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An Analysis of Technical Efficiency of Smallholder Cassava Farmers in Anambra State, Nigeria

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ABSTRACT

Despite the various cassava programmes and policies implemented over the years to raise farmers' efficiency and productivity in cassava production, farmers have not yet attained the desired technical efficiency in cassava production as a result of insufficient access to farm input such as fertilizers and herbicides. This study was carried out to investigate the factors affecting technical efficiency of cassava production among smallholder farmers in Anambra State, Nigeria. Data were collected from 120 cassava farmers through a multi-stage sampling procedure during the 2013/2014 planting season. Descriptive statistics and stochastic frontier function that incorporated inefficiency effect using the Maximum Likelihood Estimation (MLE) technique were the analytical tools. The results showed that the mean age of farmers was 47.60 years and the majority of them (63.3%) and (63.9%) were male and married respectively. About half of the respondents had primary education with about 43.0% having more than 19 years of cassava farming experience. The average farm size and household size stood at 0.9 hectares and 7 members respectively. The Maximum Likelihood Estimates of the production function show that the technical efficiencies of the farmers were found to be low with an average of 51.5% which implies that average cassava output fell short by 48.5% of the maximum possible level. The study further reveals that only education (0.210) and access to credit (0.202) are the factors that significantly influenced technical inefficiency of cassava farms in the study area. This study concludes that technical efficiency of smallholder cassava farmers in the study area was low and this was influenced by their level of education and access to credit. Therefore, the study recommends training of farmers and improvement on their access to credit.

Key words: Anambra State, cassava farmers, smallholder, stochastic frontier, technical efficiency

INTRODUCTION

Nigeria is the world's largest producer of cassava with other top producers being Indonesia, Thailand, the Democratic republic of Congo and Angola. It has been estimated that in 2010 Nigeria's production of cassava reached 37.5 million tonnes (FAOSTAT, 2012). The country has consistently been ranked as the world's largest producer of cassava since 2005 (FAOSTAT, 2012).

Indeed, almost every household grows it. However, its adaptability to climatic and soil conditions even in marginal soils has endeared cassava to most people that have to practice continuous cultivation on limited available land. According to Olanrewaju *et al*. (2009), the general acceptance of cassava and its products to all classes of Nigerians on its own draws close attention to the producers of cassava. Cassava is one of the most actively marketed food crops and it is the most promising in terms of growth and new market opportunities, hence, farmers produce cassava as a source of family food and income generation (IITA, 2004). In recent years, cassava has also been transformed from being a subsistent crop to an industrial cash crop (Egesi, *et al.,* 2006). Cassava is a very important staple food consumed in different forms by millions of Nigerians. As the cost of production is low, the commodity has a high poverty reduction potential (Nweke, 2004, FAO, 2005). Cassava root is rich in energy, containing mainly starch and soluble carbohydrates, but is poor in protein content. These and other features endowed it with a special capacity to bridge the gap in food security and poverty alleviation (Clair and Etukudo, 2000). As a result, its production must be given prompt attention as regard food policy formulation.

In Nigeria, Cassava is generally believed to be cultivated by small scale farmers who are resource poor (Ezebuiro, *et al.*, 2008). However, cassava production in Nigeria is largely driven by continuous land expansion rather than increased productivity per unit land (yield). While production quantity and area harvested have increased substantially over the years, productivity (yield) only shows a marginal increase from 100,000 kg in 1980 to 120,000 kg in 2011 (FAOSTAT, 2012). Also, cassava farmers in the country are not fully technically efficient with a mean score of: 72.14% (Ogundari and Brumer, 2011). Adewuyi *et al.* (2013) also noted that the mean technical efficiency level of cassava farmers in Ogun state stood at 79%. According to IITA (2007), high cost of production and processing are the key constraints to competitive production and commercialization of cassava in Nigeria, however these can be attributed to low productivity. Raising productivity per unit land and labour through efficient use of production resources is a sure way of reducing per unit cost of production and ensuring competitive production.

