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TECHNICAL EFFICIENCY IN CASSAVA PRODUCTION AMONG FARMERS IN OYO STATE, NIGERIA: A GENDER SITUATION ANALYSES

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Abstract
This study focused on gender dynamics and technical efficiency (TE) analyses of cassava production among farmers in Oyo State, Nigeria. Primary data was collected through structured questionnaire administered to randomly selected 245 cassava farmers made up of 68 adult male (AM), 58 adult female (AF), 61 youth male (YM) and 58 youth female (YF). A stochastic frontier production function model was estimated. The results revealed that the coefficients of stem cutting, fertilizer, labour and herbicides were significant variables influencing cassava output among AM farmers. Stem cutting influenced cassava output of AF, YM and YF farmers with different coefficients at 1% level of probability. The results of inefficiency variables showed that the coefficients for age, education, farming experience and access to extension were significant variables affecting TE among AF farmers. Only age influenced YM cassava farmers. The return to scale were 0.911, 0.963, 0.982 and 0.980 for AM, AF, YM and YF cassava farmers respectively, all at stage II of the production function. Investments in rural education through effective extension delivery program in the current economic environment in Nigeria will provide farmers with the skills essential to increase efficiency.

Keywords: Cassava farmers, gender, technical efficiency, and Oyo State

Introduction
Agriculture plays a significant role in the Nigerian economy despite the strategic importance and reliance on the oil sector. Agricultural sector provides employment for about 70% of Nigerian and accounts for more than one-third of total Gross Domestic product (Hussaini *et al.,* 2019). The decline in the contribution of agriculture to the country's GDP overtime was as a result of the slow growth of the sector relative to other sectors of the economy. The country agricultural system is characterized by multitude of small scale farmers scattered over wide expanse of land area with small holding ranging from 0.05 to 3.0 hectares per farm land, low capitalization, low productivity and low yield per hectare (Aboki *et al*., 2013). Cassava (*Manihot spp*) is one of the principal useful tropical plants found on all the continents (Nwaobiala and Isaac, 2017). In Nigeria, It is one of the most important food crops with an annual output of over 54.47 million tonnes and the largest producer of cassava globally (Nwachukwu *et al.,* 2020). The roots are rich in energy, starch and soluble carbohydrates, but poor in protein. It is vital, not only as a food crop, but also as a source of income for rural households.

Gender participation is centered mostly on the relationship of men, women and youth in the agricultural sector. In many parts of rural Nigeria, division of labour within the households is gender specific and according to age. Adult male, adult female and youth, either male or female perform distinctive roles; have unequal decision-making power and differences in access to and power over agricultural productive resources. By and large, their perspectives, needs, priorities and constraints towards enhancing their productive potentials vary (Agada *et al*., 2018). Yet, access to resources is essential to improving agricultural productivity and efficiency across all categories of gender. Improving productivity will depend to a great extent on ensuring that all the categories of gender have sufficient access to production inputs and support services (Elisha *et al.,* 2020). Croppenstedt *et al*. (2013) indicated gender and agricultural productivity as to the contribution of the differential use of inputs in explaining productivity and efficiency gaps. It is certainly true across a range of countries that women tend to have lower levels of use of various productive assets (Croppenstedt *et al*., *ibid*; Elisha *et al.,* 2020).

The low growth rate in productivity in the agricultural sector have been widely considered as one of the most important causes of current high poverty rates, food insecurity and discouragement in farming among youths particularly in rural areas. Yields on plots managed by adult female and youths are lower than those managed by adult male. This is not because they are worse farmers than adult male; indeed, evidence (Timothy and Adeoti, 2006; Adeleke *et al*., 2008; World Bank, 2012; Kilic *et al.*, 2013) shows that adult female and youth farmers are just as efficient as adult male. They spend considerable amount of time in farm activities, while also doing their regular chores. However, they are often found to produce less on their plots of land and thus less productive than their male counterparts in the agricultural sector. This is because of inadequate accessibility to fertilizer and low applications of modern inputs such as chemicals, fertilizer, improved seeds and pesticides (Mukasa and Salami, 2016). Furthermore, inputs are more difficult for adult female and youth to access than adult male. Cultural norms often influence the use of machinery. Adult female and youths' access to inputs such as improved seeds, fertilizers and pesticides is limited by their access to extension services and paucity of resources. Government-subsidized inputs to small-scale farmers are also often distributed through cooperatives. While adult female and youths are rarely members of cooperative, they often lack the funds needed to purchase inputs even when they are subsidized (FAO and CARE, 2019).

