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ANALYSIS OF GENDER DIFFERENCES IN PRODUCTION EFFICIENCY OF CASSAVA FARMERS IN BENUE STATE, NIGERIA

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ABSTRACT

The study analyzed gender differences in production efficiency of cassava farmers in Benue State, Nigeria. Primary data were obtained using questionnaire administered to 271 cassava farmers disaggregated by sex. A stochastic frontier production function model was used to analyze the data. The results revealed that the coefficients of stem cuttings, fertilizer, agrochemicals and labour were positive and significant, thus positively influencing cassava output among female farmers. For the male farmers, stem cuttings and labour were positive and significant. Technical inefficiency variables had age, marital status, educational level, and years in association as negative and significant for the female farmers, while marital status, educational level and years in association were negative and significant for male farmers, hence decreases inefficiency of cassava farmers. The allocative efficiency of cassava production variables for the female farmers were all positive and significant while only cost of stem cuttings, cost of fertilizer and cost of labour were positive and significant for the male farmers. This implies the cost variables for the cost model influences positively the efficiency of Cassava farmers. For the allocative inefficiency variable for the female farmers, educational level was negative and significant while the male farmers' allocative inefficiency variables that were negative and significant were educational level and years of farming experience. The coefficient results of these inefficiency variables revealed that they are notable thereby affecting the male and female farmers. The mean economic efficiency for the female farmers was 53 percent while that of the male farmers was 56 percent. This showed that female and male farmers can still increase their level of economic efficiency by 47 and 44 percent respectively without increasing inputs. The research concludes that farmers operate at an acceptable efficiency threshold, but there is still room for improvement because a slight downward shift in their operating threshold will result to tantamount consequences.

Keywords: Benue State, Cassava Farmers, Gender, Production Efficiency

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INTRODUCTION

The Agricultural sector remains the mainstay of most African countries' economy as it accounts for about 35 percent of gross domestic product (GDP) and 65 percent of total employment (Usman, 2018). The sector is at the centre of the Nigerian economy, providing the main source of livelihood for the majority of Nigerians. The exceptionality of the sector in the economy is buttressed by the fundamental role it plays in reducing poverty (Usman, 2017). The farming sector of Nigeria employs about 70 percent of the entire country's labour force. Nigeria's small farms produce 80 percent of the total food and 33 percent of the country's land

is under cultivation for this purpose. The major crops produced in Nigeria are cassava, yam, rice, groundnut, cocoyam, sesame, maize, millet, sorghum, vegetables, and melon seed (FAO, 2018).

Cassava (Manihot esculenta) is a perennial woody shrub with an edible root, which grows in tropical and subtropical areas of the world. Cassava supports the livelihood of over 300 million Africans (International Institute of Tropical Agriculture, IITA, 2019). Cassava is one of the most important crops for Nigerian farmers; it is the most widely cultivated crop that provides food and income for over 30 million farmers and large numbers of processors and traders (Partnership Initiatives in the Niger Delta, 2011). More than 291 million tonnes of cassava were produced worldwide in 2017, of which Africa accounted for over 60 percent. In 2017, Nigeria produced 59 million tonnes making it the world's largest cassava producer (approximately 20 percent of global production) with a 37 percent increase in the last decade (IITA, 2019). This amount of production was from a cultivated area of about 3.7 million hectares (Food and Agriculture Organisation, FAO, 2017). Nigeria exports about 3.2 million tonnes annually and earned a record of $136 million in 2013 (IITA, 2019).

