Understanding the Allocative Efficiency of Cassava Farms in Imo State, Nigeria

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In Nigeria and particularly in Imo State, cassava is one of the mostly cultivated and useful root crop. These crops not only contribute to the share of agriculture in national economy, but possess a great potential and comparative advantage to compete in the liberalized economy. Despite all these potentials of cassava, empirical studies on the allocative efficiencies of cassava farmers in Imo State, have not been fully and systematically documented. On the other hand, most empirical studies on cassava have focused mainly on participation and level of adoption of cassava improved technologies. It is on this backdrop that the study was undertaken. Specifically, the study described the socio-economic characteristics of cassava farmers in the study area and allocative efficiency of cassava farmers in the study area and Multistage random sampling technique was used in the selection of respondents. Sample size comprised ninety (90) cassava farmers. Well structured questionnaire was the main tool for data collection. Data collected were analyzed using descriptive statistical tools, and stochastic frontier production model and cost function. Result show that the mean age was 47.00 years. Greater proportions (73.33%) were female. Majority (76.67%) were married with an average household size of 6 persons. The mean educational level and farming experience were secondary and 28 years respectively. Average farm size and annual farm income were 1.42 ha and N500,500.00 respectively. Reasonable proportions (81.11%) were members of cooperative society. The estimated gamma \( \gamma \) parameter of stochastic frontier production function showed that about 82.7% variation in output among cassava farmers in the study area was due to differences in relative efficiency. The return to scale (RtS) was 0.549 in the study area. This indicates a positive decreasing return to scale and that cassava production was in stage II of the production region where resources and production were believed to be efficient. The mean allocative efficiency was 0.860. The policy implication of these findings is that cassava farmers in the study area were efficient in allocating their resources considering their scope of operation and the limited resources. Result also showed that education, membership of cooperative, extension contact, farming experience and household size were farmers socio-economic characteristics that have a significant influence on their relative efficiencies. Hence, the second hypothesis was rejected. It was recommended that farmers particularly on their own should judiciously pool productive resources together through strengthened and stable cooperative society group as this would enhance their relative efficiencies in cassava production positively in the area. Moreover, effective agricultural policies and programmes should focus on granting farmers improved access to farm credit as these would enable them increase their production efficiencies positively in the area. Government at all levels should identify genuine cassava farmers and grant them easy access to farmland as these would significantly increase their relative efficiencies and standard of living positively in the area.

Keywords: Allocative efficiency; Cassava; stochastic frontier production model; Imo State, Nigeria

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1.0 Background Information

Allocative (Pricing) Efficiency (AE) refers to the ability of a firm to produce at a given level of output using the cost-minimizing input ratios (Ettah and Angba, 2016). In Nigeria, root and tuber crops such as cassava (Manihot spp.) have a significant place in the economy (International Institute of Tropical Agriculture (IITA) (2016) and Nigeria Bureau of Statistics (NBS) 2016). These crops not only contribute to the share of agriculture in national economy, but possess a great potential and comparative advantage to compete in the liberalized economy (Denen, Ayoula, Alakali, Ater, Sanni, Ngadi, Kok, 2016 and Mohammed and Isgin, 2016). Similarly, cassava is grown by almost every household in Nigeria (Onubuogu, Esiobu, Nwosu, Okereke, 2014) and serves more as a major source of income especially for the increasing rural dwellers (Zamanti and Jaderka, 2016). Cassava is also identified as a promising crop for international trade, as demand for cassava derivatives, e.g. gari (a type of processed cassava), starch and tapioca doubled over the last two decades (Ettah and Ngweze, 2016). As a food crop, cassava has some significant inherent characteristics which make it attractive especially to farmers in Nigeria. Firstly, it is rich in carbohydrates, especially starch, and consequently has multiplicity of end uses (Ettah and Nweze, 2016). Secondly, it is available all the year round, making it preferable to other more seasonal crops such as grains, peas, beans and other crops.