Failure to take into account gender relationships leads the marginalisation of the disadvantaged sector of the society and a large part of the agricultural work force (Frishmuth, 1997) . Farm efficiency and measurement is an important concept in developing countries agriculture (Hazarika and Subramanian, 1999). There is need to understand gender efficiency while attempting to promote agricultural development strategies because development programmes often have differential impact on males and females. The stochastic frontier approach is preferred for accessing efficiency in agriculture because of the inherent stochasticity involved (Coelli, 1994). Efficiency is the ability to produce a given set of output with a minimum quantity of inputs. This occurs when a farm firm is combining resources in such a way as to produce a given output at the lowest possible average total cost. It should be noted that efficient use of resources eliminates wastes and increase productivity and farm income. One of the components of production efficiency is technical efficiency.

Gender differences in cassava productivity

Across Sub-Sahara Africa (SSA), several empirical studies indicate that adult female and youth farmers have lower yields than adult male farmers. Reports documented this pattern and have sought to explain it (FAO, 2011). Various possible factors may lead to agricultural productivity differences between adult male, adult female and youth in the developing world. First, assuming they have equal agricultural production function and utilize similar procedure for the same crop, the quantity of inputs such as fertilizer, seeds, or labor applied by adult male, adult female and youth may vary (WB/FAO/IFAD, 2009; Peterman *et al.,* 2010). Second, the quality of inputs may contrast. Land quality may differ between adult male, adult female and youth, including, yet not restricted to, soil quality, topography, and proximity to access points, for example, water sources, roads, and housing. Third, adult male, adult female and youth may have distinctive agricultural production capacities, potentially in light of the fact that crop choice differ by gender, regardless of whether affected by cultural norms or by different contemplations, for example, the absence of resources to cultivate specific crops and the culturally fitting division of labor. Fourth, whether both genders have equal agricultural production function, shadow prices of inputs and credit may lead the adult female and youth production frontier to lie beneath adult male frontier, suggesting that adult female and youth are less productive (Peterman *et al*., *ibid*). Despite all these differences, the passion for cassava production by both adult male, adult female and youth in Oyo State has increased over the years as a result of the awareness of the importance of this practice to individuals and the economy at large and the advantages attached to it. Based on this, this study seeks to analyze gender dynamics and technical efficiency performance in cassava production among farmers in Oyo State, Nigeria.

Methodology

The study was carried out in Oyo State, Nigeria. Oyo State has a projected population of 8,617,931 persons in 2020, with an estimated growth rate of 3.2% (NBS, 2017). The target population of the study was cassava farmers in Oyo State. A multi-stage random sampling procedure was employed to select the sample population of the study. Four agricultural zones were taken as the sampling units for the first stage of sampling. At the second stage, two local government areas (LGAs) were randomly selected to represent the zone giving a total of eight LGAs. The third stage involved a random selection of two villages from each of the zones to make a total of 16 villages. The last stage used the Yamane formula to calculate the minimum sample size based on the assumption of 5% expected margins of error, 95% confidence interval and applying the finite population correction factor. The formula is expressed as follows:

$$n = \frac{N}{1+N(e)^2} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Where: N= the population under study, n= the desire sample, e= the level of tolerable error assumed to be 0.05; while, 1= constant.

$$n = \frac{634}{1+634(0.05)^2};$$

$$n = \frac{634}{2.59};$$

$$n = 245;$$

$$\frac{245}{634} x\ 100 = 38\%$$

The cassava farmers are then segregated by gender for the purpose of this study. Therefore, the sample size was made up of 68 adult male, 58 adult female, 61 male youth and 58 female youth cassava farmers. Primary data was used for this study. Data collection was accomplished with the aid of structured questionnaire that was administered to cassava farmers by trained enumerators via personal interview method.

