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Research Paper

Comparative Analysis of Economic and Efficiency of Vitamin A Cassava Farmers with Other Improved Cassava Farmers in Benue and Oyo States, Nigeria.

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Abstract: *Comparative analysis of economic and efficiency of Vitamin A Cassava farmers (VAC) with other cassava farmers (OIC) in Benue and Oyo States, Nigeria was conducted. The study compared relationship between inputs and output of two cassava production practices; evaluated the technical, allocative and economic efficiencies of cassava farmers; determined the profitability and production constraints faced by farmers under the two production practices. A five- stage sampling technique was employed to select 300 farmers. In the first stage, two States out of six geo-political zones of Nigeria with high concentration of vitamin A cassava and other improved cassava production were purposively selected. By proportion, three LGAs from Oyo and two LGAs from Benue States were selected. Three communities were randomly selected among the five LGAs selected earlier to give 15 communities. Primary data were obtained using structured questionnaire and interview methods. Data obtained include socio-economic characteristics of respondents, inputs, outputs, marketing and constraints to cassava production. The data were analyzed using descriptive statistics, stochastic frontier production function, gross margin analysis and return on investment. 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 finance, planting material, labour, nutritional characteristics and market. Five major drivers of cassava production were farm size, family labour, stem, herbicide and hired labour. Education, farming experience, gender and extension contacts significantly influenced farm -specific profit inefficiencies. The OIC farmers in Oyo showed higher allocative and economic mean efficiencies (0.86 and 0.84) than Benue (0.76 and 0.66). VAC farmers in Oyo exhibited higher allocative and economic mean efficiencies (0.78 and 0.76) than Benue (0.75 and 0.67). The 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). The VAC farms in Benue were more profitable than OIC farms with gross margin of ₦181,120 and ₦105,620 per hectare of land, ROI (1.68 and 0.86). The mean efficiencies of both practices were significant at p<05. OIC and VAC production practices were operating in second level of production frontier with return to scale (RTS) of less than unity (0.457 and 0.448) in Benue, and (0.472 and 0.678) for Oyo. However, farmers complained of inadequate finance, planting stems, poor extension agents visit, low market, high labour cost and grazing of farmland by irate cattle. It is recommended that farmers develop saving culture and enter contract farming with reputable organizations, multiply their planting stems, increase extension agents' visit, venture into labour-saving technologies, government to create ready markets and encourage Fulani herders to establish ranches to prevent incursion of roaming cattle herds into farms. The study concluded that OIC and VAC were smallholder farmers who were technologically inspired to transform inputs into output by seer profitability, food security for households and poverty alleviation, but for them to achieve these, they need to improve on technical, allocative and economic efficiencies of production.*

Key words: *Technical, allocative, economic efficiencies, production practices, stochastic frontier production 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). It is widely cultivated and consumed by over 100 million people in Nigeria and Asia countries of the world for its edible roots, leaves and for its income generation potentials and as a result, cassava has been found useful in industries, animal feeds and staple foods for households (Westby,2002). These various uses imply that cassava could occupy the position of food security crop and income generation for poor households.

Globally, Nigeria is presently the largest producer of cassava with about 50 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 national average yield as reported by FAO (2019) is put at about 13.63 metric tonnes per hectare. This is against the potential yield of about 30- 40 metric tonnes per hectare of World average (Abolaji *et al.*& Oduola, 2007).

Aerni (2006) reported that cassava has previously been regarded as a "hunger fighter" crop as it provides a reliable means of food during drought and hunger periods for the poor households. It has suddenly become both a nutritional food, a global income earner, 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. 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 (Philips *et al.* & Akoroda, 2007).

To increase cassava production and utilization in the country, Adeniji (2000) reported that international fund for Agricultural Development (IFAD) and Nigerian Government partnered in introduction of vitamin A cassava production and distribution to farmers with the objective of making cassava as a food staple crop against food security.