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for food security (Emokaro and Oyoboh, 2016) and lastly it is tolerant of low soil fertility and more resistant to drought (Okoye, Abass, Bachwenkizi, Asumughia, Alenkhe, Ranaivson, Randriariveloh, Rabemanantsoa and Ralimanana, 2016). Cassava tubers are mostly processed into cassava flour (lafun). Cassava flour is dried and powdered form of cassava, garri is fried granulated form of cassava while fufu is fermented powdered form of cassava in Nigeria (Oni, 2016). Cassava can also be cooked or eaten, pounded and consumed in its raw form, most especially the sweet variety (Oyewo, Adepoju, Ojo, Oyewo, Atanda, 2016). By implication, cassava has become a regular item in household diets in Nigeria (Lora, Posthumus and Martin, 2016). In a similar vein, cassava potential for industrial utilization is yet to be adequately realized; with 84 percent of cassava production reportedly consumed as food and 16 percent utilized as industrial materials (United Nations Industrial Development Organization and Federal Government of Nigeria (UNIDO and FGN) (2016). One of the ways in which optimal relative efficiencies could be achieved is to improve the productivity of cassava farms in the study area. Farmers will be guided on the inputs to focus on, thereby improving the efficient use of scarce resources in cassava production. However, such information on relative efficiencies of resources use of cassava farmers is lacking in Imo State, Nigeria. A significant and valid contributions have been made by various researchers (Adewuyi, Agbonlahor and Oke, 2013; Onumadu et al., 2014; Riatania, Daryanto, Tambunan and Purwati, 2014; Oggunyi, 2015; Eze, Ohajianya, Ibega and Ojinnaka, 2015; Adegbite and Adeoye, 2015; Denen et al., 2016; Mohammed and Isgin, 2016; Wudineh and Geta, 2016) at various household level in understanding the concept of either technical, allocative and economic efficiencies of various agricultural enterprise at various household level in Nigeria. However, particularly in Imo State, a number of empirical studies on cassava production have focused more on economic analysis (Nwaiwu, Odi, Ohajianya, Eze, Oguoma, Ibekwe, Heni-Ukoha, Kadiri, Amaechi and Ogun, 2010 and Obasi et al., 2015), production constraint (Chiedibere-Mark, Nwosu, Nwankwo, C. Chikezie, Oduofo and Ejike, 2014 and Henri-Ukoha, Anaeo, Chikezie, Ibega and Ukoha, Oshaji and Anyiam 2015), participation and level of adoption of cassava technologies (Onyemauwa, 2012 and Nnadi, Chikaire, Umunnakwe and Henacho, 2013). Similarly, other studies (Ibekwe, Orebiyi, Henri-Ukoha, Okorji, Nwagbo and Chidedibe-Mark, 2012) that attempted to estimate the relative efficiencies of cassava farmers in Imo State, used the ordinary least squares (OLS) estimation techniques. The use of the ordinary least squares (OLS) estimating technique makes it difficult to determine farm level efficiency as it provides only an average function (Ohajianya, Mgbada, Ozu, Enyia, Henri-Ukoha, Ben-Chendo and Godson-Ibeji, 2013) though it provides consistent estimates of the parameters except the intercept (Ogunyinka et al., 2014). To overcome this shortcoming of the OLS, the stochastic frontier function was developed and has been used by several researchers (Onumadu et al., 2014; Oggunyi, Bibarif and Omnoniyi, 2015; Eze et al., 2015; Adegbite and Adeoye, 2015; Denen et al., 2016; Mohammed and Isgin, 2016; Wudineh and Geta, 2016) to estimate efficiency of agricultural production. Its beauty lies in its ability to test and quantify the inefficiency of individual farmers in a sample because it allows for statistical noise rather than attributing all deviation to efficiency difference (Ogunyimi, 2015; Abdul-Hanan and Abdul-Rahaman, 2017). It is also straightforward to implement and interpret (Riatania et al., 2014 and Ettah and Nweze, 2016). A situation that is not possible with other partial measures of efficiency such as the OLS (Okoye et al., 2016). Furthermore, little or no study have rigorously estimated the relative efficiencies (technical, allocative and economic) of resources use of cassava farmers in Imo State, Nigeria. Only the studies of Onumadu et al., (2014) attempted to estimate the concept of resource use efficiencies but his study failed to focus specifically on cassava farmers and in the same vein was conducted in Anambra State which cannot be said to be a true position and representation of Imo State, Nigeria. It is on these backdrops that the study was rigorously undertaken.