Conceptual framework and analytical technique

Descriptive statistics and stochastic frontier production function were used to analyze the data for this study. Descriptive statistics employed include: frequency, percentage, mean, standard deviation and coefficient of variation. The frontier production model for cross sectional data can be defined by considering a stochastic production function with a multiplicative disturbance terms of the forms;

$$Y = f\,(X_a;\beta)e^{\varepsilon} \text{…………..} \ (2)$$

Y = the quantity of original output; X = a vector of input quantities; b = a vector of parameters and e = error term. Where 'e' is a stochastic disturbance term consisting of two independent elements 'μ' and 'v'

$\varepsilon = u + v$……………….. (3)

The symmetric component 'v' accounts for random variation in output due to factors outside the farmer's control, such as weather and diseases. It is assumed to be independently and normally distributed with zero mean and constant variance as $N \sim (0, \sigma^2_v)$. A one-sided component (u < 0) reflects technical inefficiency relative to the stochastic frontier, $f\,(X_a;\beta)e^{\varepsilon}$ Thus, (u=0) for a farm output which lies on the frontier and (u < 0) for one whose output is below the frontier as $|N \sim 0, \sigma^2_u|$ that is, the distribution of 'u' is half normal. The frontier of the farm is given by combining equations (2) and (3).

$$Y = f\,(X_a;\beta)e^{(u+v)} \text{……….} \ (4)$$

Measures of efficiency for each farm can be calculated as: $TE = exp.[E\{\mu/\epsilon\}]$……….. (5)

And "u" in equation 4 is defined as;

$$\mu = f\,(Z_b;\delta) \text{………………} \ (6)$$

Where: Z = a vector of farmer specific factors, δ = a vector of parameters.

The parameters for the stochastic production frontier model in equation (2) and those for the technical inefficiency model in equation (5) were estimated simultaneously using the maximum –likelihood estimation (MLE) programme, FRONTIER 4.1 (Coelli, 1994), which gives the variance parameters of the likelihood function in terms of;

$$\sigma^2 = \sigma^2_{\mu} + \sigma^2_{v} \text{……………..} \ (7)$$

$$\gamma = \sigma^2_{\mu}/\sigma^2 \text{……………..} \ (8)$$

Rejection of the null hypothesis, $H_0: \gamma = 0$ implies the existence of a stochastic production frontier. Similarly, $\gamma = 1$ implies that all the deviations from the frontier are entirely due to technical inefficiency (Battese and Coelli, 1995). However, Battese and Coelli (1995) model for the technical inefficiency effects has become more popular because of its computational simplicity and its ability to examine the effects of various firm-specific variables on technical efficiency in an econometrically consistent manner, as opposed to traditional two-step procedure. According to Battese and Coelli (1995), technical inefficiency effects, $U_i s$ in equation 1 are assumed to be independently distributed and truncations (at zero) of the normal distribution with mean Z_i δ and variance, $\sigma^2_u[|N(Z_i\delta,\, s^2_u)|]$ where Z_i is a (1x m) vector of observable firm specific variables hypothesized to be associated with technical inefficiency, and δ is an (m x 1) vector of unknown parameters to be estimated. Under these assumptions, the technical inefficiency effects *U s* can be expressed as follows:

$$U_i = Z_i\delta + W_i \quad \text{……………..} (9)$$

Where; $W_i s$ are random variables, defined by the truncations of the normal distribution with mean zero and variance, σ^2_u such that the point of truncation is $-Z_i\delta$ i.e $W_i \geq Z_i\delta$ if Z-variables also include interactions between firm-specific factors and input variables. In line with Coelli (1994) adopted by Battese and Coelli (1995), the technical efficiency of the *i-th* sample cassava farms is denoted by:

$$TE = exp(-U) = exp(-Z_i\delta - W) \text{ …} (10)$$

$$lnY = \beta_0 + \beta_1 lnX_1 i + \beta_2 lnX_2 i + \beta_3 lnX_3 i + \beta_4 lnX_4 i + \beta_5 lnX_5 + (V_i - U) \text{…..} (11)$$

Where: ln = the natural logarithm; Y = output of cassava (tonnes); β_0 = constant term; β_1 - β_5 = regression coefficients; X_1 = farm size (hectares); X_2= quantity of stem cuttings in bundles; X_3= quantity of fertilizer used (kg); X_4= labour used (man-days); X_5= quantity of herbicide used (litres); V_i = random variability in the production that cannot be influenced by the farmer; U_i= = deviation from maximum potential output attributable to technical inefficiency.