Given the various cassava programmes and policies implemented over the years to raise farmers' efficiency and productivity in cassava production, farmers have not yet attained the desired technical efficiency in cassava production as a result of insufficient access to farm inputs such as fertilizers and herbicides (Ezedinma, 2006). It then becomes imperative to empirically determine the relationship between technical efficiency and smallholder farmers' socio-economic characteristics.
Researchers in the country (Ogundari and Brunner, 2011; Eze and Nwibo, 2014; Adewuyi, *et al*., 2013; Raphael, 2008 and Asogwa, *et al*., 2006), have examined technical efficiency of cassava farmers before. While Eze and Nwibo examined Economic and Technical Efficiency of Cassava production in Delta State, Adewuyi *et al*. (2013) anlysed technical efficiency of cassava farmers in Ogun state, Nigeria. Raphael (2008) analysed technical efficiency level of Cassava farmers in Abia and Imo States, while Asogwa *et al*. (2006) studied technical efficiency of Nigerian cassava farmers. To the best of our knowledge, little or nothing is known about the subject matter in the study area, hence, this study analysed technical efficiency of smallholder cassava farms in Anambra state.

MATERIALS AND METHODS

The Study Area

The study was carried out in Anambra East and West Local Government Areas (LGAs) in Northern Senatorial Zone (NSZ) of Anambra State. The state is located in the South Eastern region of Nigeria between longitudes $6^0\ 36'E\ to\ 7^0$ and latitude $5^0 38'N\ to\ 6^0 47'N$. The state is bounded in the north by Kogi State, in the west by River Niger and Delta State, in the south by Imo State and in the east by Enugu State. The state was created in 1991 with a population of 4.182 million people (National Population Commission, 2006). It has 21 LGAs which are grouped into four agricultural zones. Farming is the predominant occupation of the inhabitants, majority of who are smallholders. Farmers in the state are involved in the production of cassava, yam, rice, maize, cocoyam etc.

Data Collection and Sampling Procedure

The data used for this study was obtained from a primary source. The data were obtained with the aid of a tested well-structured questionnaire by trained enumerators. A multistage sampling technique was employed in selecting the respondents. The first stage was a purposive selection of two LGAs out of 21 LGAs because of high concentration of cassava farmers in the area. At the second stage, 12 villages were randomly selected from each of the selected LGAs. The third stage involved a random selection of 120 cassava farmers (63 from Anambra East LGA and 57 from Anambra West LGA). Data were collected on respondents' socio-economic characteristics, quantities and prices of farm inputs, quantities and price of cassava output among others during the 2014/2015 planting season.

Analytical techniques

Descriptive and inferential statistics were used in analyzing the data. The inferential statistics used is a variant of the stochastic frontier production function introduced by Aigner *et.al.* (1977), Meeusen and Van den Broeck (1977) and Bettesse and Coelli (1995). The function builds hypothesized efficiency determinants into the inefficiency error component so that focal points for action to bring efficiency to higher levels can be identified. The stochastic frontier method requires a prior specification of the most widely used functional forms like Cobb-Douglas and Translog. Cobb-Douglas is a special form of the translog production function where the coefficients of the squared and interaction terms of input variables of translog frontier are assumed to be zero. Translog frontier is susceptible to multicollinearity even if it is more flexible form (Thiam *et al.*, 2001). The Cobb-Douglas production function (in spite of its restrictive properties) is preferred because its coefficients directly represent the output elasticity of inputs and easy for interpretation and estimation than translog frontier (Coelli and Battese, 1998). Hence, in this study preference has gone to Cobb-Douglas frontier due to the above reasons. The use of Cobb-Douglas in technical efficiency studies abound in literature. Following Asefa (2011), Baloyi *et al.* (2012), Baruwa and Oke (2012) and Adewuyi *et al.* (2013), the Cobb-Douglas functional form used in this study is explicitly stated as:

$$ln\,Y\ =\ \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + V_i - U_i \ldots\ldots\ldots\ldots\ldots 1$$

Where:
ln = Logarithm to base e
Y= Output of cassava (kg)
X_1= Farm size (ha)
X_2= Labour (man-day)
X_3= Planting materials (Kg)
X_4= Fertilizer (kg)
$\beta_1, \beta_2, \beta_3, and\ \beta_4$ = Vectors of unknown parameters.

V_i = random error assumed to be independent of U_i identical and normally distributed with zero mean and constant variance N (0, σU^2).
U_i = random variable that accounts for technical inefficiency effects which are assumed to be independent of V_i and non-negative truncation at zero or half normal distribution with N (0, σU^2).