Nigeria accounts for cassava production of about 34 percent of Africa's and about 46 percent of West Africa's. The national average yield of cassava is estimated at about 13.63 metric tonnes per hectare, as against potential yield of up to 40 metric tonnes per hectare. This wide gap can be closed through the increase in productivity and efficiency of farmers (FAOSTAT, 2016). Close to two-thirds (66 percent) of total production is in the southern part of the country, while about 30 percent is in the north-central, and 4 percent in other parts of the north (Ijiaba, 2017). The crop is predominantly grown by smallholders on small plots for family consumption and local sale. Large scale commercial plantations are rare (FAO, 2017). Up to 80 percent of the cassava produced in Nigeria is used for food, leaving only a small room for exports (FAO, 2019). Despite Nigeria being the largest producer of cassava, there is still need to increase the production of cassava for export purposes (Emmanuel, 2019). The shift from production at subsistence level (for mainly consumption) to production for urban consumers, livestock and industrial uses can be described as a transformation in cassava production which will increase farmers income, invariably, helping to reduce poverty (Onwudiwe *et al.*, 2014).

The issue in gender differences in association to farm productivity in subsistence farming has been of special interest from the standpoint of public policy in developing countries (Mabundza *et al.*., 2014). The difference is usually viewed from the angle of human capital theory and measurement of discrimination. Gender has proven to be an essential variable for analyzing the roles, responsibilities, constraints, opportunities, incentives, costs and benefits in agriculture (Koyenikan, 2011; Adejoh *et al.*, 2017). According to World Development Report (2012), across Sub-Saharan Africa, it has been discovered that female farmers have lower yields than male farmers. Firstly, women are likely to have less land to cultivate than men, and when they do, tenure security may be weaker. Secondly, their access to technology, information, and agricultural extension tends to be more limited compared to men (World Bank, 2012). In growing crops, women are more prone to be constrained in their access to inputs, resulting in lower levels of fertilizer, labour, and other inputs usage, across a range of countries (Croppensted *et al.*, 2013), this is also true in the case of Nigeria. According to Phillip *et al.*., (2009), despite their significant role in agricultural production, women in Nigeria have relatively limited access to agricultural land and lower levels of inputs and use of extension services compared with men. These constraints could limit women's productivity relative to men. This research will therefore assess gender differences in production efficiency of Cassava farmers in Benue state, Nigeria.

METHODOLOGY

The study was carried out in Benue State. The State is one of the north central states in Nigeria. Its geographic coordinates are Latitude 6° 25' and 8° 8' North of the Equator and Longitude 7° 47' and 10° 0' East of the Greenwich Meridian. Using a 3% annual growth rate, the population was projected to 6,721,178 people in 2021 (National Population Commission, NPC, 2006). Benue State has a landmass of 33,955 square kilometres. It is inhabited predominantly by the Tiv, Idoma and Igede people, who speak Tiv, Idoma, and Igede languages respectively (Government of Benue State, 2017). Benue State is a rich agricultural region and it is the nation's acclaimed food basket because of its rich agricultural produce. Popularly grown crops in this region of the country include; oranges, mangoes, sweet potatoes, cassava, soya bean, guinea corn, flax, maize, yams, cowpea, sesame, rice, groundnuts, cocoyam, millet, palm tree etc.

A multi-stage sampling procedure was used in this study. Benue State is divided into three (3) agricultural zones. Namely; Northern, Central and Eastern zones. The first stage involved the purposive selection of two (2) agricultural zones in the State due to intensity of production and security stability improvement in the zone. In the second stage, two (2) L.G.A.s in each of the agricultural zones were randomly selected based on the intensity of cassava production. In the third stage, two (2) villages that are involved in cassava production from each of the chosen L.G.A.s were randomly selected making a total of eight villages. The fourth stage involved a simple random sampling of 271 cassava farmers comprising of 115 males and 156 females across the study sites which are enough to achieve the stated objectives of the study. The breakdown of the sampling procedure is given in Table 1.