The technical inefficiency model is defined by:

$$U_i = \delta_0 + \delta_1 lnZ_1 + \delta_2 lnZ_2 + \delta_3 lnZ_3 + \delta_4 lnZ_4 + \delta_5 lnZ_5 + \delta_6 lnZ_6 \text{ ……} (12)$$

Where: U_i = technical inefficiency of the ith farmer; Z_1 = age of farmers (years); Z_2 = Educational level (0 for not attended, 1 for primary, 2 for secondary, 3 for tertiary, and 4 for others); Z_3= Household Size (Number of people in the household); Z_4= Farming Experience (Years of farming); Z_5= access to extension services (Number of visits); Z_6 = Access to credit (N); δ_0 = constant; δ_1- δ_6= are parameters to be estimated, and Z_1 - Z_6 = farm-specific and farmer-specific variables.

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Results and Discussion

Description of variables

Table 1 shows the description of production and socio-economic variables used in technical efficiency model of the cassava farmers based on gender. The results show that adult male (AM) cassava farmers had a higher production inputs such as labour, cassava stem, fertilizer and herbicide compared adult female, youth male and female. The mean hired labour of 58.12 man-days per ha of AM farmers compared to 28.51 (AF), 37.12 (YM) and 29.14 (YF) man-days is an indication that adult male farmers were able to utilize more labour and other production inputs compared to other gender category. This may be because adult female (women) and youth (male and female) assist their husbands or fathers in all farming activities. This also supports the findings of Ajani (2008) and Elisha *et al.* (2020) that men and women have access to productive resources, but men have more control of production inputs. In addition, coefficient of variation of production inputs seemed to be higher among male and female youth. This also implies that variations in inputs utilization among the youth exhibit high level of variability.

Table 1: Description of variables

Variable	AM		AF		YM		YF	
	mean	CV,%	mean	CV,%	mean	CV,%	mean	CV,%
Production variables								
Labour (man-day)	58.12	23.6	28.51	12.9	37.12	42.8	29.14	54.9
Cassava stem (bundles)	22.34	18.7	12.05	39.7	10.23	41.6	7.39	63.9
Fertilizer (kg)	36.51	43.9	14.18	31.09	14.56	39.5	9.77	54.0
Herbicide (litre)	7.29	23.8	3.62	19.7	2.57	43.0	1.99	67.2
Socio-economic variables								
Household size	6.8	22.1	5.8	24.1	1.7	64.7	1.8	72.2
Farming experience	22.3	36.3	19.9	47.7	4.18	50.2	4.0	52.5
Farm size (ha)	1.9	41.7	0.93	58.4	0.71	32.0	0.42	61.6
Credit: only access ('000)	85.9	31.5	11.5	67.5	15.7	72.0	0.95	75.8
Cooperative membership	11.95	15.06	14.5	52.41	1.5	133.3	-	-
	F	%	F	%	F	%	F	%
Marital status (married)	97.1	2.9	87.9	12.1	18.0	82.0	19.0	81.0
Extension (Contact)	88.2	11.8	82.8	17.2	42.6	57.4	39.7	60.3
Education level	52	70.6	30	51.7	56	91.8	50	86.2
Total	**68**	**100**	**58**	**100**	**61**	**100**	**58**	**100**

AM= Adult male, AF= Adult female, YM= Youth male and YF= Youth female; CV denote coefficient of variation; F=Frequency, %=Percentage

