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Research Paper

ComparativeAnalysis of Technical, Allocative and Economic Efficiencies of Vitamin A Cassava Farmers with Other Improved Cassava Farmers in Oyo State, Nigeria.

Igbaifua, W.E[1]., O.R. Adeniyi[2] and R.A. Omolehin[3]
Agricultural Economics and Extension Programme, College of Agriculture, Engineering and Science, Bowen University, Iwo-Osun State, Nigeria.

Abstract: *Comparative analysis of technical, allocative and economic and efficiencies of Vitamin A Cassava (VAC) farmers with other improved cassava (OIC) farmers in Oyo State, Nigeria was conducted. A five- stage sampling technique was employed to select 180 farmers in the study area. Primary data were obtained using structured questionnaire and interview methods to seek information on socio-economic characteristics of farmers, inputs, outputs and constraints to cassava production. The data were analyzed using descriptive statistics, stochastic frontier production function and cost function.*

The result revealed that profitability alone is not the only determinant of choice of farmers for going into any of cassava production practices, other factors were adequate finance, farmland, planting material, labour availability, nutritional characteristics and market availability for output. Efficiency analysis indicated that the two group of cassava farmers did not produce at frontier level signifying the existence of inefficiency among the producers. Five major inputs drivers of cassava production were identified as farm size, family labour, stem, herbicide and hired labour. OIC production was more profitable than VAC production in the study area. Education, farming experience gender and extension contacts significantly affected farm -specific profit inefficiencies. OIC farmers showed higher allocative and economic mean efficiencies (0.86 and 0.84) than VAC farmers who exhibited lower allocative and economic mean efficiencies (0.78 and 0.76). OIC farms in Oyo were more profitable than VAC farms with gross margin of ₦139,900 and ₦132,250 per hectare of land, return on investment (1.16 and 1.01). Both production practices were operating in stage II of production frontier with return to scale (RTS) of less than unity (0.472(OIC) and 0.678(VAC). However, farmers complained of finance, planting stems, extension agents visit, low demand market, high labour cost and grazing of farmland by irate Cattle. It is therefore recommended cassava farmers develop saving culture and enter contract farming with reputable organizations, multiply their planting stems, increase the number of extension agents visit, farmers venture into labour-saving technologies, government to create ready markets and encourage Fulani herders to establish ranches while farmers fence their farms with twine rope. The study inferred that OIC and VAC were smallholder producers who were technologically inclined to convert inputs into output for profitability, food security and poverty alleviation, but for them to achieve these, they need to work harder on technical, allocative and economic efficiencies of production.

Key words: *Technical, allocative, economic efficiencies, production practices, stochastic frontier production function and cost function.*

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I. Introduction

Cassava (*Manihot esculenta Crantz*) is an important root crop grown and a major peasant food in Africa, Asia, Latin America and the Caribbean (Spencer &Ezedinma 2019). Cassava is widely produced and consumed by over 100 million people in Nigeria and Asia countries of the world for its edible products and for its income generation potentials and as a result, it has been found important as staple food for households, animal feeds and industries (Westby,2002). These various uses indicates that cassava could assume the position of food security crop and income generation for poor households.

Nigeria is presently the largest world producer of cassava with about 60 million metric tonnes of edible roots produced annually from cultivated area of about 3.7 million hectares (FAO, 2019). Nigeria accounts for cassava output of up to 20 per cent of the world, about 34 per cent for Africa continent and about 46 per cent of West Africa countries. The mean national yield as record by FAO (2019) is 13.63 metric tonnes per hectare which is against the potential yield of 30- 40 metric tonnes per hectare of World average (Abolaji*et al*.&Oduola, 2007).

Aerni (2006) reported that cassava which was previously regarded as a famine reserve crop as it provides a reliable means of food during drought and hunger periods for the poor households, has suddenly become both a nutritional food, a global income earner and an export crop in the world economy. Due to the relatively high yield of cassava under conditions of unstable precipitation and poor soils, 250 million Africans rely on cassava as food. Philips *et al*. &Akoroda (2007) reported that production from over 90 % of the 117millions hectares cultivated in Sub-Saharan Africa (SSA) in 2006 is being utilized for fresh consumption and processed food.

Adeniji (2000) asserted that to increase in efficiency of cassava production and utilization in Nigeria, the Federal Government and International Fund for Agricultural Development (IFAD) partnered in the introduction' of Vitamin A Cassava multiplication programme with the aim of promoting cassava utilization as a commodity-based approach against food security. Vitamin A cassava is a different type of cassava with a deep yellow colour compared to the conventional whitecolour varieties. It is biofortified through traditional breeding with beta-carotene which the body converts to vitamin A precursor. It has the ability when consumed to reduce vitamin A deficiency and are at least six times more nutritious than common, white-fleshed cassava (Ilona, 2014). The purpose of Vitamin A cassava multiplication program is to improve food nutrition, reduce poverty and boost income among farmers. In alignment to these objectives, HarvestPlus Nigeria developed and disseminated Vitamin A cassava varieties to four states of Oyo, Imo, Akwa Ibom, and Benue in Nigeria for adoption by farmers to boost income of rural farmers and improve nutritional food security situation of the population.

Consequently, Vitamin A cassava multiplication programme was initially inaugurated in 2001 by the Federal Government with the purposes of increasing productivity, profitability, acceptability, and income of the farmers but failed to accomplish these objectives as the farmers refused to use improved planting stems released for them. (Ilona *et al*. &Oparinde, 2017). On 7th December 2011, the Nigerian government released the pro-vitamin A cassava varieties developed by International Institute of Tropical Agriculture (IITA) in conjunction with the National Root Crop Research Institute (NRCRI),Umudike and funded by HarvestPlus project and the cassava transformation agenda of the Federal Ministry of Agriculture and Rural Development of Nigeria. The first three-wave Vitamin A cassava varieties released by National Varietal Release Committee of Nigeria are UMUCASS 36, UMUCASS 37 and UMUCASS 38.