2.0 Methodology
The study was carried out in Imo State, Nigeria. The State is located in the rainforest agro-ecological region of Nigeria and shares common boundaries with Abia State on the east and northeast, Rivers State on the south, and Anambra State on the west and northwest (Imo State Agricultural Development Project (Imo-ADP, 2013). The State lies between Latitudes 5°45' and 6°35' North of the equator and Longitudes 6°25' and 7°28' East of the Greenwich Meridian (Chineke et al., 2011). It occupies the area between the lower River Niger and the upper and middle Imo River (Imo-ADP, 2013). It is bounded on the east by Abia State, on the west by the River Niger and Delta State and on the north by Anambra State, while Rivers State lies to the south (Imo State Ministry of Land and Survey and Urban Planning, 2013). Imo State covers an area of about 5,067.20km², with a population of 3,934,899 persons with many subsisting farmers (Nigeria Population Commission (NPC), 2006 and National Bureau of Statistics (NBS), 2007) and population density of about 725km² (Imo-ADP, 2015). The State has an average annual temperature of 28°C, an average annual relative humidity of 80%, average annual rainfall of 1800 to 2500mm and an altitude of about 100m above sea level (Imo-ADP, 2013).

The State has three agricultural zones namely Orlu, Owerri, and Okigwe agricultural zones. Farming is the main occupation of the rural dwellers in the State. The farmers produce both root and tuber crops of which cassava are predominant. The sample for the study was drawn from cassava farmers in the study area. A multi-stage random sampling technique was adopted in the selection of respondents for the study. Firstly, three Local Government
Areas (LGAs) were randomly selected from each of the agricultural zone (Orlu, Owerri and Okigwe) in Imo State. The three (3) LGAs selected from Orlu agricultural zone of the State were Njaba, Orlu and Ideato-North. Similarly, the three (3) LGAs selected from Owerri agricultural zone of the State included Ikeduru, Mbaite and Owerri North. In the same vein, Hitte-Uboma, Onuimo and Ehime Mbano were the three (3) LGAs selected from Okigwe agricultural zone. Furthermore, three (3) communities were randomly selected from each of the sampled LGAs, selected from each of the three (3) agricultural zone of the State (Orlu, Owerri and Okigwe) to give a total number of twenty-seven (27) communities each from the area. Finally, four (4) households the three (3) LGAs selected from Owerri agricultural zone cassava farmers were randomly selected from each of the twenty-seven (27) communities to give a total sample size of one-hundred and eight (108) cassava farmers for the study. Ultimately, from the retrieved questionnaires, only ninety (90) individual responses were found useful. The list of cassava farmers in the communities, which forms the sample frame, was obtained from the zonal extension agents of Imo State Agricultural Development Programme (Imo-ADP) in the study area. Primary data was used for the study. Primary data was collected through the use of structured questionnaire and it was supplemented with oral interview in places where the respondents could neither read nor write. Descriptive statistics such as frequency distribution, percentages, mean and flow charts were used analyze the data so as to realize objectives. The objectives were modelled using the stochastic frontier production function. The implicit form of the stochastic frontier production model is specified as follows;

\[
\text{Ln}\text{Yij} = \beta_0 + \beta_1\text{lnX1} + \beta_2\text{lnX2} + \beta_3\text{lnX3} + \beta_4\text{lnX4} + \beta_5\text{lnX5} + \beta_6\text{lnX6} + (\text{V_i} - \text{U_i}) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots .25
\]

