

Comparative Economic Analysis of Improved and Local Cassava Varieties in Selected Local Government Areas of Taraba State, Nigeria

J.I. Onu and A. Edon

*Department of Agricultural Economics and Extension, Federal University of Technology, Yola, Adamawa State, Private Mail Bag 2076, Nigeria
E-mail: justiceonu@yahoo.co.uk*

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ABSTRACT The study was carried out in some selected local government areas of Taraba State. The result revealed that the elasticity of output with respect to land (0.2013 and 0.0912), hired labour (0.5444 and 0.2555) were significant at 1% level for the improved and local varieties respectively, while family labour (0.1597 and 0.1629), fertilizer (0.2314 and 0.1766), stem cutting (0.1944 and 0.3291) and land preparation (0.3416 and 0.1090) were significant at 5% level respectively. It was also revealed that the level of technical efficiencies varied widely across farms with 88% and 81% been the mean technical efficiency of the improved and local varieties. The result revealed further that on the average, the output of cassava fell by 12.64% and 18.72% from the maximum level due to inefficiency of the improved and local cassava varieties. The analysis also shows that the gross farm margin and net farm profit were ₦26, 384.62 per hectare and ₦21, 908.87 per hectare and ₦19, 399.72 per hectare and ₦15, 515.73 per hectare for the improved and local cassava varieties. The study concluded that it is more profitable to venture into the business of farming improved varieties than the local varieties.

INTRODUCTION

Cassava is a perennial woody shrub. Osirus (1997) reported that tuberous roots of cassava are valuable source of cheap calories. FAO (2000) estimated that over 600 million people depend on cassava as a staple food in Africa, Asia and Latin America. In the past cassava was never seen as cash crop (industrial crop). It has always been seen as a food crop. However, this view has changed with the inauguration of the Presidential Initiative on Cassava Production in Nigeria. Uses of cassava can be classified into two: the industrial use and the local food need use of cassava. The crop has assumed greater attention because of its potential for the production of ethanol which can be used to complement petroleum. In spite of the economic and nutritional importance of cassava to the Nigerian economy, its production in the country is grossly inadequate because of the wide gap between the demand and supply of the products. According to Adewumi (2007)

presently Nigeria import 90 million litres annually for industrial use and this could rise to as much as one billion litres when we start using it for automobiles. This means that cassava production capacity has to be increased rapidly to be able to meet with the rising demand. To stem this situation there is a current effort by the Nigerian government to promote cassava production both for local industries and for export. For cassava production to grow in a sustainable manner the present level of technical efficiency and productivity in the cassava industry must be improved upon. However, only little is known about the level of technical efficiency of the Nigerian cassava industry.

The Stochastic Frontier Model

The stochastic frontier production function was proposed by Aigner (1977), Meeusen and Van de Broeck (1977). The original specification of the model involved a production function of the normal regression form which had an error term with two components, one to account for random effects and another to account for technical inefficiency. The model is expressed as follows:

$$Q_i = F(X_i, \beta) e^{\varepsilon_i} \quad (1)$$

$$i = 1, 2, 3, \dots, N. \quad k = 1, 2, 3, \dots, N$$

Corresponding Author:

J.I. Onu,
Department of Agricultural Economics and Extension,
Federal University of Technology, Yola, Adamawa State,
Private Mail Bag 2076, Nigeria.
Telephone: +2348052728396, +2348036050936
E-mail: justiceonu@yahoo.co.uk

Where Q is the output of the i^{th} farm. X_{ki} is a vector of k inputs of the i^{th} farm, β is a vector of parameters, ε is a farm specific error term and $f(x)$ is the appropriate function of the vector. This stochastic is called a composed error model because the error term is composed of two independent elements.

$$\varepsilon_i = v_i - u_i \quad (2)$$

$i = 1, 2, 3, \dots, N.$

The symmetric component v_i permit random variation in output due to factors outside the control of the farmer such as weather, disease, topography etc. It is assumed to be independently and identically distributed as $N(0, \sigma^2 v)$. A one sided component U_i is a non negative random variable and reflects technical inefficiency due to all environmental factors, performance of the farmers etc and this is relative to Stochastic Frontier

$$F(X_{ki}\beta)e^{v_i} \quad (3)$$

Thus $U_i = 0$ for any output lying on the Frontier and is strictly positive for any output lying below the Frontier, representing the amount by which the frontier exceed the actual output of the farm. It is assumed that U_i is independently distributed as $N(0, \sigma^2 u)$. The distribution of U is half normal and arises from truncation (at zero) of the normal distribution. This is defined as

$$\sigma^2 = \sigma^2 v + \sigma^2 u \quad (4)$$

The combination of (1) and (2) gives the frontier of the farm which is given as

$$Q = F(X_{ki}\beta)e^{v_i - u_i} \quad (5)$$

This paper considers similar specification to that of Battese et al. (1996). The study also employed a Cobb-Douglas Stochastic frontier production function as defined in (5) above.