. Ilona *et al*. &Oparinde (2017) reported that the pro-vitamin A cassava project commenced with 100 bundles of stems of three first-wave varieties in 2010 and witha decentralized community-based seed production scheme, the project was able to increase stem availability to 250,000 bundles by 2012.In 2011, the biofortification (Vitamin A Cassava) programme commenced with stem multiplication in ten Local Government Areas (LGAs) in each of the four states of Nigeria; Oyo in the South-west, Imo in the South-east, Akwa Ibom in the South-south and Benue in the North-central. In 2012, the programmeincreased in scope to six villages in each LGA making a total of 60 communities per state and 240 farming communities in the four states of Oyo, Imo, Akwa Ibom and Benue. The major objectives of this programme were to attain self-sufficiency in micronutrients such as vitamin A consumption, food security and better income for the poor in Nigeria (Ilona *et al*. &Oparinde, 2017).

Despite the economic and food nutritional relevance of cassava to the Nigerian economy, its production and utilization in the country is lacking behind because of the wide gap between the supply and demand of the products (Nweke, 2004). If Nigeria is to be self-sufficient and sustainable in cassava production, productivity and resource use efficiency must increase. This implies that the resources allocated to cassava production must be efficiently utilized and profitable to attract more producers.

The problem of cassava production in Nigeria is attributed to low resources productivity, profitability, under-capitalization and efficient use of farm-based inputs by farmers (Sanusi,2012; UNECA, 2009). Cassava also lacks essential micronutrients like iodine, calcium, zinc, iron and vitamin A resulting into an insidious type of hunger-a hidden hunger (Brenda, 2019). Hence, to examine efficiency and productivity of the resources by vitamin A cassava farmers and other improved cassava farmers in Oyo State, this paper is therefore structured to: (i) evaluate the technical relationship between the inputs and output of the two cassava production practices (ii) evaluate the technical, allocative and economic efficiencies of cassava farmers in both production practices (iii) determine the profitability of cassava production under the two production practices (iv) identify the production constraints faced by farmers under the two production practices.

II. Theoretical Framework

Stochastic frontier production and cost function

The magnitude of technical efficiency of a producer is distinguished by association between actual production and some ideal unrealized production. The estimation of farm-firm peculiar technical efficiency is hinged on deviations of actual yield from the greatest production frontier. If a producer's observed production rests on the frontier, it is assumed to be perfectly efficient and if is lies below the frontier, it is said to be technically inefficient where the ratio of the observed to the unrealized production describes the strength of efficiency of the specific farmer.

The estimation of production frontier could be described under two general approaches. There is complete frontier which emphasizes all observations to be on or below and therefore, all deviations from the frontier is due to inefficiency and so the stochastic frontier where deviation from the constituents returning hypothesized error and statistical noise and a constituent returning inefficiency. The drawback of these approaches is that they are greatly sensitive to deviations. Thus, if the deviations return calculated errors, they will gradually introduce bias into the estimated frontier and the efficiency computations obtained from it. In all, the stochastic frontier approach seems better due to its involvement of traditional random error of regression. As a result, the parameter error, apart from indicating the impact of insignificant left out variables and errors of measurements in the dependent variables, could also show the impact of arbitrary failure on input supply routes not correlated with the inaccuracy of the regression as given by Jondrow*et al*., & Schmidt (1982). Farrell, (1957) began the measurement of efficiency by proposinga division of technical efficiency into two approaches. The first approach describes a producer's capacity to produce a maximum amount of yield from a bundle of inputs and secondly, allocated efficiency which he referred to capacity of a farmer to utilize inputs in optimum amounts with their corresponding prices and present technology available. From these descriptions, he came about economic efficiency which is the combination of the two efficiencies.

Several approaches are in use to estimate the determinants of technical efficiency from stochastic production frontier functions. Some researchers followed a two-step process in which the frontier production function is initially calculated to estimate the technical efficiency parameters, while the parameters obtained are regressed against a bundle of socio-economic explanatory variables that are normally farm-firm attributes. (Ogundele, 2003, Ben-Belhassen, 2000, Parikh, Ali & Shah, 1995). However, the approach contravenes the hypothesis of error terms of stochastic frontier production function, which is assumed to be identically, normally and independently distributed (Jondrow*et al.* & Schmidt, 1982). As a result, more development of a more reliable method that modeled inefficiency effects as an explicit function of some factor attributed the farm and all parameters are measured in one step employing maximum likelihood estimate (Ajibefun and Daramola, 2003, Obwona, 2000, Battese&Sarfaz, 1998). The maximum likelihood approaches of the production model are calculated employing the computer programme referred to as FRONTIER (Coelli&Battese, 1996). This approach was adopted and used in this research work.

Model specification

The two approaches discussed above can be modeled into mathematical specifications. The econometric model is regarded as either deterministic frontier model or stochastic frontier model assumed that the farmer is producing sole output. It is equally assumed that the quantum of inputs used to produce the sole output is easily available for individual number of producers. Thus, the production frontier model is given as:

$Y_j = f(X_{ij}\beta).\ TE_{ij}$ ………………………………………………………………… (1)

whereY_j= yield of farmer j=1……..N

X_i=bundle ofinputs usedbyfarmer j

$f(X_{ij}\beta)$ =production frontier

β=variableto becomputed

TE_{ij}=yield aligned technical efficiency of farmer j

From (2)

$$TE_{ij} = \frac{Y_i}{f(X_{ij}\beta)} \quad \ldots\ldots(2)$$

Equation(2)measuresthetechnicalefficiencyontherelationshipofpotentialyieldto maximumyieldpossiblegiventheavailabletechnology.$Y_i$obtaineditsmaximum profitoff($X_{ij}\beta$)onlyifTE_i=1.Theamountbywhicha value under considerationliesbelowthe frontier is called inefficiencywhen $TE_i<1$.

Itcanbeseenfromequation(2.2)thatf($X_{ij}\beta$)isdeterministicwhileinequation(2.3),the totaldeficitofactual yield f($X_{ij}\beta$)isrelated withtechnicalinefficiency.This gavetheinadequacyofthis approachsince environmental and institutional factorsoutsidethecontrolof producerslike badweather,badmarket,anderrorinmodelspecificationcan leadinto increasing theinefficiency estimates.Withthe incorporationofrandom variable tothe production frontierequation in (2.1)

Y_i=f(X_{ij}β), exp [vi]). TE_{ij}……………………………………………………(3)

where[f(X_{ij}β), exp [Vi]]=stochasticproduction frontier.