Where;

- \(Y_i\) = Cassava output (kg)
- \(X_1\) = Farm size (Hectares)
- \(X_2\) = Labour used (man days)
- \(X_3\) = Fertilizer (₦)
- \(X_4\) = Equipments (₦)
- \(X_5\) = Cassava stem cuttings used (₦)
- \(L_n\) = log to base-e
- \(ij\) = \(j^{th}\) observation of the \(i^{th}\) farmer
- \(V_i\) = Is a one-sided efficiency component with a half-normal distribution
- \(U_i\) = Is a two-sided, normally distributed random error

4.0 Maximum Likelihood Estimates of Stochastic Frontier Production Model

The results of estimates of production and cost functions are presented in table 1. The estimate of the parameters of the stochastic frontier production model reveals that all the estimated coefficients of the variables of the production function were positive except for that of fertilizer and equipment. The two significant variables are farm size and cassava stem cuttings which were statistically significant at 1% and 5% level respectively. The estimate of sigma square (\(\sigma^2\)) of 419.52 was statistically significant at 5% level and therefore, assures us of the goodness of fit and correctness of the distributional assumptions of the composite error. The estimated gamma parameter (\(\gamma\)) of 0.827 indicates that 82.7% of the total variation in cassava output was due to differences in their percentages, mean and flow charts were used analyze the data so as to realize objectives. The objectives were modelled using the stochastic frontier production function. The implicit form of the stochastic frontier production model is specified as follows;
with higher years of education are in a better position to be more technically efficient than their counterparts. It is very possible that farmers with higher level of education respond easily to the use of improved technology, such as the application of fertilizers, use of pesticides, herbicides and so on thus assisting the farmers to produce close to the frontier. This finding is in conformity with the finding of Ogguniyil et al., (2012) and Tanko and Jirgi (2008) who reported a positive relationship between education and technical efficiency. This shows that education is an important factor that reduces inefficiency among cassava farmers in the study area. This finding supports the study of Emokaro and Oyoboh (2016) who opined that higher level of education determines the quality of skill of farmers, their allocative abilities, efficiency and how well informed they are about the innovations and technologies around them. It also supports the result of Simpa et al., (2014) who reported that farmers with higher educational attainment are usually faster in adoption of improved farming technologies and marketing technique than farmers with little or no education. The membership of cooperative had a positive coefficient with efficiency of the cassava farmers and it was statistically significant at 1% level of probability. This implies that cassava farmers who belong to cooperative society gather more information, exchange labour, acquire reasonable amount of credit and knowledge on how to efficiently use production resource to enhance their output than those who do not belong to any agricultural cooperative society. Membership of cooperative gives farmers easy access to farm credit, share information, ideals and project a collective demand (Tijjani and Bakari, 2014). Similarly, the studies of Aboki et al., (2013) and Idris et al., (2013) opined that membership of cooperative was positive and significantly related to relative efficiency of farmers. The finding is supported by the result of Berhan (2016) who argued that the more active the farmers are in their involvement in the farmer association, the more information of farm activities carried out and agricultural input distribution they have compared to those who do not join the association. The extension contact was found to be positively related to the efficiency of the cassava farmers. This implies that farmers who received more visit and/or in frequent contact with extension staff/agents are in a better position of being technically efficient in the use of production resources to enhance their agricultural production than those who receive little or no visit. The relationship is significant at 1% level of probability. The study of Nwaiwu et al., (2015) argued that extension contact enhance farmers production and promote their knowledge on modern farming methods. The findings of Ochi et al., (2016) showed extension contact was positive and significantly related to relative efficiency of cassava farmers. Household size had a negative coefficient with the inefficiency of the cassava farmers. This implies that farmers with larger household size were more technically efficient than smaller household size. The implication of the negative coefficient of household size is that it contributes to resource use efficiency in cassava production in the study area. The effect of household size on farm level resource use efficiency is traceable to its use as a source of labour supply for work on the farm. In some instances family labour may be forced resulting in drudgery and poor workmanship. This relationship is significant at the 1% level of probability. This findings support the result of Simpa et al., (2014) who reported that large household size is a proxy to labour availability, ensure ease allocation of resources and reduce the cost of hired labour. Farming experience had a positive coefficient with the inefficiency of the cassava farmers and hence it is statistically significant at 1% level of probability. This implies that increase in year of farming experience leads to increase in efficiency of the farmers. This implies that the more experienced cassava farmers know the problems involved in cassava production and are in a better position to overcome them and improve on their yield than those that had little or no experience. The studies of Ochi et al., (2016) and Berhan (2016) asserted that farming experience is positively and significantly related with efficiency of farmers. This implies that increase in year of farming experience leads to decrease in inefficiency of the farmers. Similarly, The findings is also in line with the study of Akhilomen et al., (2015) who reported that farmers with more years of farming experience would be more efficient, have better knowledge of climatic conditions, better knowledge of efficient allocation of resources and market situation and are thus, expected to run a more efficient and profitable enterprise.
Table 1. Maximum Likelihood Estimate of Stochastic Frontier Models