Table 1: Population/Sample Size of Cassava Farmers Based on Gender in the Study Area

Agricultural Zones	L.G.A	No. of Villages	Names of Villages	Sample frame for male farmers	Sample size for male farmers (13%)	Sample frame for female farmers	Sample size for female farmers (13%)	Total sample size (13%)
Northern Zone	Makurdi	50	Ikpayongu	70	9	96	12	21
			Apir	150	19	200	26	45
	Gwer-West	24	Naka	116	15	142	18	33
			Nage	96	12	204	27	39
Central Zone	Otukpo	80	Allan	50	7	67	9	16
			Upu	201	26	245	32	58
	Ohimimi	30	Aigboke	144	19	176	23	42
			Ojano	58	8	72	9	17
	4	**184**	**8**	**885**	**115**	**1202**	**156**	**271**

Source: Benue State Agricultural Development Programme, 2021

Statistical Analysis

Stochastic Production Frontier Model (SPFM) was used to achieve the objective for this study. The Cobb Douglas Stochastic Frontier Production Function specifying the technical efficiency in production is expressed explicitly as:

$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + (Vi - Ui)$ ..... [1]

Where:

ln = Natural logarithm

Y = Cassava output (kg)

β_0 = Constant term

β_1- β_4 = Regression coefficients

X_1 = Quantity of stem cuttings (kg)

X_2 = Quantity of fertilizer used (kg)

X_3 = Total labour used in production (man-days)

X_4 = Quantity of agrochemicals used (litres)

Vi = random error term in the production that cannot be influenced by the farmer

-Ui = inefficiency effect which are non-negative (deviation from maximum potential output attributed to technical inefficiency)

The -Ui is expressed as:

$-Ui = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7$ ----------[2]

Where:

-Ui = technical inefficiency of the ith farmer

δ_0 = constant

δ_1-δ_7 = Parameters to be estimated

Z_1 = Age of the farmer (years)

Z_2 = Marital Status (Single = 0, Married = 1)

Z_3 = Education (years)

Z_4 = Household size (number)

Z_5= Experience in cassava production (years)

Z_6 = Years in farmers' association

Z_7 = Access to extension services (number of extension contact)

Allocative Efficiency

The explicit form of the Cobb Douglas stochastic frontier cost function is specified as:

$\ln C = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + (Vi + Ui)$..... [3]

Where;

ln = the natural logarithm

C = Total cost of cassava production (₦)

X_1 = Cost of stem cuttings (₦)

X_2 = Cost of fertilizer (₦)

X_3 = Cost of labour (₦)

X_4 = Cost of agrochemical (₦)

β_0 = Constant term

β_1- β_4 = Regression coefficients

Vi = Random variability that cannot be influenced by the farmer.

Economic Efficiency

The product of technical efficiency (TE) and allocative efficiency (AE) provides the index of economic efficiency (EE).

EE = TE * AE……..... [4]

Where:
EE=Economic Efficiency,
TE=Technical Efficiency
AE=Allocative Efficiency

RESULTS AND DISCUSSION

Socio-economic and Productivity Characteristics across Gender

The differences in productivity and socio-economic characteristics by gender was achieved through a t-test as presented in Table 2. The result showed that there were statistically significant differences among male and female farmers in terms of years of cassava farming experience, household size and labour at 10 percent level while age, fertilizer, number of extension visits and cassava yield were found to be significant at 1 percent level. This implies that there is a significant difference in production and socio-economic variables between the male and female cassava farmers in the study area.

Table 2: Socio-economic and Productivity Description of Respondents by Gender

Characteristics	Female (n=156)	Male (n=115)	t values
Age (years)	46.481	52.609	6.647*
Years of cassava Farming experience	17.160	18.870	1.713***
Fertilizer (kg/ha)	131.776	154.522	3.382*
Number of extension visits	2.955	4.339	4.136*
Household size (persons)	8.545	9.096	1.713***
Access to credit	0.237	0.278	0.765
Labour (man-days/ha)	162.500	134.583	1.897***
Years in farmers' cooperative	6.603	7.730	1.248
Cassava yield (kg/ha)	3638.141	4180.000	4.650*
Stem cuttings (kg/ha)	46.282	49.052	1.472
Agrochemicals(litre/ha)	2.920	3.035	0.475
Access to intervention	0.468	0.478	0.168

Note: * significant at 1% level, ** significant at 5%, *** significant at 10%.