Vitamin A cassava is a deep yellow variety of cassava compared to the conventional white types. It is biofortified through traditional breeding or modern biotechnology by adding beta-carotene compound which the body transforms to vitamin A. It can potentially reduce deficiency of vitamin A when consumed and is estimated to be at least six times more nutritious than existing, improved, white-fleshed cassava (Ilona, 2014). The purpose of introduction of Vitamin A cassava production and distribution programme to producers in Nigeria is to reduce destitution associated with smallholders, boost productivity and cash income. In alignment to these objectives, HarvestPlus Nigeria developed and disseminated Vitamin A cassava varieties to four states namely: Oyo, Imo, Akwa Ibom and Benue in Nigeria for adoption by farmers to increase income of rural farmers and improve nutritional food security situation of the populace (Ilona et al. & Oparinde, 2017).

Consequently, Vitamin A cassava multiplication programme was initially inaugurated in 2001 by the Federal Government with the purposes of increasing output, profitability, acceptability, and income of the farmers but failed to accomplish these aims as the farmers persisted in using outdated varieties of cassava planting materials (Ilona *et al*. & Oparinde, 2017). However, On 7th December 2011, the Nigerian government announced the release of the pro-vitamin A cassava varieties developed by International Institute of Tropical Agriculture (IITA) in partnership with the National Root Crop Research Institute (NRCRI) Umudike and funded by HarvestPlus 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 and recognized as IITA genotypes -TMS 01/1368, TMS 01/1412 and TMS 01/1371.

The project started with 100 bundles of stems (50 stems per bundle) of three first-wave Vitamin A cassava varieties in 2010. A decentralized community-based seed production scheme was used to increase stem availability to 250,000 bundles by 2012 (Ilona *et al.* & Oparinde,2017). 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 programme expanded to six villages in each LGA making a total of 60 villages per state and 240 villages in the four states of Oyo, Imo, Akwa Ibom and Benue. The core 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 vital role cassava cultivation played in Nigerian economy coupled with its profitability and nutritional importance, its cultivation is far inadequate to meet up with the demand for its products by numerous consumers (Nweke, 2004). For the country to be cassava surplus and sustainable, productivity 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 productivity, profitability, under-capitalization and efficient use of 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 the productivity and profitability of the resources used by vitamin A cassava farmers with 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 peculiar technical efficiency is rested on deviations of actual yield from the greatest production limit. If a producer's observed production rests on the border, it is hypothesized to be perfectly efficient and if it lies below the border line, it is said to be technically inefficient where the ratio of the observed to the unrealized production describes the strength of productivity of the specific producer.

The measurement of production frontier could be discussed under two general forms. There is complete frontier which emphasizes all observations to be on or below and therefore, all variations from the border line are ascribed to inefficiency and so the stochastic frontier where variation from the constituents returning estimation error and statistical noise and a constituent returning inefficiency. The demerit of these approaches is that they are greatly sensitive to deviations. Thus, if the deviations return computation errors, they will slowly introduce bias into the hypothesized frontier and the efficiency computations obtained from it. In all, the stochastic frontier method seems better due to its involvement of conventional random error of regression. As a result, the parameter error, apart from showing the impact of insignificant left out variables and errors of computations 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) commenced the computation of productivity by suggesting a partition of technical efficiency into two forms. The first describes a farmer's capacity to produce an optimal amount of yield from a given bundle of inputs and secondly, allocated efficiency which he referred to capacity of a producer to utilize inputs in maximum 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 methods exist 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 computed to measure the technical efficiency variables, while the variables achieved are regressed against a bundle of socio-economic explanatory variables that are normally farm 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 hypothesized to be individually, normally spread (Jondrow *et al*. & Schmidt, 1982). As a result, more development of a more reliable approach that modeled inefficiency impacts as an explicit function of some factor attributed to the farm and all variables are computed in one step employing maximum likelihood estimate (Ajibefun and Daramola, 2003, Obwona, 2000, Battese & Sarfaz, 1998). The maximum likelihood procedures of the production model are computed utilizing the computer programme referred to as FRONTIER (Coelli & Battese, 1996). This method was adopted and employed in this research.