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \ldots\ldots\ldots\ldots\ldots 2$$

Where:
Z_i = Age (in years)
Z_2 = Household size
Z_3 = Off farm income (in Naira)
Z_4 = Access to credit (Yes =1, otherwise = 0)
Z_5 = Education (in years)
Z_6 = farming experience (in years)

The maximum likelihood estimates for all the parameters of the stochastic frontier and inefficiency model stated in equations 1 and 2, were simultaneously obtained. The variance parameters were estimated in terms of the parameterization as follows:

$$\sigma^2 = \sigma_U^2 + \sigma_v^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

$$\gamma = \frac{\sigma_U}{\sigma_v} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

Where: γ ranged from 0-1.

RESULTS AND DISCUSSION

Summary statistics of the respondents

The result of summary statistics of cassava farmers in the study area is presented in Table 1. The majority of the farmers (about 46%) were within the age range of 50-59 years with the mean age of 47.6 years. At this age, farmers had acquired experience and relatively energetic to meet the rigours of subsistence farming. The majority of the respondents (about 63% and 64%) were males and married suggesting that cassava production in the study area was dominated by males. This is however contrary to the findings of Battesse and Coelli (1995) and Eze and Nwibo (2014) who reported that females dominated cassava production business in Akwa Ibom and Delta States respectively. The mean years of schooling was 5.3, indicating a low level of education among the respondents. Level of education is believed to affect the acquisition of required skills in cassava production, which can enhance efficient use of farm inputs. Adewuyi *et al*. (2013) also reported low level of education among cassava farmers.

The results further show that the majority of the respondents had been in the business for the past 19 years with the mean years of experience of 15.8. The implication is that most of the farmers were knowledgeable in the business. Less than half of the respondents cultivated between 1-2 hectares of land for cassava during the last planting season.

Table 1: Descriptive statistics of respondents (n = 120)

Variables	Frequency	Percentage
Age (years)		
<40	32	26.67
40-49	22	18.33
50-59	55	45.83
>59	11	9.17
Mean	47.6	
Standard deviation	13.48	
Sex		
Male	76	63.33
Female	44	36.67
Marital status		
Single	9	7.5
Married	79	63.85
Divorced	17	14.17
Widow/widower	15	12.1
Education		
0	12	10
6	59	49.17
12	16	13.33
>12	33	27.5
Mean	5.2	
Standard deviation	6.1	
Years of farming experience		
<10		
10-19	38	31.67
>19	30	25
Mean	52	43.33
Standard deviation	15.8	
Farm size (hectares)		
<1	5	
1-2		
>2	34	28.33
Mean	56	46.67
Standard deviation	30	25
Household size	0.9	
<7	0.5	
7-12		
>12	39	32.5
Mean	75	62.5
Standard deviation	6	5
	7	
	3.1	

Source: Field Survey, 2015

The average farmland cultivated for cassava stood at 0.9 hectares during the said season indicating the subsistence nature of farming in the study area. The findings are in consonance with Adewuyi *et al*. (2013) who opined that cassava farmers in eastern part of Nigeria cultivated less than 1 hectare of land for cassava on the average. Farmers with household size of between 7-12 constituted the majority and the mean household size stood at 7, suggesting availability of family labour for farm work at least or no cost. This is however higher than the recommended national average of four (Alabi and Aruna, 2005).

Table 2: Maximum likelihood estimates of the stochastic production frontier function for cassava production

Variable	Coefficient t-ratio	t-ratio
Constant	-0.342	-2.721***
Farm size (X_1)	0.144	0.977
Labour (X_2)	0.732	5.783***
Planting materials (X_3)	0.799	0.182
Fertilizer (X_4)	0.636	1.766*
Inefficiency function		
Constant	-0.125	-1.153
Age (Z_1)	0.937	1.630
Household size (Z_2)	-0.965	-1.336
Off farm income (Z_3)	0.478	1.081
Access to credit (Z_4)	-0.202	-1.821*
Education (Z_5)	-0.210	-2.295**
Years of farming (Z_6) experience	0.584	0.928
Diagnostics statistics		
Sigma square (σ^2)		2.778***
Gamma (γ)		5.127***
Log likelihood ratio	124.22	
LR test	77.87	
Average Technical efficiency	51.5	

Source: Field survey, 2015; *, ** and *** significant at 10%, 5% and 1% respectively

The Maximum-Likelihood Estimates of the stochastic frontier production parameters for cassava is presented in Table 2. The result revealed that the estimated sigma squared (σ^2) parameter (2.78) in the stochastic frontier function is significantly different from zero at 1%, suggesting a good fit of the model and the correctness of the specified distributional assumptions. The estimated variance parameter (γ) (5.13) is significant at 1% indicating that the production inefficiency effects are significant in determining the level and variation in cassava production in the study area. The variability in production efficiency among the farmers is due mainly to differences in farming activities and respondents' characteristics rather than random factors. Also, the estimated variance parameter revealed the fact that cassava farmers in the study area are technically inefficient. This again showed that most respondents in the study area are using their existing resources inefficiently.