Thus, TEij=$\frac{Y_i}{(f(Xij\beta),\exp[vi])}$…………………………………………………(4)

Describingtechnical efficiencyastheproportionofactualyieldtooptimal possibleyield with effect ofenvironment byexp {Vi}.

As a result of theaboveequationsthetwo-disturbance parameterofproductionfrontieris missing, neither ofthem cangive a vividstate oftechnicalefficiency.

Thesecond approachiscalledthestochasticproductionfrontiermodel.The important elementofthisapproachisthatthedisturbancetermis made upoftwo forms.Thefirst disturbancetermisthesymmetric part Viwhichrepresentstherandomoferror outsidethecontroloffarmerwhilethenon-negativeone-sidedpartUirepresents therandomofhumanerror,whichisunderthecontrolofthefarmer.Therandomterms are identically,independently and normallydistributed (Meeusen&Broeck, 1977).

Thenormalequationforstochasticfrontiermodelintermofgeneralproduction function is as thus:

Y_i=f(X_{ij}β) +V_i-U_i--(5)

where:

Y_j, = yield of farmer j =1----N

X_i=bundle of farminputs usedbyfarmer j

β = variable to be computed

V_i=isthestochasticerror,whichishypothesizedtobeindependently, identicallyand normallydistributed withzero mean and aconstant variance(σv^2)

U_i=is aone-sided errorterm whichis independent of Viand is normallydistributed with zero mean and aconstantvariance (σu^2).

Inthestochasticproductionfrontier,thetechnicalefficiencyofthefarmisdescribedas the proportionofreal physical yieldtothe assumedpotential yield subject tothelevelof input usedbythe farmer.Thus,thetechnical efficiencyof the cassavafarm is given thus:

TEij= $\frac{Y_i}{Y^*}=\frac{f(X_{ij}\beta)exp(Vi-Ui)}{f(xij\beta)\exp(Vi)-\exp(Ui)}$---------------------------(6)

whereTE_{ij}=technicalefficiencyoffarmer j

Y_i=actual yield from i^{th}farm

Y^*=potentialyield

X_{ij}, β, Vi, Ui = as given in equation 5

TE ranges between 0and1 and optimum efficiencyhas a valueof 1.

III. Methodology

Study Area and Data Collection

This study was conducted in Oyo States. Oyo State is in Southwestern part of Nigeria.Oyo State liesbetween latitude 8^0 00’N and longitude 4^0 00’E. The major economic activities of the people in the state include crop and animal production.

A five-stage sampling procedure was used to select the respondents. Oyo State was purposively selected from Southwestern zone as it represented one of the States where HarvestPlus 2011 delivered her Biofortification programme of vitamin A cassava stem multiplication and distribution and high concentration of cassava production.During the study, three Local Government Areas (Ido, Ibarapa Central and Ibararpa East) from Ibadan/Ibarapa ADP zone was obtained from HarvestPlusprogramme Coordinator indicating as the LGAs biofortification and multiplication of vitamin A cassava was implemented. Three communities were randomly selected in each of the three Local Government Areas given a total of 9 communities. A total of 180 farmers were then randomly selected from the 9 communities. Primary data were collected via structured questionnaire schedule and information was sought from vitamin A cassava and other improved cassava producers on socio-economic characteristics, inputs, outputs, marketing, constraints to cassava production and income generated during the 2019/2020 production season.

Analytical Techniques

(a) Descriptive statistical tools like frequency distributions, percentages, mean, standard deviation were used to describe socio-economic characteristics of adopters and non-adopters of vitamin A cassava and other improved cassava varieties. The tool was also used to evaluate constraints experienced by cassava farmers.

(b) The stochastic frontier production model was employed to evaluate the input-output relationship and implicit form of the stochastic frontier production model is given as thus:

$In\ Q_1 = \alpha_0 + \alpha_1 lnX_1 + \alpha_2 lnX_2 + \alpha_3 lnX_3 + \alpha_4 lnX_4 + \alpha_5 lnX_5 + \alpha_6 lnX_6 + \alpha_7 lnX_7 + V_j - U_i$ ....(7)

where *In*=the natural logarithm

Q_1 = total farm output of cassava in kilogramme

X_1= cultivated land area for cassava in hectares

X_2 = family labour utilized in man- hours

X_3 = quantity of cassava stem cuttings in kilogramme

X_4 = quantity of fertilizer used in kilogramme

X_5 = quantity of herbicide in litres

X_6 = quantity of pesticides in litres

X_7 = hired labour utilized in man-hour

α_0 =intercept

$\alpha_1 - \alpha_7$ = parameters to be estimated

V_i=isthestochasticerror,whichisassumedtobeindividuallyand normallyspread withzero mean and aconstant variance(σv^2)

U_i=is aone-sided errorterm whichis independent of viand is normallyspread with zero mean and aconstantvariance (σu^2).

(c) The allocative efficiency was calculated using the Cobb-Douglas stochastic frontier cost function stated thus: (

$lnCy = \beta 0 + \beta 1lnX1 + \beta 2lnX2 + \beta 3lnX3 + \beta 4lnX4 + \beta 5lnX5 + \beta 61nX6 + \beta 71nX7 + Vi + Ui$ - ----------- (8)

where:

Cy = Total cost of production (Naira)

X1 = Cost of fertilizer (Naira)

X2 = Cost of land (Naira)

X3 = cost of herbicide (Naira)

X4 = cost of pesticide (naira)

X5= cost of stem (naira)

X6= cost of family labour (naira)

X7= cost of hired labour (naira)

β = vector of the coefficients for the associated independent variables in the production function.

Ui = are non-negative random variables, assumed to be half normally distributed

N (0, σU_2) | and account for the cost inefficiency in production.