Gender Differences in Production Efficiency of Cassava Farmers

The technical efficiency of cassava farmers based on gender in Benue State is presented in Table 3. The value of gamma (γ) is estimated to be 42 percent for female and 57 percent for male farmers and statistically significant at 1 percent. This is in line with the theory that a true γ-value should be greater than zero. The farmers have a performance capacity to produce a total of 42 percent and 57 percent of their farm potential. The remaining 58 percent and 43 percent variation in the yield lost among female and male farmers was due to the farmers' inefficiency in their respective farms and not as a result of random variability. Since these factors are under the control of the farmer, reducing the influence of the effect of γ will greatly enhance the technical efficiency of the farmers and improve their yield. The inefficiency effects make significant contribution to the technical inefficiencies of cassava farmers. The value of sigma squared (σ2) is estimated to be 52 percent and 38 percent for the female and male farmers respectively. This value is significantly different from zero at 1 percent. This indicates a good fit and correctness of the specified distributional assumptions of the composite error terms.
The estimated coefficients of some of the parameters of the production function for the male farmers such as stem cuttings (0.081) and labour (0.009) were positive and statistically significant at 1 percent. For all coefficients that are positive and significant, it entails that a unit

increase in the use of such inputs, adds to cassava farmers' output and the variable is important in determining the output level of cassava farmers and vice versa for variables that have a negative relationship. The average technical efficiency estimated for the male farmers was 0.85. This implies that, on the average, the cassava male farmers were able to obtain 85 percent of their farm output from a combination of some production inputs. This shows that there is still room for efficient improvement by 15 percent.

The estimated coefficients of the parameters of the production function for the female farmers such as stem cuttings (0.051), fertilizer (0.124), agrochemicals (0.092) and labour (0.036) were found to be statistically significant at 1 percent while only the agrochemical was significant at 5 percent. All the positive significant variables imply that a unit increase in these variables will lead to a corresponding increase in output by their equivalent units. Also, all the negative coefficients imply that a unit increase in these variables will lead to a decrease in output by their corresponding units. The average technical efficiency for the female farmers was 0.77 implying that, on the average, the cassava female farmers were able to obtain 77 percent of potential output of their farms from a combination of some production inputs. This shows that there is still room for efficient improvement by 23 percent. In line with this finding, Ogundari and Ojo (2006) adopted a stochastic production function, using the Maximum Likelihood Estimating (MLE) technique to estimate farmer's technical efficiency and their determinants in cross river. The result confirmed that the cassava farmers were technically inefficient, implying that there was room to improve technical efficiency with the farmers' current resource base and available technology.

Table 3: Maximum Likelihood Estimates (MLE) Results of the Stochastic Frontier Cobb Douglass Production Function of Cassava Farmers Based on Gender

Variables	Male			Female		
	Coefficient	SD error	t-ratio	Coefficient	SD error	t-ratio
Production Variables						
Constant	7.680*	0.066	12.21	7.400*	0.121	16.99
Stem cuttings	0.081*	0.023	3.5	0.051*	0.039	4.129
Fertilizers	0.016	0.011	1.415	0.124*	0.019	6.525
Agrochemicals	-0.028	0.021	-1.352	0.092**	0.04	2.315
Labour	0.009*	0.002	5.08	0.036*	0.009	4.194
Diagnostic Statistics						
sigma-squared	0.383*		5.484	0.515*		6.795
Gamma	0.569*		75.33	0.419*		41.11
Mean Tech. Eff.	0.85			0.77		

Note: * significant at 1% level, ** significant at 5%, *** significant at 10%.