Model specification

The two procedures enunciated above can be modeled into mathematical notations. The econometric model is categorized as either deterministic frontier model or stochastic frontier model hypothesized that the farmer is producing sole outpu such as cassava tuberst. It is equally hypothesized that the quantity of inputs utilized to produce the sole output is readily available for individual number of farmers. Thus, the production frontier model is given as:

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

where Y_j= yield of farmer j=1……..N

X_i= bundle of inputs used by farmer j

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

β=variable to be computed

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

From (2)

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

Equation (2) measures the technical efficiency on the relationship of actual yield to optimal yield possible given the available technology. Y_i obtained its optimal benefit of $f(X_{ij}\beta)$ only if TE_i=1. The amount by which a value under consideration lies below the frontier is called inefficiency when $TE_i<1$.

It can be seen from equation (2) that $f(X_{ij}\beta)$ is deterministic while in equation (3), the total deficit of actual yield $f(X_{ij}\beta)$ is associated with technical inefficiency. This gave the inadequacy of this approach since environmental and institutional factors outside the control of farmers like bad weather, bad market and error in model specification can result into raising the inefficiency estimates. With the incorporation of random parameter to the production frontier equation in (1)

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

where [$f(X_{ij}\beta)$, exp [Vi]]=stochastic production frontier.

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

Describing technical efficiency as the proportion of actual yield to optimal possible yield with effect of environment by exp {Vi}.

As a result of the above equations the two-disturbance parameter of production frontier is missing, neither of them can give a true picture of technical efficiency.

The second method is called the stochastic production frontier model. The important element of this method is that the disturbance term is made up of two parts. The first disturbance term is the symmetric part Vi which represents the random of error outside the control of producer while the non-negative one-sided part Ui represents the random of human error, which is under the control of the producer. The random terms are normally, and individually spread (Meeusen & Broeck, 1977).

The normal equation for stochastic frontier model in term of general production function is as thus:

$Y_i=f(X_{ij}\beta) + V_i-U_i$--(5)

where:

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

X_i= bundle of inputs used by farmer j

β = variable to be computed

V_i= is the stochastic error, which is hypothesized to be individually and normally spread with zero mean and a constant variation (σv^2)

U_i= is a one-sided error term which is independent of Vi and is normally spread with zero mean and a constant variation (σu^2).

In the stochastic production frontier, the technical efficiency of the farm is described as the proportion of actual yield to the respective potential yield subject to the level of input utilized by the producer. Thus, the technical efficiency of the farm is represented as:

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

where TE_{ij} = technical efficiency of farmer j

Y_i= actual yield from i^{th} farm

Y^* = potential yield

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

TE ranges between 0 and 1 and optimum productivity has a value of 1.

III. Methodology

Study Area and Data Collection

This study was conducted in Benue and Oyo States. Benue State is located in North Central part of Nigeria while Oyo State is in Southwestern part of the country. Benue State lies between latitudes 6^0 25' and 8^0 8' North and longitudes 7^0 47' and 10^0 00' East, while Oyo State lies between latitude 8^0 00'N and longitude 4^0 00'E. The major economic activities of the people in both states include crop and animal production.

A five-stage sampling procedure was used to select the respondents. Benue and Oyo States were purposively selected form North central and Southwestern zones respectively as they represented 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 zone, and two LGAs (Utukpo and Agatu) from Central ADP zone was obtained from HarvestPlus programme Coordinator indicating as the LGAs biofortification and multiplication of vitamin A cassava was implemented. Three communities were randomly selected in each of the five Local Government Areas given a total of 15 communities. A total of 300 farmers were then randomly selected from the 15 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:

$$\text{In } Q_1 = \alpha_0 + \alpha_1 lnX_1 + \alpha_2 lnX_2 + \alpha_3 lnX_3 + \alpha_4 lnX_4 + \alpha_5 lnX_5 + \alpha_6 lnX_6 + \alpha_7 lnX_7 + V_{j} - U_i \quad (7)$$

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
Vi= is the stochastic error, which is assumed to be individually and normally spread with zero mean and a constant variation ($\sigma v2$)
Ui= is a one-sided error term which is independent of vi and is normally spread with zero mean and a constant variance ($\sigma u2$).