The results of socio-economic characteristic reveals that the mean household size (7 persons),farming experience (22.3 years), farm size (1.9 ha), cooperative membership (12 years) and credit utilized (₦85,900.00) were high with a low coefficient of variation compared to these variables in adult female, youth male and female. It is pertinent to mention that 97.1% of AM are married and 85.9% had access to one form of credit or the others. The significance of marital status on agricultural production is related with supply of agricultural labour. Based on these result, it is expected that adult male and female may have ample opportunity to access agricultural labour for cassava production, while youth farmers may have to outsource for labour or work on their farm themselves. The results exhibit wide variation and disparity in terms of access to production inputs and credit institutions among the gender based cassava farmers. Therefore, efforts must be made to assess the gender roles, differences and disparities between adult male, adult female and youths for the effectiveness of the agricultural development agenda. It has been argued in literature that most policies, programs, and projects that are targeted towards rural farming households have not made their intended impacts because the role and position of gender are not been considered. Educational level established that majority of AM (70.6%), AF (51.7%), YM (91.8%) and YF (86.2%) cassava farmers had at least secondary education. This result suggests that majority of the farmers were literate and this is expected to enhance the degree of awareness, access and adoption of agricultural development relating to cassava production among farmers is expected to be high. Ameh *et al.* (2020) indicated that education is an important socio-economic factor that influence farmer's decision making as it influences farmer's awareness, perception and adoption of innovations that can bring about increased productivity.

Estimation of stochastic frontier production model

The stochastic frontier production model was estimated using the maximum likelihood estimate (MLE) of Cobb-Douglas stochastic frontier and the result is presented in Table 2. The log-likelihood ratio values which represents the value that maximizes the joint densities in the estimated model show values of AM (90.24), AF (-15.65), YM (22.96) and YF (38.83) exceeding the critical chi-square values at 1% level of significant with number of restriction (degree of freedom) of 4. Therefore, the Cobb-Douglas functional form adequately represents the data. The 1% levels of statistical significance of sigma square for adult female and youth male shows the appropriateness of the assumption for the distribution of the component error term.

Table 2: MLE Results of Stochastic Frontier Production Function of cassava-based gender farmers

Variables	Adult male β (t-value)	Adult female β (t-value)	Youth male β (t-value)	Youth female β (t-value)
Production factors				
Constant	6.670***	8.738	7.565***	7.007***
	(5.75)	(0.013)	(15.02)	(22.50)
Farm size	0.010	0.086	0.300**	0.125
	(0.369)	(0.356)	(2.21)	(0.68)
Stem cutting	0.896***	0.840***	0.676***	0.799***
	(3.05)	(3.28)	(5.19)	(8.79)
Fertilizer	0.017***	-0.007	0.005	0.007
	(3.66)	(-0.690)	(0.85)	(1.25)
Labour	0.003*	-0.001	-0.010	0.052***
	(1.88)	(-0.102)	(-1.15)	(4.58)
Herbicides	-0.017***	0.045**	0.006	-0.002
	(-3.48)	(2.07)	(0.89)	(-0.34)
Diagnostic statistics				
Sigma square	0.094	0.100***	0.028***	0.049
	(1.29)	(5.63)	(4.00)	(0.69)
Gamma	0.991***	0.332	0.063	0.930***
	(12.8)	(0.00)	(0.395)	(13.72)
Likelihood ratio test	51.67	11.008	7.628	20.46
Log likelihood function	90.24	-15.645	22.963	38.826

Note: Figures in parenthesis are t-values; *; **; * denote significant at 1, 5, 10 % respectively**

The results of the stochastic frontier model estimated further shows that there are differences in the determinants of farmers' technical efficiency across the 4 gender groups. The coefficients of stem cutting (0.896), fertilizer (0.017), labour (0.003) and herbicides (-0.017) were significant variables influencing output of AM farmers, while stem cutting (0.840) and herbicides (0.045) influence output of AF farmers. Furthermore, farm size (0.300) and stem cutting (0.676) influenced YM farmers and Stem cutting (0.799) and Labour (0.052) for YF farmers. The positive sign on all significant variables across all the gender groups implies that a unit increase in these variables will lead to corresponding increase in output by their equivalent units. Consequently, all the coefficients with negative signs imply that a unit increase in these variables will lead to a decrease in output by their corresponding units.