Inefficiency Variables

The socio-economic characteristics (independent variables) used in the inefficiency model are 7, namely; age, marital status, household size, education level, experience in cassava production, extension agent contact and years in association. A negative sign on a parameter means that the variable reduces technical inefficiency, while a positive sign increases technical inefficiency, as shown in Table 4. The result shows the coefficient of marital status (-3.488), educational level (-0.298) and years in association (-0.136) for male farmers, with marital status significant at 1 percent and educational level significant at 5 percent. The result also shows the

coefficient of age (-0.152), marital status (-3.637), educational level (-1.070) and years in association (-0.254) for female farmers, with age and years in association being significant at 1 percent. Marital status and educational level, significant at 5 percent. All the negative significant variables for both groups imply that a unit increase in these variables will lead to a decrease in inefficiency by their equivalent units, as shown in Table 4.

Table 4: Estimated Technical Inefficiency Results of Cassava Farmers Based on Gender

Inefficiency Variables	Male			Female		
	Coefficient	SD error	t-ratio	Coefficient	SD error	t-ratio
Constant	4.129*	0.904	4.566	8.809*	2.796	3.151
Age	-0.011	0.021	-0.521	-0.152*	0.044	-3.441
Marital Status	-3.488*	0.928	-3.76	-3.637**	1.480	-2.457
Educational Level	-0.298**	0.141	-2.114	-1.070**	0.502	-2.133
Household size	-0.014	0.032	-0.431	-0.052	0.104	-0.5
Farming Experience	0.009	0.016	0.585	0.012	0.037	0.325
Years in Association	-0.136*	0.032	-4.221	-0.254*	0.039	-6.562
Frequency of EA Visit	0.150*	0.030	4.945	0.502*	0.064	7.861

Note: * significant at 1% level, ** significant at 5%, *** significant at 10%.

Allocative Efficiency

The allocative efficiency of cassava farmers based on gender in the study area is presented in Table 5. The value of the gamma parameter (γ) is estimated at 99 percent for both male and female farmers. This indicates the variability in the total cost of cassava production which results in the existence of allocative inefficiency. The value of sigma squared (**σ2**) is significantly different from zero at 1 percent. This indicates a good fit and correctness of the specified distributional assumptions of the composite error terms while the gamma γ indicates the systematic influences that are unexplained by the production function and the dominant sources of random error. This means that the inefficiency effects make significant contribution to the allocative inefficiencies of cassava farmers.

In terms of input costs for male farmers, the allocative efficiency coefficient for stem cuttings was (0.014), significant at 5 percent, fertilizer had a coefficient of (0.206), significant at 1 percent, and labour had a coefficient of (0.018), also significant at 5 percent. For female farmers, the allocative efficiency coefficient for stem cuttings was (0.231), significant at 5 percent, fertilizer had a coefficient of (0.234), significant at 1 percent, and labour had a coefficient of (0.082), significant at 5 percent. Additionally, the cost elasticity with respect to agrochemicals was (0.341), significant at 1 percent. All the positive significant variables for both groups imply that a unit increase in the price of these variables will lead to a corresponding increase in cost of cassava production by their equivalent units. These results show that input cost substantially influence resource allocation among the farmers. The mean allocative efficiency for male was 71 percent and 65 percent for female farmers. This implies that, on the average, the cassava male and female farmers were found to be efficient at 71 percent and 65 percent in their total cost of production.

Table 5: Maximum Likelihood Estimates (MLE) Results of the Stochastic Frontier Cost Function

Variables	Male			Female		
	Coefficient	SD error	t-ratio	Coefficient	SD error	t-ratio
Constant	11.366*	1.664	6.829	4.615*	0.809	5.709
Cost of Stem cuttings (Ha)	0.014**	0.115	2.001	0.231**	0.102	2.272
Cost of Fertilizers (Ha)	0.206*	0.174	1.184	0.234*	0.048	4.914
Cost of Agrochemicals (Ha)	0.058	0.141	0.411	0.341*	0.111	3.062
Total Labour Cost (Ha)	0.018**	0.022	1.962	0.082**	0.039	2.095
Diagnostic Statistics						
Sigma-squared	0.545*	0.074	7.411	0.753*	0.083	9.049
Gamma	0.988*	0.004	60.39	0.992*	0.004	45.71
log likelihood function	-128.3145			-199.3018		

Note: * significant at 1% level, ** significant at 5%, *** significant at 10%.