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

$$lnCy = \beta0 + \beta1lnX1 + \beta2lnX2 + \beta3lnX3 + \beta4lnX4 + \beta5lnX5 + \beta61nX6 + \beta71nX7 + Vi + Ui \quad (8)$$

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 Uj is defined thus:

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

Where U_j= the technical inefficiency of the j^{th} farmer
R_1= level of education (Number of years spent in school)
R_2=household size (number of persons in the household)
R_3= cassava farming experience (years)
R_4= number of contacts with extension agent (Number of visits per year)
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)

where GM=gross margin

P_i=unit price of cassava (₦)

Q_i =quantity of cassava (kg)

P_j=unit price of jth input (₦) (j=1…2……7)

X_j =quantity of the jth input (litre or kg) (j= 1…2……7).

where X_j of 1-7 are as follows:

X_1=cultivated land area for cassava (ha) X_2=family labour (man-hour)

X_3=quantity of stem planted (bundle),

X_4= quantity of fertilizer used (kg)

X_5=quantity of herbicide used (liters),

X_6= quantity of pesticide (litres)

X_7=hired labour (man-hour)

n = number of hectares

The calculation of the return on investment will further strengthen the decision making on the best profitable investment. Hence to strengthen the gross margin analysis, the return on capital invested in both the vitamin A cassava and other improved cassava production was calculated using the following formula thus:

Return on Investment (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 that in Benue State, majority of OIC and VAC farmers were males accounting for 75% each respectively. Similarly, in Oyo State, the male dominance was recorded 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 Oyo State. Generally, the analysis revealed that cassava production in both States is a male dominance occupation. The age distribution of the farmers in Benue State showed that 30% of the OIC farmers were between the age bracket of 41-50 years with a mean age of 45.9 ± 11.9 years and 31.7% of VAC farmers were between the age range of 41-50 years and a mean age of 45.6 ± 5.2 years. In Oyo State, 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 ± 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 in both states. The findings also revealed that in Benue State, most (96.7%) of the OIC had formal education and a very few (3.3%) had none. Similarly, majority accounting for 96.7% of VAC farmers in Benue State also had formal education. OIC cassava farmers in Oyo State who had formal education were 91.1% and those without formal education accounting for 8.9%. VAC farmers in Oyo State with formal educational 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

Table 1: Socio-Economic Characteristic of Cassava Farmers

	Benue State cassava varieties				Oyo State cassava varieties			
	OIC		VAC		OIC		VAC	
Characteristics	f*	%	f	%	f	%	f	%
Gender								
Male	45	75	45	75	64	71.1	62	68.9
Female	15	25	15	25	26	28.9	28	31.1
Age								
20-30	9	15	7	11.7	6	6.7	7	7.8
31-40	15	25	16	26.7	15	16.7	16	17.8
41-50	18	30	19	31.7	27	30.0	36	40.0
51-60	11	18.3	11	18.3	21	23.3	24	26.7