Farm size was significant at 5% for YM farmers. This implies that increase in farm size will lead to an increase in output of cassava by 0.300 units. Results also indicate that stem cutting was positive and significant at 1% probability level for all the 4 groups. This relationship implies that an increase in stem cutting used for the cultivation of cassava production will lead to an increase in output of cassava. Fertilizer showed a positive and significant relationship for AM farmers ($p<0.01$). It revealed that cassava production comparable to quantity of fertilizer used among them was inelastic, meaning that a unit increase in quantity of fertilizer will only lead to 0.017 unit increase in the output level *ceteris paribus.* Labour also showed a positive and significant relationship for AM and YF cassava farmers. The implication of these is that cassava output will increase if the farmers increase the use of labour. This result is comparable to findings of Elisha *et al.* (2020) on frontier profit efficiency of Strawberry production among male and female farmers in Plateau State, Nigeria.

Estimation of technical inefficiency

Socio-economic variables were considered as inefficiency variables and the results of technical inefficiency of cassava production are presented in Table 3. The results shows that the coefficients of access to extension (-1.164) and credit (0.334) were significant inefficiency variables affecting technical inefficiency for AM cassava producers. The coefficients for age (-0.814), educational level (-0.173), farming experience (0.224) and access to extension (0.476) were significant inefficiency variables affecting technical inefficiency among AF cassava producers. Only age (1.184) was significant among YM cassava farmers at 5% level of probability.

The coefficient of extension contact was negative and significant at 10% for adult male cassava farmers. This implies that holding other factors constant, a unit increase in the extension contact will decrease their technical inefficiency by magnitude of 1.164 units. This suggests that adult male cassava farmers often sought better agricultural technologies and information and utilized it. However, credit utilized was positive, signifying that a unit increase in credit utilized will lead to corresponding increase in technical inefficiency by 0.334 units.

Table 3: Determinants of cassava-based farmers' technical inefficiency based on gender

Variables	Adult male β (t-value)	Adult female β (t-value)	Youth male β (t-value)	Youth female β (t-value)	Pooled data t-value
Constant	1.816*	5.212	-3.538**	4.493	0.502***
	(1.716)	(0.008)	(-2.10)	(0.562)	(9.320)
Age	-0.240	-0.814**	1.184**	-1.693	-0.213***
	(-0.785)	(-2.01)	(2.12)	(-0.544)	(-12.621)
Educational level	0.151	-0.173**	-0.029	-0.010	-0.074**
	(1.004)	(-2.24)	(-0.41)	(-0.158)	(-2.310)
Household size	-1.445	-0.132	-0.016	0.238	0.190*
	(-1.222)	(-0.78)	(-0.13)	(0.595)	(1.989)
Farming experience	-0.028	0.224**	-0.182	0.442	0.028
	(-0.278)	(2.43)	(-1.30)	(0.681)	(0.539)
Access to extension	-1.164*	-0.476***	0.033	-0.062	-0.059
	(-1.716)	(-2.54)	(0.19)	(-0.231)	(-1.301)
Access to credit	0.334*	0.031	0.353	-0.053	0.275**
	(1.713)	(0.21)	(1.47)	(-0.159)	(2.217)

Note: Figures in parenthesis are t-values; *; **; * denote significant at 1, 5, 10 % respectively**

The coefficient of age was negative for AF (-0.814) and positive for YM (1.184) at 5% level of probability. For AF, this implies that a unit increase in age will lead to a decrease in inefficiency of farmers by 0.814 units. This might be because adult female cassava farmers have adopted better technologies, rather than the traditional farming techniques, hence, becoming more technically efficient compared to other gender groups. In contrast, coefficient of age among YM cassava farmers that is positive implies higher inefficiency. The results are comparable to Elisha *et al.* (2020) on efficiency of strawberry production in Plateau state, Nigeria. The negative coefficient of educational level ($p<0.05$) among AF farmers imply that a unit increase in this variable will lead to 0.173 unit increase in efficiency of AF cassava farmers. This implies that AF farmers might have utilized their educational advantage as an opportunity to develop their farming experience and capability to adopt innovations and technologies for improved productivity. This is in line with the findings of Isitor *et al*. (2017) and Akerele *et al*. (2019) that identified an inverse relationship between education and farmers' level of technical inefficiencies. The coefficient of farming experience (0.224) was positive and significant at 1% level of probability for AF farmers. This implies that holding other factors constant, a unit increase in farming experience among adult female cassava farmers will increase their technical inefficiency by 0.224 units. In other words, as adult female cassava farmers' years of experience increases, their efficiency also decreases. This contradicts the findings of Orewa and Izekor, (2012) that found a negative and significant relationship between farmers' experience and technical inefficiency.