| Production function variables | Parameters | Coefficient | t-value | Cost function variables | Parameters | Coefficient | t-value |
|-------------------------------|------------|-------------|---------|--------------------------|------------|-------------|---------|
| Constant                      | $\beta_0$  | 35.249      | 6.842***| Constant                 | $\beta_0$  | -437.528    | -7.610***|
| Land                          | $\beta_1$  | 0.372       | 5.092***| Depreciation on Land     | $\beta_1$  | 0.311       | 1.992*  |
| Cassava stem Cutting          | $\beta_2$  | 0.215       | 3.575** | Cost of Cassava stem Cutting | $\beta_2$  | 1.302       | 6.201***|
| Labour                        | $\beta_3$  | 0.017       | 0.025   | Cost of Labour           | $\beta_3$  | 0.085       | 2.405** |
| Fertilizer                    | $\beta_4$  | -0.024      | -0.310  | Cost of Fertilizer       | $\beta_4$  | 0.115       | 0.050   |
| Equipments                    | $\beta_5$  | -0.031      | -0.550  | Cost of Equipments       | Output     | $\gamma$    | 0.914   |
| Inefficiency Factor           | Education  | $Z_1$       | 0.381   | Sigma – square           | $\sigma^2$ | 472.532     | 4.312** |
| Membership of cooperative     | $Z_2$       | 0.262       | 3.271***| Gamma                    | $\gamma$    | 0.914       | 5.853***|
| Extension contact             | $Z_3$       | 0.201       | 3.191****| Log – Likelihood function | $L(\theta)$ | -3311.561   |         |
| Household size                | $Z_4$       | -0.305      | -4.111***|                          |             |             |         |
| Farming experiences           | $Z_5$       | 0.227       | 3.010***|                          |             |             |         |
| Sigma – square                | $\sigma^2$  | 419.52      | 4.026***|                          |             |             |         |
| Gamma                         | $\Gamma$    | 0.827       | 10.738***|                          |             |             |         |
| Log – Likelihood function     | $L(\theta)$ | -915.53     |         |                          |             |             |         |
| Return to Scale               | (RtS)       | 0.549       |         |                          |             |             |         |
| Sample size                   | N           | 90.00       |         |                          |             |             |         |

*Statistically Significant at 10%; **Statistically Significant at 5%; *** Statistically Significant at 1%; Source: Frontier 4.1 (2018)