Vi = random variables which are assumed to be normally distributed N (0, σV2), and independent of the Ui

The technical and allocative inefficiency model U_j is defined thus:

$U_j = \delta_0 + \delta_1 R_1 + \delta_2 R_2 + \delta_3 R_3 + \delta_4 R_4 + \delta_5 R_5 + \delta 6R6 + \delta 7R7 + \delta 8R8$---------------------- (9)

WhereU_j=the technicalinefficiencyof thej^{th}farmer

R_1=level of education (Number ofyears spent inschool)

R_2=household size (number ofpersons in the household)

R_3= cassavafarmingexperience(years)

R_4=numberof contacts with extension agent (Number ofvisits peryear)

R_5=sex(1-male, 0-female)

R_6=land ownership (1-owned, 0-otherwise)

R_7=membership of association (1-belong, 0-otherwise)

R8= access to credit (amount of credit received for cassava production in naira)

δ0-δ7= unknown variables which are inserted in model to represent possible effect on technical efficiency of the producers.

(d) Gross margin represented by cost and returns and Return on Investment were employed for profitability analysis as defined by:

$GM = \sum n/_{i=1} P_j Q_1 - \sum n_{/j=1} P_j X_j$-- ------(10)

whereGM=gross margin

P_i=unit priceof cassava (₦)
Q_i=quantityof cassava (kg)
P_j=unit priceof jth input(₦) (j=1…2……7)
X_j=quantityof thejth input (litre or kg) (j=1…2……7).
where$X_j$of1-7 areasfollows:
X_1=cultivated land areafor cassava(ha) X_2=familylabour(man-hour)
X_3=quantity of stem planted (bundle),
X_4=quantityof fertilizer used (kg)
X_5=quantityof herbicide used (liters),
X_6=quantityof pesticide(litres)
X_7=hired labour(man-hour)
n = number of hectares
Thecalculationofthereturnoninvestmentwillfurtherstrengthenthe decisionmakingonthebestprofitableinvestment.Hencetostrengthenthegrossmargin analysis,thereturnoncapitalinvestedinboththevitamin A cassavaand other improved cassava production was calculated usingthefollowingformula thus:
Return onInvestment (ROI) =GM/TVC …………………………… (11)
where:
ROI= the return on investment and
GM and TVC is as explained in equation 10.

IV. Results and Discussion

Socio-economic characteristic

As presented in Table 1, are the socio-economic characteristics of other improved cassava (OIC) and Vitamin A cassava (VAC) respondents. The table revealed male dominance for both cassava varieties with OIC producers accounting for 71.1% and VAC recorded 68.9%. This implies more males' producers of OIC than VAC in the study area. Generally, the analysis revealed that cassava production is a male dominance occupation. The age distribution of the farmers in the study area showed that 30% and 40% respectively were obtained as the proportions of OIC and VAC farmers representing age class of 41- 50 years. The result indicates that cassava farmers were in their middle age and active in production and could be ready to accept agricultural innovations. This is in tandem with result obtained by Igbaifua (2018) in Guinea Savanah Zone of Nigeria where he had a similar result of age bracket of 41-50 years and a mean age of 44 $\pm$ 8.9 years for TME – 419 cassava farmers. The analysis also revealed that married couples (81.7% - 100%) comprise the majority of OIC and VAC farmers. The findings also revealed that OIC cassava farmers in Oyo State who had formal education were 91.1% and those without formal education accounting for 8.9% while VAC farmers in with formal educational levels accounted for 94.4% and 5.6% of them have never gone to school. The result of the analysis in Table 1 indicates that farming is the major occupation of the respondents in the study area. The result showed that 64.4% of the respondents were OIC producers and 47.8% were VAC farmers. The means years of farming experience for OIC and VAC farmers were 29.3 $\pm$ 13.5 and VAC farmers accounted for 23.7 $\pm$ 11.4.Generally, the result of the analysis as depicted inferred that the farmers had more than ten years' experience and this agrees with Eze &Nwibo (2014) who reported that most of the cassava farmers in Delta State had more than ten years' experience in cassava business and therefore were experienced in the business which is a factor to enhance profitability and productivity.36.7% of OIC farmers and 67.8% of VAC farmers cultivated less than 2 hectares with OIC farmers cultivating more hectares than VAC farmers who cultivated less than 1 hectare. This implies that both Vitamin A cassava producers and other improved cassava farmers are smallholders in study area. The survey result reveals that majority of OIC and VAC farmers representing 73.3% and 68.9% respectively in the study area had no access to credit facilities to expand their farms. This implies that they financed their cassava production using their personal savings implying that expansion of cassava land and purchase of required inputs were constrained in both production practices. This finding agrees with Omotayo & Oladejo (2015) who reported that 75.5% of cassava farmers in Oyo State financed their cassava enterprise with their personal savings.

Table 1: Socio-Economic Characteristic of Cassava Farmers

Characteristics	OIC Frequency	OIC Percentage	VAC Frequency	VAC Percentage
Gender				
Male	64	71.1	62	68.9
Female	26	28.9	28	31.1
Age				
20-30	6	6.7	7	7.8
31-40	15	16.7	16	17.8
41-50	27	30.0	36	40.0
51-60	21	23.3	24	26.7
61-70	18	20.0	7	7.8
71-80	3	3.3	0	0.0
Marital status				
Married	85	94.4	90	100
Others	5	5.6	0	0.0
Educational attainment				
Informal	8	8.9	5	5.6
Primary	16	17.8	22	24.4
Secondary	35	38.9	38	42.2
Tertiary	31	34.4	25	27.8
Occupation				
Farming	58	64.4	43	47.8
Business/Trade	25	27.8	34	37.8
Civil servant	6	6.7	13	14.4
Others	1	1.1	0	0.0
Farming experience				
1-10	8	8.9	15	16.7
11-20	18	20	31	34.4
21-30	33	36.7	30	33.3
31-40	16	17.8	5	5.6
41-50	9	10.0	8	8.9
51-60	6	6.7	1	1.0
Farm size				
0.1-1.0	30	33.3	61	67.8
1.1-2.0	33	36.7	15	16.7
2.1-3.0	21	23.3	7	7.8
3.1-4.0	4	4.4	4	4.4
4.1-5.0	1	1.1	3	3.3
5.1-6.0	0	0.0	0	0.0
≥ 6.1	1	1.1	0	0.0
Credit accessibility				
Yes	23	26.7	28	31.1
No	66	73.3	62	68.9

Source: Survey data analysis

Relationship Between Inputs and Output of OIC and VAC Production Practices in Oyo State

Presented in Tables 2 is the hypothesized parameters for the production function of OIC and VAC production practices. The disaggregated estimates of the parameters of the stochastic frontier production model using Maximum Likelihood estimation (MLE) revealed that in both OIC and VAC in study area, the hypothesized coefficients of the production function of farm size, family labour, planting material and herbicide were positive and significantly different from zero at 1 percent level of significance. Similarly, fertilizer used, pesticide and hired labour were negative at 1 percent level of significant. The positive coefficient of the variables implies that as each of these variables are increased, cassava output equally increased, while negative coefficient of the variables is the inverse.