Technical Efficiency

Technical efficiency of an individual farm is defined as the ratio of the observed output to the corresponding frontier output given the available technology.

$$\begin{aligned} \text{Technical efficiency (TE}_i\text{)} &= \\ &= \exp(X_{ki}\beta v_i - u_i) / \exp(X_{ki}\beta v_i) \\ &= \exp(-u_i) \end{aligned}$$

Where Y_i is the observed output and Y_i^* the frontier output. Technically efficient farmers are those that operate on the production frontier and the level by which a farm lies below its production frontier is regarded as the measure of technical efficiency.

Data Collection

The study was based on primary data

collected from cassava farmers in three local government areas in Taraba State, Nigeria. The local government areas were Wukari, Gassol and Ardo-kola. A multi stage random sampling technique was used in the selection of the three local government areas. The villages were purposively selected because of the high concentration of cassava farmers in the area. A total of 180 cassava farmers comprising 90 farmers each for improved and local varieties were randomly selected. Data were collected on production inputs as well as output and on farm and farmer specific factors such as age, sex, marital status, education level and farming experience for each of the respondents farming improved and local cassava varieties.

Model Specification

The stochastic frontier production function was used to capture the maximum likelihood estimate of the parameters and coefficients of the selected cassava farmers. It is assumed to be defined by:

$$\ln Q_i = \ln \beta_0 + \beta_1 \ln X_{1i} + \varepsilon_i$$

Where

Q = total output in kilograms

X_1 = land under cultivation in hectares

X_2 = hired labour utilised in naira.

X_3 = family labour utilised in man days

X_4 = expenses on transportation in naira.

X_5 = expenses on agro chemicals in naira

X_7 = expenses on cassava stem cuttings in naira.

X_8 = expenses on land preparation in naira.

β_0 = constant term

β_1^0 to β_8 = coefficients of independent variables to be estimated.

ε_i = error term defined by $\varepsilon_i = v_i - u_i$.

$\ln$ denotes the natural logarithm.

Where technical inefficiency model is assumed to be explained by

$$U_{ij} = \ln \delta_j + \delta_1 \ln z_{if} + \delta_2 \ln z_{ij} + \delta_3 \ln z_{3ij}$$

Where

Z_1 = years of farming experience of the i^{th} farmer

Z_2 = household size

Z_3 = constant term

= unknown parameters to be estimated.

U_{ij} = technical inefficiency of the i^{th} farmer

Gross Margin Analysis

This tool was used to determine the

profitability of the enterprise. The gross margin (GM) is the difference between the gross farm income (GFI) and the total variable cost (TVC) incurred in cassava production, while the net farm profit (NFP) is the difference between the gross margin and the total fixed cost (TFC). This is specified below:

$$GM = GFI - TVC$$

Where

GM = gross margin for the i^{th} variety

GFI = gross farm income for the i^{th} variety

TVC = total variable cost for the i^{th} variety

NFP = GM - TFC

Where NFP = net farm profit; for the i^{th} variety

TFC total fixed cost for the i^{th} variety

RESULTS AND DISCUSSION

The distribution of the respondents according to their educational status is presented in Table 1. The majority (72.2%) of the respondents farming improved varieties are literate, as compared to 58.89% of the farmers farming local varieties that are illiterate. This implies that the farmers farming local varieties would find it difficult to understand and adopt technological innovations on method of production. Hence they are likely to be more inefficient in their production. On the other hand the respondents that farmed improved varieties would find it easier to understand and adopt new production technology since they could read and write. As a result they are likely to be more efficient in their production. The result further revealed that education has a significant impact on farmers' efficiency in production.

Table 1: Distribution of respondents according to level of education

Level of educational	Improved varieties		Local varieties	
	Fre-quency	%	Fre-quency	%
Non formal	11	12.22	30	33.33
Primary school	20	22.22	17	18.89
Secondary school	29	32.22	10	11.11
Post secondary school	16	17.78	10	11.11
Informal education	14	15.56	23	25.56
Total	90	100	90	100

Source: computed from field data, 2006.

Farming Experience

The distribution of farmers according to their

farming experience is presented in Table 2. It can be seen that 81.1% of the farmers farming improved varieties had farming experience of more than 5 years with a mean farming experience of 9 years; while 80% of the farmers farming local varieties had farming experience of more than 5 years with a mean farming experience of 10 years. It is expected that the farmers are aware of new production technology and method of production, and would be likely to achieve higher level of productivity. This supports the findings of Maurice (2004) who reported a positive and significant relationship between farming experience and technical efficiency.