4.0 Estimation of Allocative Efficiency of the Cassava Farmers

The results of estimates of allocative efficiency of the cassava farmers are presented in table 2. The allocative efficiency analysis of cassava production revealed that there was presence of allocative efficiency effects in cassava production in the study area as confirmed by the gamma value of 0.827 that was significant at 5% level of probability. The gamma ($\gamma$) value of 0.827 implies that about 82.7% variation in the output of cassava farmers was due to differences in their allocative efficiencies. The predicted allocative efficiencies (AE) range between 0.412 and 0.980 while the mean AE was 0.860. The result also showed that there is ample opportunity for improvement on the level of allocative efficiency in cassava production in the study area. Similarly, the finding shows that if the average cassava farmer in the area was to achieve the AE level of its most efficient counterpart, then the average farmer could realize about 12.30% of cost saving [i.e., 1-(98.0/86.0) x100]. A similar calculation for the most allocative inefficient farmer reveals cost saving of approximately 53.00% [i.e., 1-(41.2/86.0) x100]. Moreover, the frequencies of occurrences of the predicted allocative efficiencies in deciles range indicate that the highest number of farmers have allocative efficiencies between 0.90 - 0.99. The sample frequency distribution indicates a clustering of allocative efficiencies in the region 0.90 - 0.99 efficiency ranges, representing 58.89% of the cassava farmers in the area. This implies that the farmers are fairly allocatively efficient. That is, the farmers are fairly allocatively efficient in producing cassava at a given level of output using the cost minimizing input ratio as approximately 90.66% of the farmers have AE of 0.70 and above. This implies that the farmers are fairly allocative
efficient. That is, the farmers are efficient in deriving maximum output from input, given the available resources. The study of Onu and Edon, (2009) and Simpa et al., (2014) reported that training/orientation to the farmers, especially towards the new technology and other farming practices improve allocative efficiency of farmers. The result revealed that farmers in the study area are fairly efficient in producing cassava at a given level of output using the cost minimizing input ratio. The study further revealed ample opportunity that exists for improving the level of allocative efficiency of cassava production in the study area. The results tallies with the studies of Obike et al., (2016) and Nwike et al., (2017) who reported the allocative inefficiencies of cassava farmers in cassava production.

Table 2. Deciles Range of Frequency Distribution of Allocative Efficiency of the Cassava Farmers

| Efficiency Level | Frequency | Percentage (%) |
|------------------|-----------|----------------|
| 0.40-0.49        | 2         | 2.22           |
| 0.50-0.59        | 1         | 1.11           |
| 0.60-0.69        | 9         | 10.00          |
| 0.70-0.79        | 12        | 13.33          |
| 0.80-0.89        | 20        | 22.22          |
| 0.90-0.99        | 46        | 55.11          |
| Total            | 90.0      | 100.0          |

Mean 0.860
Standard Deviation 0.026
Minimum 0.412
Maximum 0.980

Source: Frontier 4.1 (2018)

Conclusion and Recommendation

The estimated gamma (γ) parameter of stochastic frontier production function showed that about 82.7% variation in output among cassava farmers in the study area was due to differences in relative efficiency. The result of the study showed that the major factor affecting cassava production in the study area were educations, membership of cooperative, extension contact, farming experiences and farm size, household size, labour and fertilizer. These factors have positive influence on cassava output. The return to scale (RtS) was 0.549 in the study area. This indicates a positive decreasing return to scale and that cassava production was in stage II of the production region where resources and production were believed to be efficient. The mean allocative efficiency was 0.860. The policy implication of these findings is that cassava farmers in the study area were efficient in allocating their resources considering their scope of operation and the limited resources.

Recommendation

These recommendations were made based on the major findings of the study;

(i) Farmers particularly on their own should judiciously pool productive resources together through strengthened and stable cooperative society groups as this would enhance their relative efficiencies in cassava production positively in the area.

(ii) Effective agricultural policies and programmes should focus on granting farmers improved access to farm credit and subsidized inputs as these would enable them increase their production efficiencies positively in the area.

(iii) Government at all levels should identify genuine cassava farmers and grant them access to farmland as these would significantly increase their production efficiencies and standard of living positively in the area.

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