The return to scale (RTS) evaluation, which suggests a determination of total resource-use productivity is presented in Table 3 using the maximum likelihood estimates of the Cobb-Douglas stochastic production function indices of 0.472 and 0.678 for OIC and VAC farmers in the study area respectively were arrived at from the addition of the coefficients of the estimated elasticities or inputs. The results indicate that cassava production in both practices operated in the second level of the production frontier. Second level of the production is assumed as a stage of decreasing positive return–to-scale where resources and production were predicted to be efficient, referred to as the rational stage. Therefore, it is important that the production resource parameters should adhere to the level of input utilization at this stage since a given level of inputs will result into maximum output all things being equal. This is in tandem with the submission of Ogundari& Ojo (2007) where they indicated a decreasing positive return to scale (DPRS) of 0.840 among cassava farmers in Osun State. Ogunniyi (2015) also reported similar report in Oyo State, Nigeria. He obtained RTS value of 0.54 for cassava production. Okoh (2016) obtained RTS value of 0.824 for cassava production in Benue State, Nigeria.

Thecomparative estimates of the stochastic frontier cost function for OIC and VAC productions are shown in Table 4. The result indicated that all the variables acted along prior expectation due to all estimated coefficients of average cost of fertilizer, cost of land used, price of planting material, average wage rate per man days of labour and cassava yield in kilogramme gave positive coefficients, implying as these variables increased, total production cost increased if all things are equal. The result emanated from t-ratio test indicates that all variables are significant and statistically greater than zero at three levels of significance. Therefore, these parameters are drivers of OIC and VAC in Oyo State.

Table 3: Return to scale in OIC and VAC production in Oyo State

Variables	**Elasticities**	
	OIC	**VAC**
Farm Size	0.542	0.435
Family Labour	0.222	0.324
Quantity of Stem	0.140	0.256
Fertilizer	-0.056	-0.058
Herbicide	0.207	0.228
Pesticide	-0.336	-0.259
Hired Labour	-0.247	-0.248
Return to scale	**0.472**	**0.678**

Source: Field survey, 2019

Technical Efficiency

Table 2: Maximum Likelihood Estimate for Stochastic Frontier Production Modelin Oyo State

		OIC		VAC	
Variables	Parameters	Coefficient	t-ratio	Coefficient	t-ratio
Constant	β_0	7.356***	4.128	6.136***	6.347
Farm size	β_1	0.542***	4.422	0.435***	5.346
Family labour	β_2	0.222***	3.322	0.324***	3.345
Stem cutting	β_3	0.140***	3.338	0.256***	3.542
Fertilizer	β_4	-0.056	0.765	-0.058	0.886
Herbicide	β_5	0.207***	2.766	0.228***	2.226
Pesticide	β_6	-0.336***	-3.458	-0.259***	-3.336
Hired labour	β_7	-0.247***	-2.412	-0.248***	-3.645
Variance Parameters					
Sigma squared	σ^2	0.764*	4.348	0.524*	4.445
Gamma	y	0.767*	4.467	0.634*	4.436

***p<0.01, **p<0.05, *p<0.1

Source: Survey data analysis

Table 4: Comparative Maximum Likelihood Estimate of Frontier Cost Function Frontier Model in Oyo State for OIC and VAC Production

		OIC		VAC	
Variables	Parameters	Coefficient	t-ratio	Coefficient	t-ratio
Constant	β_0	0.346*	3.967	0.166*	2.735
Cost of fertilizer	β_1	0.748*	3.487	0.538*	2.457
Cost of land	β_2	0.431**	3.655	0.237***	4.234
Cost of stem	β_5	0.356*	3.264	0.543***	5.346
Cost of family labour	β_6	0.236**	2.356	0.265***	2.642
Hired labour cost	β_7	0.238**	3.314	0.324**	2.132
Total cassava output	β_8	0.228**	3.436	0.288***	2.565
Variance Parameters					
Sigma squared	σ^2	0.836*	44.586	0.8674*	38.787

Gamma	y	0.668*	3.723	0.788*	4.846

***p<0.01, **p<0.05, *p<0.1
Source: Survey data analysis

Technical Efficiency

Analysis of OIC growers in the study area revealed that the mean, maximum and minimum technical efficiencies were 0.88, 1.0 and 0.13 as presented in Table 5, respectively. This implies that OIC cassava growers with the best practice in the study area is 1.0 while OIC grower with least practice is 0.13. Also, if the mean OIC cassava grower in the sample was to obtain the technical level of its most efficient counterpart, then the average OIC cassava grower could obtain a 12% cost saving [i.e., 1-(0.88/1.00) x 100]. In like manner, computation for the least economically efficient OIC farmer will require efficiency gain of about 87% [1-(0.13/1.00) x 100] to be able to experience the status of the most economically efficient OIC cassava growers in the sample. The frequency in deciles ranges as presented in figure 1 revealed that 50% of the OIC growers have technical efficiencies between 0.61- 0.80. The result indicates that about 10% of OIC cassava growers had technical efficiency below 60%, while about 90% had technical efficiency from 60% and above. The research work further inferred that wide gap exists for improvement in the level of technical efficiency of OIC production in Oyo State. The result showed that OIC farmers in Oyo State are moderately efficient in producing cassava at a given level of output using the cost minimizing input ratio. The minimum, maximum and mean technical efficiencies obtained from the study of VAC cassava production in Oyo State were 0.14, 0.95 and 0.86 respectively as shown in Table 5. The technical efficiency distribution of the VAC producers is skewed in the class of less than 0.61 and representing about 47% while figure 1 showed the technical efficiency distribution of production practice. VAC farmers' technical efficiency mean was 0.86. The result agrees with the findings of Onu&Edon (2009) and Aboki*et al*. & Umaru (2013) where they obtained 0.88 technical efficiency for improved cassava varieties farmers in selected local Government Areas of Taraba State and 0.89 as technical efficiency for cassava production in Taraba State respectively. The mean technical efficiency of 0.86 for VAC production in Oyo State suggests that the VAC farmers had 14% range for improving their production efficiency employing current technology. The estimated technical efficiencies range between 0.14 and 0.95 with an average of 0.86 means that if an average VAC farmer in the sample of 90 farmers was to obtain the technical efficiency level of its most efficient counterpart, then the average VAC farmer could obtain a 9.47% cost saving [i.e. 1-(0.86/0.95) x 100]. Similarly, computation for the least technically inefficient farmer shows cost saving of 85.26% [i.e., 1-(0.14/0.95) x 100].