Sources of Technical efficiency

The results of the technical efficiency score of the cassava farmers are presented in Table 4. The results revealed that adult male and female had a mean technical efficiency of 0.93 and 0.94 compared to male and female youth with 0.95 and 0.90 respectively. A large percentage of AM (85.29%), AF (81.03%), YM (81.97%) and YF (74.14%) were within the technical efficiency range of 0.90 – 1.00. This implies that on the average, AM, AF, YM and YF farmers were able to achieve about 85.29, 81.03, 81.97 and 74.14 % of optimal output from the set of inputs and technology available to each gender based farmer. Thus, the output of the AM, AF, YM and YF gender based farmers in the study can be increased by 14.71, 18.97, 18.03 and 25.86 % through improved resource allocation with no additional cost. The results are indication that gender based farmers in the study area operated below their frontier levels, which shows a shortfall in the technical efficiencies.

Table 4: Frequency distribution of technical efficiencies of cassava farmers based on gender

Decile class	AM	AF	YM	YF	Pool data
	F (%)	**F (%)**	**F (%)**	**F (%)**	**F (%)**
0.40-0.59	0(0)	0(0)	0(0)	2(3.44)	0(0)
0.60 – 0.79	4 (5.88)	3(5.17)	2(3.28)	4(6.90)	3(1.22)
0.80-0.89	6(8.82)	8(13.79)	9(14.75)	9(15.52)	28(11.43)
0.90-1.00	58(85.29)	47(81.03)	50(81.97)	43(74.14)	214(87.35)
Total	**68(100)**	**58(100)**	**61(100)**	**58(100)**	**245(100)**
Mean	0.93	0.94	0.95	0.90	0.96
Minimum	0.63	0.61	0.76	0.49	0.85
Maximum	0.99	0.99	1.00	0.98	1.00

AM= Adult male; AF= Adult female; YM= Youth male; YF= Youth female; F= Frequency

Return to scale

The return to scale (RTS) analysis, which serves as a measure of total resource productivity is shown in Table 5. The total maximum likelihood estimates (MLE) of the Cobb-Douglas based stochastic production function parameter of 0.911, 0.963, 0.982 and 0.980 for AM, AF, YM and YF cassava farmers respectively were obtained from the summation of the coefficients of the estimated inputs (elasticities). This indicates that, cassava production were in stage II of the production stage. This is also called the rational stage of production were resources and production could be efficient at this stage. This implies cassava farmers across the groups were operating at decreasing positive return to scale or supra-optimal scale, that is, proportion of cassava output produced is less than the desired increased input during the production process.

Table 5: Elasticity of production and return to scale in cassava production based on gender

Elasticity of production	AM	AF	YM	YF	Pool data
Farm size	0.011	0.086	0.299	0.125	0.241
Stem cutting	0.897	0.84	0.68	0.798	0.723
fertilizer	0.017	-0.007	0.006	0.007	0.004
labour	0.003	-0.001	-0.009	0.052	-0.007
Herbicides	-0.017	0.045	0.006	-0.002	0.002
Return to scale (RTS)	0.911	0.963	0.982	0.98	0.963

AM= Adult male; AF= adult female; YM= Youth male; YF= Youth female

Conclusion

The result of the MLE of the production function established that production inputs and socio-economic variables were factors influencing technical efficiency in cassava production among the four cassava production actors in the study area. Farmers were not able to operate at the frontier due to some socio-economic factors. Efforts should therefore be made to make farming less labour intensive through introduction of mechanization to avert inefficiencies resulting from use of labour in the state. Investments in rural education through effective extension delivery program in the current political and economic environment in Nigeria will provide farmers with the skills essential to increase efficiency. Stem cuttings significantly affect production across the four gender actors, thus, it should be increased alongside with intensive use of farm size to boost more production. Agricultural agencies and Bank of Agriculture should provide soft loans at reduced interest rates for cassava based farmers in other to acquire the necessary inputs to increase their outputs.

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