61-70	7	11.7	7	11.7	18	20.0	7	7.8
71-80	0	0	0	0	3	3.3	0.	0.0
Marital status								
Married	49	81.7	50	83.3	85	94.4	90	100
Single	5	8.3	4	6.7	0	0.0	0	0.0
Others	6	10.0	6	10.0	5	5.6	0	0.0
Educational attainment								
Informal	2	3.3	2	3.3	8	8.9	5	5.6
Primary	11	18.3	10	16.7	16	17.8	22	24.4
Secondary	21	35.0	22	36.7	35	38.9	38	42.2
Tertiary	26	43.3	26	43.3	31	34.4	25	27.8
Occupation								
Farming	53	88.3	54	90.0	58	64.4	43	47.8
Business/Trade	2	3.3	2	3.3	25	27.8	34	37.8
Civil servant	4	6.7	3	5.0	6	6.7	13	14.4
Others	1	1.7	1	1.7	1	1.1	0	0.0
Farming experience								
1-10	12	20	3	5.1	8	8.9	15	16.7
11-20	19	32	27	45.8	18	20	31	34.4
21-30	9	15	20	33.8	33	36.7	30	33.3
31-40	10	17	8	13.6	16	17.8	5	5.6
41-50	10	17	1	1.7	9	10.0	8	8.9
51-60	0	0	0	0	6	6.7	1	1.0
Farm size								
0.1-1.0	34	56.7	35	58.3	30	33.3	61	67.8
1.1-2.0	12	20.0	13	21.7	33	36.7	15	16.7
2.1-3.0	6	10.0	5	8.3	21	23.3	7	7.8
3.1-4.0	4	6.7	3	5.0	4	4.4	4	4.4
4.1-5.0	1	1.7	2	3.3	1	1.1	3	3.3
5.1-6.0	2	3.3	1	1.7	0	0.0	0	0.0
≥ 6.1	1	1.7	1	1.7	1	1.1	0	0.0
Credit accessibility								
Yes	14	23.3	18	30.0	23	26.7	28	31.1
No	46	76.7	42	70.0	66	73.3	62	68.9

Source: Survey data analysis f* = frequency

of the respondents in both Benue and Oyo States. The results showed that 88.3% of the respondents in Benue State were OIC producers, 90.0% as VAC producers. Similarly, in Oyo State, 64.4% were OIC producers and 47.8% were VAC farmers. The means years of farming experience for OIC and VAC farmers were 23.3 ± 13.9 and 21.6 ± 13.0 for Benue State and in Oyo State, the mean years of experience for OIC cassava producers stood at 29.3 ± 13.5 and VAC farmers accounted for 23.7 ± 11.4. Generally, the results of the analysis as depicted in both States 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. Majority (56.7%) of OIC farmers and 58.3% of VAC farmers in Benue State cultivated 1 hectare and below. Similarly, in Oyo State, 36.7% of the 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 areas. The survey result reveals that majority of OIC and VAC farmers representing 76.7% and 70.0% respectively in Benue State had no access to credit facilities to expand their farms. This implies that they financed their cassava production using their personal savings. Similarly, in Oyo State, the trajectory was same where those who were unable to access credit were in the majority in both production practices. The proportion of these farmers in Oyo State for OIC was 73.3% and 68.9% for VAC farmers 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.

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

Presented in Tables 2 is the hypothesized parameters for the production function. 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 0.457 and 0.448 for OIC and VAC farmers in Benue State respectively and 0.472 and 0.678 for OIC and VAC farmers in Oyo State 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 and States operated in second level the of the production frontier. Second level is regarded as a stage of decreasing positive return–to-scale where resources and production were assumed to be productive, 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 of Nigeria. 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.

The estimates of the stochastic frontier cost function 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 Benue and Oyo States.

Table 3: Return to scale in OECV and VAC production

Variables	Benue State cassava varieties Elasticities		Oyo State cassava varieties Elasticities	
	OECV	VAC	OECV	VAC
Farm Size	0.526	0.426	0.542	0.435
Family Labour	0.122	0.222	0.222	0.324
Quantity of Stem	0.040	0.240	0.140	0.256
Fertilizer	-0.044	-0.064	-0.056	-0.058
Herbicide	0.177	0.127	0.207	0.228
Pesticide	- 0.225	-0.246	-0.336	-0.259
Hired Labour	-0.139	-0.257	-0.247	-0.248
Return to scale	**0.457**	**0.448**	**0.472**	**0.678**