Allocative Efficiency

As shown in Table 5, the mean, minimum and maximum allocative efficiencies of OIC and VAC growers were 0.86, 0.25, 0.88 and 0.86, 0.14 and 0.96, respectively. This infers that if a standard OIC cassava farmer in the sample was to achieve the allocative efficiency level of its most efficient equal, the average OIC grower could obtain 2.3% cost saving [i.e., 1-(0.86/0.88) x 100]. However, if the most allocatively inefficient OIC cassava farmer could actualize cost saving of 97.2% if the efficiency level of the most efficient producer in the group is achieved [i.e., 1-(0.025/0.88) x100]. A vivid picture is shown in Figure 2. VAC growers in Oyo State sampled allocative efficiency indices suggest that for an average farmer among the VAC producers to attain the equivalent allocative efficiency status as the most efficient VAC producer, the average producer will be saving 10.4% cost saving [i.e. 1-(0.86/0.96) x 100], however, if the most allocatively inefficiency VAC grower will realize cost saving of 85.4% if the efficiency level of the most efficient grower in the group is achieved [i.e. 1-(0.14/0.96) x 100] of the cost of producing cassava. This analysis is presented in Table 5 and for more picture, this is depicted in figure2.

Economic Efficiency

As presented in Table 5, the mean, minimum and maximum economic efficiency for OIC production were 0.84, 0.42 and 0.96 respectively. The results showed that economic efficiency for VAC farmers ranged between 0.42 and 0.96 implying that a wide gap exists between the best economically efficient farmers and the worst economically efficient farmer in the group. The mean economic efficiency is 0.84 indicating that OIC farmers in Oyo State were reasonably economically efficient in the utilization of limited inputs. The estimated result equally suggests that for a standard OIC cassava producer in Oyo State to obtain the status of the most economically efficient farmers in the group, the farmers must achieve efficiency profit of 12.5% [i.e., 1-(0.84/0.96) x 100]. The finding equally depicts that the least economically efficient OIC cassava farmer in Oyo State will need efficiency profit of about 56.3% [i.e., 1-(0.42/0.96) x 100] to be able to achieve the status of the most economically efficient producers in the category examined. To show a more vivid picture of the distribution of the OIC farmers economic efficiencies, a frequency distribution of the estimated economic efficiencies is presented in figure 3. The distribution of the frequencies of observation of the estimated OIC farmers' economic efficiencies in decile bracket implies that the topmost cluster of farmers have economic efficiencies between 0.61 – 0.80, accounting for 37.8% of the sample, while 62.2% of the OIC farmers have economic efficiency of 0.61 and above thus implying that the farmers are reasonably efficient. This infers that the OIC cassava farmers are reasonably good in growing a given quantum of cassava at a determined lowest cost level of technological innovation. In a similar analysis, the mean, minimum and maximum economic efficiencies of VAC production in Oyo State are 0.76, 0.06 and 0.92 respectively as presented in Table 5. This suggests that if a standard VAC farmer in the group was to attain the economic efficiency level of its best efficient fellow, then the standard farmer could obtain a 17.4% cost saving [i.e., 1-(0.76/0.92) x 100]. A similar computation for most economically inefficient farmer indicates cost saving of 93.5% [i.e., 1-(0.06/0.92) x 100]. To show a better picture of the distribution of the VAC farmers economic efficiencies, a frequency distribution of the forecasted economic efficiencies is shown in figure 3. The distribution of the frequencies of observation of the forecasted VAC farmers' economic efficiencies in decile ranges imply that the topmost cluster of farmers have economic efficiencies from 0.61 and 1.00 representing 55.6% of the sample, while 80% of the VAC farmers have economic efficiency of 0.61 and above thus signifying that the VAC cassava farmers are reasonably good in producing a given amount of cassava at a determined lowest cost level of practice.

Table 5: Distribution of Efficiencies between OIC and VAC Cassava Production in Oyo State

Efficiency Level	OIC TE f	OIC TE %	OIC AE f	OIC AE %	OIC EE f	OIC EE %	VAC TE f	VAC TE %	VAC AE f	VAC AE %	VAC EE f	VAC EE %
≤ 0.20	5	5.6	0	0.0	0	0.0	4	4.4	0	0.0	0	0.0
0.21-0.40	4	4.4	10	11.1	0	0.0	15	16.7	17	18.9	18	20
0.41-0.60	20	22.2	22	24.4	22	24.4	28	31.1	22	24.4	22	24.4
0.61-0.80	45	50.0	34	37.8	34	37.8	24	26.7	26	28.9	25	27.8
0.81-1.00	16	17.8	24	26.7	34	37.8	19	21.1	25	27.8	25	27.8
Total	90	100	90	100	90	100	90	100	90	100	90	10
Mean	0.88		0.86		0.84		0.86		0.78		0.76	
Std. Deviation	0.026		0.028		0.036		0.034		0.026		0.03	
Minimum	0.13		0.25		0.42		0.14		0.35		0.06	
Maximum	1.00		0.88		0.96		0.95		0.96		0.92	

Source: Computed from maximum likelihood estimation result of survey data analysis
TE= Technical Efficiency, AE= Allocative Efficiency, EE=Economic Efficiency

Gross Margin Analysis

As presented in Table 6 is the result gross margin analysis as represented by cost and returns of OIC and VAC per hectare in Oyo State. The profitability analysis in the study area revealed a Gross Margin (GM) of N139,900 (OIC) and N132,250 (VAC) and ROI were 1.158 and 1.006 respectively. The results indicated that OIC cultivation is more profitable than VAC. The table also showed a higher return on investment in like order.

