as these factors increased, total production cost increased under the condition that all other situations will remain unchanged. The result of the t-ratio test shows that all the production variables are statistically different from zero at 1% level of significance except for labour, fertilizer and farm for the non-cooperative farmers, which are significant. Hence, these variables are essential determinants of cassava production in the study area. The model's test of goodness of fit and correctness of the distributional form assumed for the composite error term as indicated by "sigma squared" (δ^2) is statistically significant at 1% level for both group of farmers. The economic efficiency analysis of cassava farmers reveals the presence of cost inefficiency effects in cassava production as confirmed by the significant gamma value of 0.947 and 0.914% at 1% level. This implies that about 95% and 91% variation in the total production cost is due to differences in their cost efficiencies for cooperatives and non-cooperative respectively. The negative coefficients for labour and cost of fertilizer in the analysis imply that labour use and fertilizers are not significant factors to efficiency and hence farm productivity of non-cooperative cassava farmers.

The inefficiency variables in Table 1 are considered in identifying the factors responsible for inefficiencies among the two categories of cassava farmers: age, farming experience, households' size and years of schooling. For cassava farmers in cooperative societies, all the variables are significant, and their mean technical efficiency value is 0.724. On the other hand, among the non-cooperative farmers, only farming experience is significant, and their mean technical efficiency value 0.609.

Table 1: Estimates of Stochastic Frontier Models

Variables	**Parameters**	**Cooperative Farmers**		**Non-cooperative Farmers**	
Production Factors		**Coefficients**	**t-ratio**	**Coefficients**	**t-ratio**
Constant	α_0	3.9215	10.626***	6.3292	7.787***
Labour	α_1	0.1447	6.0841***	-0.8606	0.7843
Land preparation	α_2	1.5818	2.9491***	0.7944	6.084***
Planting materials (stem cuttings)	α_3	0.2607	5.104***	0.4320	2.8622***
Fertilizer	α_4	0.1672	3.6223***	-0.5767	0.828
Farm size	α_5	0.1256	3.6341***	0.8828	0.1041
Inefficiency function					
Intercept	$\beta 0$	14.797	1.138	0.208	0.194
Age	$\beta 1$	0.746	2.66**	-0.108	1.25
Household size	$\beta 2$	0.162	2.3**	0.243	1.50
Farming experience	$\beta 3$	0.568	3.02***	0.313	2.45**
Years of education	β 4	0.280	2.78***	0.169	0.16
Variance parameter					
Sigma –square	δ^2	0.8162	6.028***	1.2735	9.851***
Gamma	Γ	0.947	4.323***	0.9144	13.297***
Average Technical Efficiency		0.724	10.05***	0. 609	7.19***
Log-Likelihood Function	150.9281				
LR Test	15.9122				

Source: Computed from field survey, 2018. **, *** represents 5% and 1% level of significance respectively

The coefficient of farming experience is positive and significant for both farmer groups. The implication is that farmers with more years of experience tend to be more efficient in cassava production. This result agrees with *a priori* expectations following Adejobi, and Awotide (2004), Idiong (2006), Okezie and Okoye (2006) and Nwaru (2007) but differed from Onu *et al*. (2000), who reported a negative relationship between technical efficiency and experience, while, Idiong (2007) indicated a positive but no significant relationship. Experience, according to Nwaru and Ndukwu (2004), is the knowledge and skill gained by contact with facts and events. It indicates the practical knowledge and skills gained over time on how to overcome most of the core problems confronting increased agricultural production and output processing and marketing. The present result implies that programmes and policies for enhancing efficiency in cassava production should be targeted more at experienced farmers. Traditionally, rural households count more on their household members than hired workers as sources of farm labour. The coefficient for household size have a direct relationship with technical efficiency and is significant (P=0.10) for the cooperative farmers but not significant for the non-cooperative farmers. This is at variance with Nwaru and Ndukwu (2004) who reported a significant but negative relationship between technical efficiency and household size and with Dimelu *et al*. (2009).

The frequency distribution of technical efficiency in cassava production is presented in Table 2. The result indicates that the cooperative farmers' technical efficiency indices ranged between 63 percent and 99 percent with a mean of 92 percent, while, the non-cooperative farmers' technical efficiency indices ranged between 31 percent and 98 percent with a mean of 85 percent. The implication is that an average cassava farmer has some room for productivity increase through increased inefficiency. It would take the average and the least efficient non-cooperative farmer about 13 percent [(1 – 0.85/0.98)100] and 68 percent [(1 – 0.31/0.98)100] cost-saving respectively to become the most efficient farmer. Similarly, for the average and the least technically efficient cooperative farmers to attain the efficiency level of their most efficient counterparts, they would need cost saving of about 7 percent [(1 – 0.92/0.99)100], and 37 percent [(1 – 0.63/0.99)100] respectively. A test of difference for means carried out at 5% between the technical efficiency indices for cooperative and non-cooperative farmers show that the χ^2 value calculated is 19.18, while, the tabulated is 13.92. The result implies that the mean technical efficiency of cooperative farmers is significantly higher than those of the non-cooperative cassava farmers.

Table 2: Distribution of the farmers according to technical efficiency indices

Technical efficiency range indices	Cooperative Farmers		Non-cooperative Farmers	
	Frequency	Percentage	Frequency	Percentage
0.30 – 0.39	0	0	10	11.1
0.40 - 0.49	1	1.1	10	11.1
0.50 – 0.59	1	1.1	16	17.8
0.60 – 0.69	10	11.1	12	13.3
0.70 – 0.79	15	16.6	10	11.1
0.80 – 0.89	30	33.3	22	24.4
0.90 – 0.99	33	36.6	10	11.1
Total	90	100	90	**100**
Maximum	0.99		0.98	
Mean	0.92		0.85	
Minimum	0.63		0.31	

***Source: Computed from field survey, 2018*. χ^2_{cal}=19.18; χ^2_{tab} = 13.92**

Conclusion

Technical efficiency analysis reveals the presence of technical inefficiency effects in cassava production for both cooperatives and non-cooperative cassava farmers, because farmers were not producing at the frontier. The minimum efficiency for cooperative and non-cooperative farmers is 0.63 and 0.31; the maximum 0.92 and 0.99; mean 0.92 and 0.85, respectively. With a test of difference for means at 5%, we conclude that the mean technical efficiency of cooperative farmers is significantly higher than those of the non-cooperative cassava farmers in the study area. The implications of the findings for non-cooperative farmers with a mean efficiency of 85% means that they still have room to increase to the optimum (100%). This will require addressing those factors which will enhance their membership into effective and viable farmers' cooperatives societies. Such factors include but not limited to a robust/focused extension education, conscious/consistent awareness on the need for farmers to join cooperative societies and creating an easy/acceptable framework for the operation of this "quasi-farm- efficiency- increase-intermediary."

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