Source: Field survey, 2019

Technical Efficiency

Table 2: Maximum Likelihood Estimate for Stochastic Frontier Production model

		Benue State cassava varieties				Oyo State cassava varieties			
		OIC		VAC		OIC		VAC	
Variables	Parameters	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio>
Constant	β_0	8.138***	4.340	7.138***	6.220	7.356***	4.128	6.136***	6.347
Farm size	β_1	0.526***	5.332	0.426***	5.226	0.542***	4.422	0.435***	5.346
Family labour	β_2	0.122***	4.412	0.222***	3.532	0.222***	3.322	0.324***	3.345
Stem cutting	β_3	0.040***	3.449	0.240***	3.354	0.140***	3.338	0.256***	3.542
Fertilizer	β_4	-0.044	0.865	-0.064	0.879	-0.056	0.765	-0.058	0.886
Herbicide	β_5	0.177***	2.865	0.127***	2.176	0.207***	2.766	0.228***	2.226
Pesticide	β_6	-0.225***	-3.238	-0.246***	-3.229	-0.336***	-3.458	-0.259***	-3.336
Hired labour	β_7	-0.139***	-2.241	-0.257***	-3.446	-0.247***	-2.412	-0.248***	-3.645
Variance Parameters									
Sigma squared	σ^2	0.752*	4.234	0.442*	4.334	0.764*	4.348	0.524*	4.445
Gamma	y	0.667*	5.542	0.547*	5.245	0.767*	4.467	0.634*	4.436

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

Source: Survey data analysis

Table 4: Maximum Likelihood Estimate of Frontier Cost Function Frontier Model

		Benue State cassava varieties				Oyo State cassava varieties			
		OIC		VAC		OIC		VAC	
Variables	Parameters	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Constant	β_0	0.146	0.967	0.159	0.728	0.346*	3.967	0.166*	2.735
Cost of fertilizer	β_1	0.745*	3.407	0.527*	0.407	0.748*	3.487	0.538*	2.457
Cost of land	β_2	0.431***	2.869	0.131***	1.869	0.431**	3.655	0.237***	4.234
Cost of stem	β_5	0.343*	3.264	0.503*	5.236	0.356*	3.264	0.543***	5.346
Cost of family labour	β_6	0.169***	2.223	0.177***	1.642	0.236**	2.356	0.265***	2.642
Hired labour cost	β_7	0.221**	2.212	0.321**	2.032	0.238**	3.314	0.324**	2.132
Total cassava output	β_8	0.128***	1.643	0.188***	1.546	0.228**	3.436	0.288***	2.565
Variance Parameters									
Sigma squared	σ^2	0.825*	44.585	0.838*	46.597	0.836*	44.586	0.8674*	38.787
Gamma	y	0.680*	3.816	0.685*	5.855	0.668*	3.723	0.788*	4.846

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

Source: Survey data analysis

Technical Efficiency

In Benue State as shown in Tables 5 and 6, the mean technical efficiencies for OIC and VAC were 0.85 and 0.88 respectively. This result suggests that OIC and VAC farmers have 15% and 12% range for improving their production efficiency using the existing technology. This implies that VAC farmers in Benue State are more technical efficient than OIC farmers. Similarly, the technical efficiencies for OIC and VAC farmers in Oyo State were 0.88 and 0.86 implying that OIC and VAC producers have 12% and 14% range for improving their cassava production using the existing technology. This signifies that OIC farmers are more technically efficient than VAC farmers in Oyo State. Furthermore, the mean technical efficiencies of OIC farmers in Benue and Oyo States were 0.85 and 0.88 respectively, indicating that OIC farmers in Oyo State have a more technical efficiency than Benue State OIC farmers. Similarly, the mean technical efficiencies of VAC farmers in Benue and Oyo State were 0.88 and 0.86 implying that VAC farmers in Benue State were more technically efficient than VAC farmers in Oyo State.

Allocative Efficiency

The mean allocative efficiencies of OIC and VAC farmers in Benue were 0.76 and 0.75 respectively. The result indicates that OIC and VAC farmers have 24% and 25% range for improving their production efficiency using the existing technology. This implies that OIC farmers in Benue State are better allocatively efficient than VAC farmers. The mean allocative efficiencies recorded for OIC and VAC farmers in Oyo State were 0.86 and 0.78 indicating that OIC and VAC farmers in the State have 14% and 22% range for improving their allocative efficiencies using the available technology. This implies that OIC farmers in Oyo State have better allocative efficiency than VAC farmers. The mean allocative efficiencies of OIC farmers in Benue and Oyo States were 0.76 and 0.86 respectively indicating that VAC farmers in Oyo State have a better allocative efficiency than VAC farmers in Benue State. Similarly, the average allocative efficiencies of VAC farmers in Benue and Oyo States were 0.75 and 0.78 implying a higher allocative sufficiency by VAC farmers in Oyo State than Benue State. The results are shown in Tables 5 and 6.