Table 2: Distribution of respondents according to experience in cassava farming

Years of farming	Improved varieties		Local varieties	
	Fre-quency	%	Fre-quency	%
1-5	17	18.89	18	20.00
6-10	10	11.11	12	13.33
11-15	22	24.44	20	22.22
16-20	20	22.22	17	18.89
>20	21	23.33	23	25.56
Total	90	100.00	90	100.00

Source: Computed from field data.

Stochastic Frontier for Improved Cassava Varieties

$$\begin{aligned} \ln Q = & 0.2038 + 0.02013 \ln X_1 + 0.544 \ln X_2 \\ & (0.414) \quad (0.059) \quad (0.156) \\ & + 0.1597 \ln X_3 + 0.2314 \ln X_4 + 0.1114 \ln X_5 \\ & (0.08) \quad (0.067) \quad (0.154) \\ & - 0.1772 \ln X_6 + 1949 \ln X_7 + 0.3416 \ln X_8 \\ & (0.265) \quad (0.0681) \quad (0.1491) \end{aligned}$$

Inefficiency Model for Improved Cassava Varieties

$$\begin{aligned} U_{ij} = & -0.3352 - 0.2374 \ln Z_1 + 0.8536 \ln Z_2 \\ & (0.121) \quad (0.049) \quad (0.039) \\ & + 0.5963 \ln Z_3 \\ & (0.432) \\ \text{Variance parameter } \delta^2 = & 0.5406, \quad Y = 0.9040 \\ & (0.2145) \quad (0.0314) \\ \text{Likelihood ratio} = & -49.24. \end{aligned}$$

Stochastic Frontier for Local Cassava Varieties

$$\begin{aligned} \ln Q = & 0.0975 + 0.0912 \ln X_1 + 0.2555 \ln X_2 \\ & (0.274) \quad (0.0312) \quad (0.054) \end{aligned}$$

$$\begin{aligned}
& + 0.1629\ln X_3 + 0.1766\ln X_4 + \\
& \quad (0.0548) \quad (0.081) \\
& 0.2574\ln X_5 - 0.0823\ln X_6 + 0.3291\ln X_7 \\
& \quad (0.1419) \quad (0.1145) \quad (0.1379) \\
& + 0.1090\ln X_8 \\
& \quad (0.0514)
\end{aligned}$$

Inefficiency Model: For Local Cassava Varieties

$$\begin{aligned}
U_{ij} &= -0.2008 - 0.1542\ln Z_1 + 0.3875\ln Z_2 \\
& \quad (0.03830) \quad (0.0267) \quad (0.029) \\
& + 0.7314\ln Z_3 \\
& \quad (0.6319) \\
\text{Variance parameter}^2 &= 0.5125, \quad Y = 0.880 \\
& \quad (0.1984) \quad (0.0221) \\
\text{Likelihood ratio} &= -52.40
\end{aligned}$$

Figures in parenthesis are standard error of estimates.

The signs of the coefficients of the stochastic frontier are as expected. The positive coefficient of land (0.2013 and 0.0912) confirms the expected positive relationship between the quantity of output and the size of land used in the production of improved and local varieties respectively. The estimated coefficient for hired labour (0.5444 and 0.2555), fertilizer (0.2314 and 0.1766), family labour (0.1597 and 0.1090), stem cutting (0.0944 and 0.1291) and land preparation (0.1416 and 0.1090) respectively were statistically significant at 1% and 5% levels, while agrochemicals (-0.1772 and -0.0823) and transportation (0.1114 and 0.2574) were not significant for both varieties.

The estimated coefficients in the inefficiency model are of particular interest to this study. For years of farming the estimated coefficient is negative (-0.2374 and -0.1542) and statistically significant at 1% level for the improved and local varieties. This means that farmers with less farming experience are inefficient compared to their counterparts with more years of farming experience for the improved varieties. The estimated coefficient for household size (0.8536 and 0.3875) is positive and statistically significant at 5% for both varieties. This means that farmers with large household size are inefficient. The reason for this could be that as family size increases the resources of the family are thinly spread out to take care of feeding, clothing and other family needs. The estimated coefficient for years of schooling (0.5963 and 0.7314) was positive and not statistically significant.