Furthermore, the relative importance of farm inputs is revealed in the stochastic production function estimates. The coefficients of labour had positive sign and statistically significant at 1%. This implies that increase in labour supply will increase the output of cassava significantly. Fertilizer is directly linked with cassava output and statistically significant at 10%. It could be inferred from this result that increase in fertilizer application will increase the output of cassava significantly. The result is in consonance with Girei *et al*. (2013) who revealed a positive association between fertilizer and cassava output.

Table 3: Frequency of technical efficiency of cassava farmers in the study area

Efficiency	Frequency	Percent
<40	51	42.5
40-59	36	30
60-79	30	25
80-99	3	2.5
Total	120	100
Average	51.5	-
Maximum	83.3	-
Minimum	31.7	-

Source: Field Survey, 2015

The estimates of the sources of the inefficiencies as presented in Table 2 showed that the coefficients for access to credit (0.202) is negative and significant at 10%. This means that this variable is capable of reducing inefficiencies among cassava farmers in the study area. The indirect relationship that exists between access to credit and level of respondents' technical inefficiency follows *apriori* expectation. The implication is that farmers who have access to credit seem to exhibit lower levels of inefficiency. This may be due to the fact that the credit that was received was used for the purpose of cassava farming. This is contrary to the submission made by Baruwa and Oke (2012) and Raphael (2008) who opined that there was a direct relationship between access to credit and cassava farmers' technical inefficiency.

Also, coefficient of education (0.210) is negative and significant at 5% level, implying that education is capable of reducing inefficiencies among respondents. The negative effect of level of education on technical inefficiency is expected, given that education is an important factor in technology adoption. Educated farmers are expected to be more receptive to improved farming techniques and hence, make more profitable use of improved agricultural innovations than their uneducated counterparts. As such, they are expected to have higher level of technical efficiency than farmers with less or no education. These findings are consistent with earlier findings by Raphael (2008) who reported an inverse association between education and farmers' level of technical inefficiencies.

The technical efficiency frequency distribution

The results of the frequency distribution of estimated technical efficiencies of cassava farmers in the study area are presented in Table 3. As shown in the table, there is variation in the levels of efficiency. The majority of the farmers (42.5%) had efficiency level of below 40%, while only very few of them (2.5%) had efficiency level of between 80-99% with the mean level of technical efficiency of 51.5%, which signifies a technical inefficiency level of 48.5%. The implication is that on the average, a cassava farmer in the study area requires about 48.5% more resources to produce the same output as an efficient cassava farmer on the frontier. This simply means that there is still room for improvement in the cassava production in the study area. The findings are in sharp contrast with those of Raphael (2008) who reported that the mean level of efficiency of farmers in south eastern part of Nigeria was 77%. The low level of technical efficiency of the respondents could be as a result of their low level of education as revealed by the descriptive analysis.

CONCLUSION AND RECOMMENDATIONS

This study examined the technical efficiency of cassava production among smallholder farmers in Anambra State, Nigeria. Primary data were used for the purpose of this study and analysed using descriptive statistics and stochastic frontier production function approach. The study shows that the level of technical efficiency varies across farmers and it ranges from 31.7%-83.3% with an average of 51.5% implying that cassava output falls by 48.5% short of the maximum possible level on the average. Evident from the study indicates that education and inefficiency levels are inversely related. The policy implication is that inefficiency in cassava production can be reduced significantly by improving the level of education among farmers. Furthermore, access to credit and inefficiency level are negatively linked. The policy implication is that with improvement in access to credit, it will be possible to reduce inefficiency in cassava cultivation significantly in the study area. Based on these, the study recommended intensification of adult education on the new cultivation practices involved in cassava production. In addition, more funds should be made available to farmers in form of loans.

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