Economic Efficiency

As presented in Tables 5 and 6, the mean economic efficiencies of OIC and VAC farmers in Benue State were 0.66 and 0.67 respectively. This suggests that OIC and VAC farmers have 34% and 33% range for improving their production efficiency using the existing structure. This indicates that VAC farmers are more economically efficient than OIC farmers in Benue State. Similarly, the economic efficiencies of OIC and VAC farmers in Oyo State were 0.84 and 0.76, implying that OIC and VAC farmers in Oyo State have 16% and 24% range for improving their production efficiency using the available technology. This suggest that OIC farmers in Oyo State are more economically efficient than VAC farmers. The mean economic efficiencies of OIC farmers in Benue and Oyo States were 0.66 and 0.84 suggesting a higher economic efficiency for OIC farmers in Oyo State than Benue State. Similarly, the average economic efficiencies of VAC farmers in Benue and Oyo States were 0.67 and 0.76 signifying a higher economic efficiency for VAC farmers in Oyo State.

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

Efficiency	OIC						VAC					
level	TE		AE		EE		TE		AE		EE	
	f	%	f	%	f	%	f	%	f	%	f	%
≤ 0.20	5	8.3	6	10.0	6	10.0	7	11.7	4	6.7	3	5
0.21-0.40	4	6.7	5	8.4	5	8.4	9	15.0	7	11.7	8	13.3
0.41-0.60	10	16.7	11	18.3	11	18.3	8	13.3	12	20.0	12	20
0.61-0.80	25	41.7	24	40.0	24	40.0	24	40.0	26	43.3	25	41.7
0.81-1.00	16	26.6	14	23.3	14	23.3	12	20.0	11	18.3	12	20.0
Total	**60**	**100**	**60**	**100**	**60**	**100**	**60**	**100**	**60**	**100**	**60**	**100**
Mean	0.85		0.76		0.66		0.88		0.75		0.67	
Std. Deviation	0.024		0.021		0.034		0.032		0.028		0.029	
Minimum	0.0013		0.013		0.02		0.03		0.04		0.05	
Maximum	1.00		0.96		0.96		0.97		0.96		0.89	

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

Table 6: Distribution of Efficiencies between OIC and VAC Cassava Production in Oyo State

Efficiency	OIC						VAC					
Level	TE		AE		EE		TE		AE		EE	
	f	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**
≤ 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 7 is the result gross margin analysis as represented by cost and returns of OIC and VAC per hectare in Benue and Oyo States. The profitability analysis in Benue State revealed a Gross Margin (GM) of N105,620 (OIC) and N181,120 (VAC) while Return on Investment (ROI) were 0.863 and 1.67 for OIC and VAC respectively. Similarly, in Oyo State, the GM were N139,900 (OIC) and N132,250 (VAC) and ROI were 1.158 and 1.006. The results indicated that VAC cultivation is more profitable in Benue State, while OIC is more profitable in Oyo State to cultivate. The table also showed a higher return on investment in like order.