Table 6: Gross margin analysis per hectare of OIC and VAC in Oyo State

Variables	OIC (₦)	VAC(₦)
Total variable cost (TVC)	120,800	131,450
Total Revenue	260,700	263,700
Gross margin (TR-TVC)	139,900	132,250
Return on Investment (ROI) GM/TVC	**1.158**	**1.006**

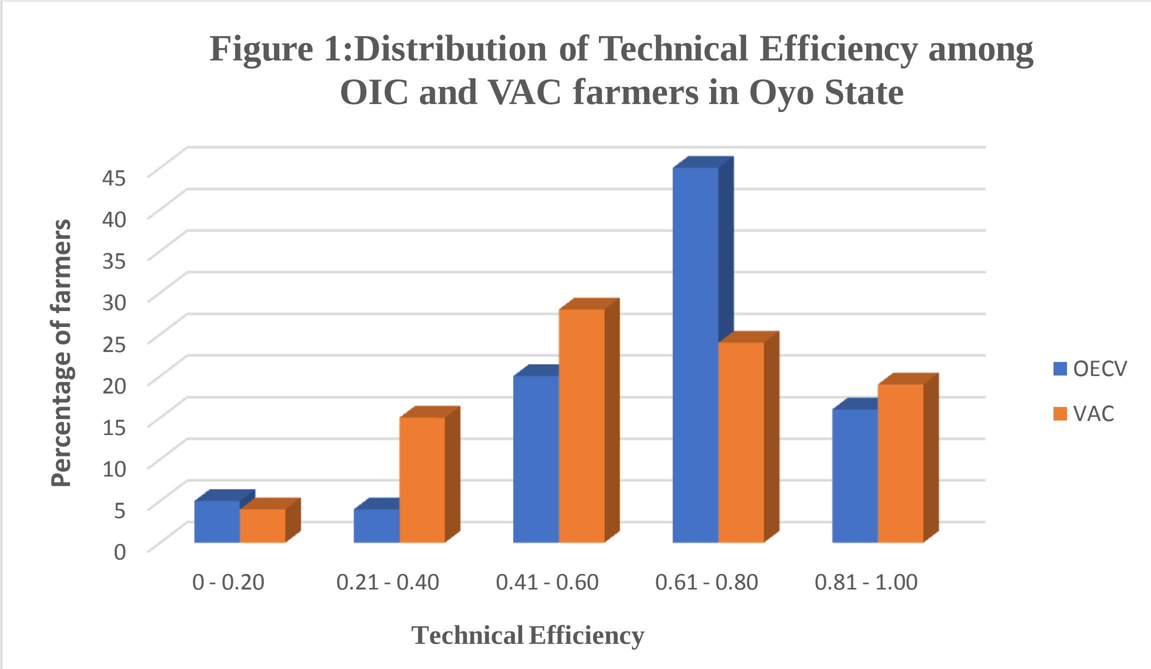
Source: survey data analysis

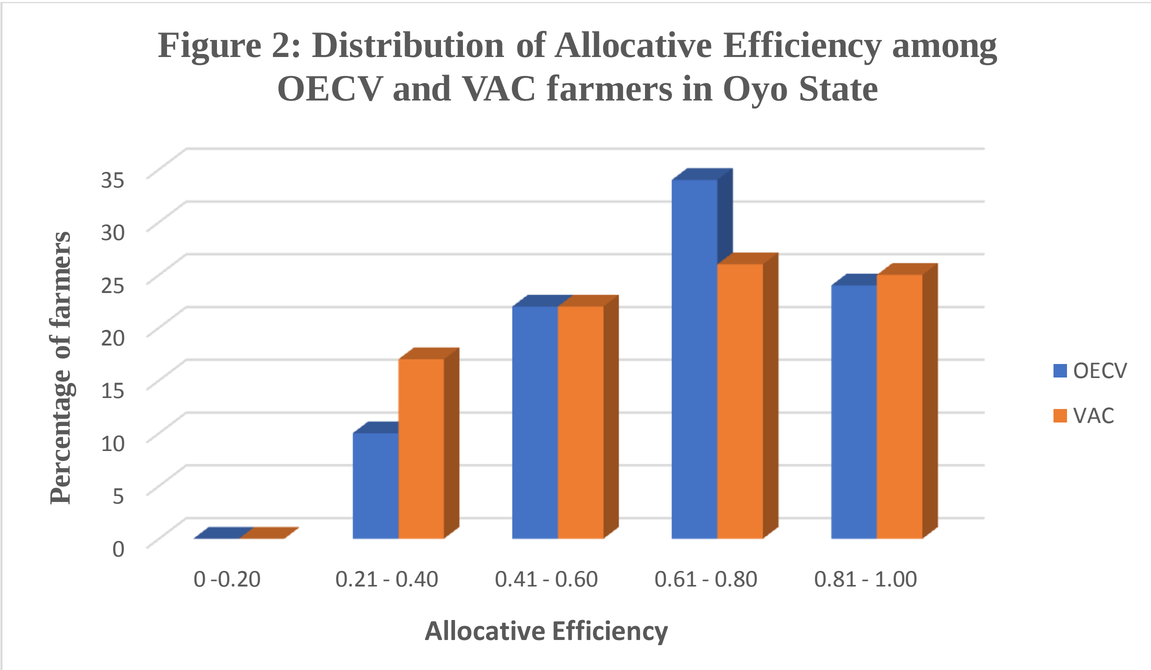
Table 7: Constraints Associated with OIC and VAC Production in Oyo State