Inefficiency model

The estimated coefficient of the explanatory variables in the inefficiency cost model; Education, farming experience, extension contact, and years in association were all found to be statistically significant. A negative sign on a parameter means that the variable reduces allocative inefficiency, while a positive sign increases allocative inefficiency, as shown in Table 6.

For the male farmers, the coefficient for educational level was (-0.216), statistically significant at 5 percent, while farming experience had a coefficient of (-0.389), significant at 1 percent. Among the female farmers, the coefficient for educational level was (-0.172), also significant at 5 percent. These results highlight the critical role of education in enhancing farmers' decision-making capacity. Educated household heads may better understand and process information provided by different sources regarding new investments, thereby reducing their allocative inefficiency. This result is consistent with the findings of Babangida (2016), who reported that education exerts a negative effect on allocative inefficiency. The existence of these coefficients imply that a unit increase in any of the aforementioned negative significant variables for both male and female farmers will lead to a decrease in allocative inefficiency by their equivalent units.

Table 6: Cassava Farmers' Allocative Inefficiency Based on Gender

Variables	Male		Female	
	Coefficient	**t-ratio**	**Coefficient**	**t-ratio**
Constant	0.223*	4.824	0.113*	3.194
Age	0.709	0.126	0.221	0.204
Marital Status	0.113	1.377	0.592	0.814
Educational Level	-0.216**	-2.373	-0.172**	-1.981
Household size	-0.172	-0.852	0.618	0.004
Farming Experience	-0.389*	-3.691	0.223	1.472
Years in Association	0.572*	6.397	0.179*	5.154
Frequency of EA Visit	0.523*	2.800	0.545*	3.562
Access to Credit	0.530	0.100	0.334	0.219

Note: * significant at 1% level, ** significant at 5%, *** significant at 10%.

Economic Efficiency

The economic efficiency of cassava farmers based on gender in the study area is shown in Table 7. The results from the table revealed that male farmers (79.1 percent) economic efficiency score ranges between 0.51 to 0.75 with an average of 56 percent while female farmers (66.7 percent) score ranges between 0.51 to 0.75 with an average of 53 percent in the study area. This implies that the male farmers who have an average economic efficiency of 56 percent can still increase their level of economic efficiency by 44 percent while the female farmers who have an average economic efficiency of 53 percent can still increase their level of economic efficiency by 47 percent without increasing inputs.

Table 7: Distribution of Farmers Based on their Economic Efficiency Scores

Category	Male		Female	
	Frequency	**Percentage**	**Frequency**	**Percentage**
0.01 - 0.25	-	-	1	0.6
0.26 - 0.50	7	6.1	11	7.1
0.51 - 0.75	91	79.1	104	66.7
0.76 - 1.00	17	14.8	40	25.6
Total	**115**	**100**	**156**	**100**
Min	0.26		0.01	
Max	0.99		0.97	
Mean	0.56		0.53	

Conclusion and Recommendations

The study examined gender differences in production efficiency of cassava farmers in Benue State, Nigeria. Based on the findings of this study, the result of the Maximum Likelihood Estimates (MLE) of the production function established that production inputs, cost of production inputs and socio-economic variables were factors that influenced technical and allocative efficiency in cassava production in the study area. The female and male cassava farmers could not attain the frontier of production with a reported technical, allocative and economic efficiency. Age, marital status, educational level, years in association, farming experience and extension visits were major socio-economic determinants of technical and allocative efficiencies for both female and male cassava farmers.

Based on the findings of this study, the following recommendations are proposed:

i. Both male and female farmers should form functional cooperatives to pull their resources together and to take advantage of bulk purchase of inputs for cassava production in order to increase their output.
ii. Farmers should be trained on better agronomic practices in cassava production to increase their technical and economic efficiencies.

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