Table 7: Gross margin analysis per hectare of OIC and VAC in Benue and Oyo State

Variables	Benue cassava varieties		Oyo State cassava varieties	
	OIC (Naira)	VAC(Naira)	OIC(Naira)	VAC(Naira)
Total variable cost (TVC)	122,400	107,900	120,800	131,450
Total Revenue	258,020	289,020	260,700	263,700
Gross margin (TR-TVC)	105,620	181,120	139,900	132,250
Return on Investment (ROI) GM/TVC	**0.863**	**1.679**	**1.158**	**1.006**

Source: survey data analysis

Constraints in OIC and VAC Production practices in Benue and Oyo States

The results of the evaluation of constraints of production practices in the Benue and Oyo States as presented in Table 8 indicated that the respondents are faced with several challenges in their cassava production practices. The constraints were ranked based on its severity and seriousness as perceived by farmers. These are ranked in percentages ranging from the most severe to least critical constraints. These constraints include the following: low market demand, inadequate finance, high cost of herbicide, pesticides, high cost of labour, inadequate farmland, and poor transportation. Others given as regards hinderances to smooth cultivation of both the 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 constraints recorded showed that out of the eleven challenges experienced by the respondents in Benue State, inadequate finance, low market demand, poor market policy, and agrochemicals mostly affected both OIC and VAC farmers. The high cost of labour and poor transportation system was ranked 4th and 5th, 4th and 6th respectively for the VAC and OIC, OIC and VAC. These constraints could determine the quantum of output and land size in terms of input. They could reduce the size of their hectarage to adjust to the size they could plant. Similarly, in Oyo State, the most serious constraint recorded revealed by the farmers of both production practices was grazing of cassava farms by cattle. Others include low market demand, inadequate finance, and high cost of labour.

Table 8: Constraints Associated with OIC and VAC Production in Benue and Oyo State

Constraints	Benue State cassava varieties						Oyo Sate cassava varieties					
	OIC			VAC			OIC			VAC		
	*F	%	Rank	*F	%	Rank	*F	%	Rank	*F	%	Rank
Low market demand	2	1.0	11th	59	24.2	1st	0	0.0	11th	3	15.8	2nd
Inadequate finance	46	23.4	1st	36	14.8	2nd	56	19.1	2nd	44	11.1	3rd
Agrochemicals cost	35	17.8	3rd	31	12.7	3rd	25	8.5	5th	29	7.3	8th
High labour cost	16	8.1	5th	29	11.9	4th	35	11.9	3rd	38	9.6	4th
Inadequate farmland	10	5.1	8th	24	9.8	5th	21	7.1	6th	22	5.5	10th
Poor transportation system	19	9.6	4th	19	7.8	6th	7	2.4	8th	32	8.0	6th
Poor market pricing	36	18.3	2nd	16	6.5	7th	19	6.5	7th	26	6.5	9th
Insufficient planting stem	3	1.5	10th	12	4.9	8th	5	1.7	9th	35	8.8	5th
Pests and disease	12	6.1	7th	9	3.7	9th	33	11.2	4th	30	7.6	7th
Weed infestation	14	7.1	6th	6	2.5	10th	3	1.0	10th	10	2.5	11th
Grazing of farmland by Cattle	4	2.0	9th	3	1.2	11th	90	30.6	1st	69	17.3	1st
Total	**197**	**100**		**244**	**100**		**294**	**100**		**398**	**100**	

*Multiple responses
Source: survey data analysis

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 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 cassava 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 cassava production practices need to work more on technical and allocative efficiencies to reach the optimum production level using the present production technology at second level of production level. The study also observed that five major inputs are important in both cassava production practices viz: farm size, family labour, stem, herbicide and hired labour implying that for an increase in the production output of cassava, the five inputs must be ready and efficiently used. In Benue State, VAC production is a more profitable enterprise while in Oyo State it is OIC enterprise. Analysis of socio-economic characteristics revealed that most respondents of the two production practices were males, married, educated, had long years of farming experience, in their productive age and were smallholder farmers in both production practices in the two States. Most respondents used their personal savings for cassava production and cassava farming as the main occupation. Three topmost constraints of cassava farmers in Benue State were inadequate finance, low market demand and high cost of agrochemicals, while in Oyo State they were grazing of farmland by cattle, inadequate finance and low market demand. Farmers in Benue State are encouraged to invest more in VAC production practice, while farmers in Oyo State are encouraged to venture into OIC as it is a profitable enterprise in the state.

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 production practices of cassava with more intensity on 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 in both states with more emphasis in Oyo State 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 production efficiency 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 formulated, 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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