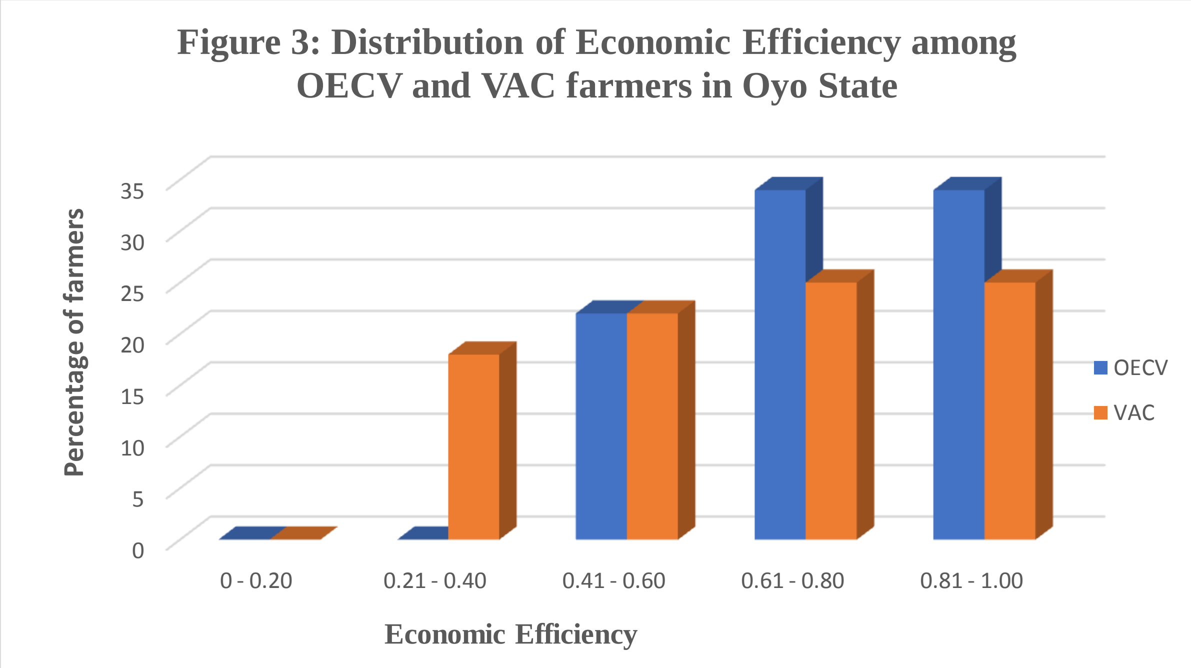
Constraints	**OIC *F**	**OIC %**	**OIC Rank**	**VAC *F**	**VAC %**	**VAC Rank**
Low market demand	0	0.0	11th	3	15.8	2nd
Inadequate finance	56	19.1	2nd	44	11.1	3rd
Agrochemicals cost	25	8.5	5th	29	7.3	8th
High labour cost	35	11.9	3rd	38	9.6	4th
Inadequate farmland	21	7.1	6th	22	5.5	10th
Poor transportation system	7	2.4	8th	32	8.0	6th
Poor market pricing	19	6.5	7th	26	6.5	9th
Insufficient planting stem	5	1.7	9th	35	8.8	5th
Pests and disease	33	11.2	4th	30	7.6	7th

Weed infestation	3	1.0	10th	10	2.5	11th
Grazing of farmland by Cattle	90	30.6	1st	69	17.3	1st
Total	**294**	**100**		**398**	**100**	

*Multiple responses
Source: survey data analysis







Constraints in OIC and VAC Production practices in Oyo States

The results of the evaluation of constraints of production practices in Oyo State as presented in Table 7indicated that the respondents are faced with several challenges in their cassava production practices. The constraints were ranked based on their severity and seriousness as perceived by farmers. These are ranked in percentages ranging from the most severe to least critical constraints. The constraints include the following: low market demand, inadequate finance, high cost of herbicide and pesticides, high cost of labour, inadequate farmland and poor transportation. Others given as regards hinderances to smooth cultivation of both OIC and VAC included poor market pricing, insufficient planting stem, pests and diseases infestation, weed infestation and control, and illegal grazing of farmland by irate cattle.The most serious constraint recorded by the farmers of both production practices in the study area was grazing of cassava farms by cattle. Others include low market demand, inadequate finance, and high cost of labour.

V. Conclusion

Profitability level alone is not the only determinant of choice of farmers for going into any of the cassava production practices, other factors were observed to be adequate finance for production, farmland acquisition and planting material accessibility, labour availability, physical and nutritional characteristics and market driven factors for output. The statistically significant result of efficiency levels suggested that the farmers in both production practices did not produce at the frontier level hence signifying the existence of inefficiency among the producers. The result emanating from the return to scale inferred that both production practices need to work more on technical and allocative efficiencies to reach the optimum production level using the present production technology at stage II of production level. The study also observed that five major inputs are important in both production practices viz: farm size, family labour, stem, herbicide and hired labour. This indicates that for an increase in the production output of cassava, the five inputs must be ready and efficiently used. OIC was found to be most profitable cassava production than VAC. Analysis of socio-economic characteristics revealed that most respondents of the two production practices were males, married, educated, had long years of farming experience, were in their productive age and smallholder farmers in both production practices. Also, most respondents used their personal savings for production and cassava farming as the main occupation. Three topmost constraints of cassava farmers were grazing of farmland by cattle, inadequate finance and low market demand. Farmers in the study area are encouraged to invest more in OIC production practice as it is a more profitable enterprise.

VI. Recommendation

Thus, the following recommendations are suggested to raise the production of cassava based on the results obtained. (i) Cassava planting stem was found to be a significant hindrance to both the production practices of cassava with more on the VAC production practice. It is recommended that cassava farmers are encouraged to multiply their planting stems with the support of extension agents. More of extension agents visit should be intensified to enhance awareness of farmers and usefulness of Vitamin A as most farmers in the study area did not have in-depth technical knowledge about Vitamin A cassava variety. (ii) Finance was found to be a major determinant factor of cassava productivity and a major challenge in both OIC and VAC production practices. Farmers are advised to develop saving culture and enter contract farming with reputable companies and individuals to overcome this challenge. (iii) Relevant policies aimed at discouraging cattle grazing of farmland should be in place, such as encouraging Fulani herders on establishing grazing ranches. Cassava farmers are encouraged to purchase and use strong twine rope with iron poles to construct fence round their farms. (iv) The government should make agricultural policy measures towards the provision of a ready market with stable prices for cassava roots as low market demand was one of the topmost constraints identified. (v) Labour cost was found to be very high and accounted for the highest cost of production input, it is recommended that the farmers venture into labour – saving technologies and small-scale mechanization to reduce production cost such as encouraging efficient use of agro-chemical like herbicides for weed control.

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