The estimated sigma square (σ^2), 0.5406 and 0.5125, are large and significantly different from

zero at 1% level for the improved and local varieties respectively. The magnitude of the variance ratio defined as $Y = \frac{\sigma^2}{\sigma^2 + \sigma_u^2}$, estimated to be as high as 90% and 88% of the variation in output of the improved and local varieties among the cassava farmers, is due to difference in technical efficiency. The log likelihood function is estimated to be -49.24 for the improved varieties and -52.40 for the local varieties. These values represent the values that maximize the joint densities in the estimated model.

Frequency distribution of the estimated technical efficiency of the cassava farmers are presented in Table 3. The Table reveals that the mean technical efficiency of cassava farmers is 88.36% and 81.28% for the improved and local varieties respectively. The result also showed that majority (56.67%) of the farmers farming improved varieties had technical efficiency above 80% while greater (61.11%) number of the farmers farming local varieties had technical efficiency below 80%. The reason could be that majority of the farmers (as shown in Table 1) farming improved varieties are literate, who might understand and adopt new technological innovations that could lead to increase in productivity as a result of their educational background. Therefore, farmers make better technical decisions if they have basic education and this would help them to allocate their production inputs efficiently to achieve higher level of technical efficiency.

COSTS AND RETURNS

Table 4 shows that the percentage gross farm margin of the improved and local varieties are 53.3%

Table 3: Frequency distribution of technical efficiency rating of the cassava farmers

Efficiency index	Improved varieties		Local varieties	
	Frequency	%	Frequency	%
0.90-1.00	23	25.56	17	18.89
0.80-0.89	28	31.11	18	20.00
0.70-0.79	31	34.44	30	33.33
0.60-0.69	2	2.22	12	13.33
0.50-0.59	-	-	-	-
0.40-0.49	5	5.56	5	5.56
<0.40	1	1.11	5	5.56
Total	90	100	90	100
Minimum efficiency	0.3940		0.2970	
Maximum efficiency	0.9873		0.9705	
Mean efficiency	0.8836		0.8128	

Source: Computed from stochastic frontier result

Table 4: Farm gross margin and net farm profit of cassava farmers.

	<i>Improved varieties (Naira)</i>	<i>Local varieties (Naira)</i>	<i>Total</i>
Gross farm income (GFI)/Ha	4, 500,000	3, 900, 000	8, 400, 000
Total variable cost (TVC)/Ha	1,703, 230	1, 449, 730	3, 152, 960
Total fixed cost (TFC)/Ha	474, 430	487, 530	961, 960
Gross farm margin (GFI-TVC)/Ha	2, 796, 770	2, 450, 270	5, 247, 040
Net farm margin(GM-TFC)/Ha	2, 322, 340	1, 962, 740	4, 285, 080
% gross farm income	53.57	46.43	100.00
%gross farm margin	53.30	46.70	100.00
%net farm profit	54.20	45.80	100.00
Average gross farm income/Ha	42, 452.83	30, 830.04	
Average gross margin/Ha	26, 384.62	19, 369.72	
Average net farm profit/Ha	21, 908.87	15, 515.73	

Source: Computed from field data.

and 46.70 % respectively while the net farm profit of the improved and local varieties are 54.2% and 45.8% respectively. The table also reveals that the average gross farm margin and net farm profit for the improved varieties are ₦26, 384.62 per hectare and ₦21, 908.87 per hectare while that of the local varieties are ₦19, 369.72 per hectare and ₦15, 515.73 per hectare respectively. The result reveals that the business of farming improved varieties is more profitable than that of the local varieties in view of the farm profit of the two enterprises.

CONCLUSION

The study estimated farm level technical efficiency and its determinants using stochastic parametric method of estimation. The stochastic frontier production function approach using maximum likelihood (ML) procedure was used to estimate the model and predict the individual technical efficiency. The parameters of the ML estimates and inefficiency determinants were asymptotically efficient, unbiased and consistent and were obtained using Cobb-Douglas production function estimated by maximum likelihood estimation technique. The analysis showed that the predicted technical efficiency ranged between 39.4% and 98.7% with a mean technical efficiency of 88.4% for the improved varieties while the local varieties ranged between 29.7% and 97.1% with a mean technical efficiency of 81.3%. The farm specific technical efficiency distribution reveals that none of the farmers reached the frontier threshold.

The policy implication of the findings in this study is that there are ample opportunities to raise the present level of technical efficiency of cassava production in the study area given the wide

variation in the level of technical efficiency. Since education has relationship with the technical efficiency government policy should concentrate on addressing ways to raise the level of education of cassava farmers. However, for the purpose of theoretical and applied work, it is required to include more variables of farm and farmers in modeling of technical inefficiency so as to obtain better and general models for the stochastic frontiers and technical inefficiency effects in the Nigerian cassava production industry.

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