

Analysis of Technical Efficiency of Cassava Processing Methods among Small Scale Processors in South – West, Nigeria

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Abstract This study employed a stochastic frontier model to analyze the productivity and technical efficiency (TE) of cassava processing methods among small scale processors in South – West, Nigeria. The study was carried out in three states of Ogun, Oyo and Ondo, Nigeria. Data were obtained from primary sources using a set of structured questionnaire assisted with interview schedule. The multistage sampling technique was used. Data were analyzed using: descriptive statistics and the stochastic frontier production function using a farm level survey data collected from 373 small scale cassava processors. Results showed that cassava processing under local and modern methods was in stage one (stage of inefficiency) of the production region and that processors using the local method of processing cassava were more technically efficient than those using the modern method.

Keywords: *cassava processing methods, technical efficiency, small scale processors, south-west Nigeria*

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1. Introduction

Nigeria is the highest cassava producer in the world; its production is a third more than that of Brazil and almost double the production in Thailand and Indonesia. Cassava production in Nigeria in 2004 jumped to about 38 million tons (CBN, 2002), which ranks cassava production higher in volume than yam, sorghum and rice. Current projections show that cassava will remain a leading African crop, Nigeria’s present production figure amounts to an increase of 10% over the last five years and this figure is expected to double by 2020.

Cassava processing activities are widespread in the rural areas being the most formal processed crop in the Southern and Middle Belt areas of the country and small – scale cassava processing equipments are by far more widespread in the country than for any other agricultural produce (Oni, 2005). Processing cassava root tuber into dry form reduces its moisture content and converts it to a more durable and stable product with less volume which makes it more transportable. Processing is also necessary to eliminate or reduce the level of cyanide in cassava and improve the palatability of the products.

Cassava roots are processed by a variety of methods into different products, according to local customs and preferences. Compared with fresh cassava, the processed products have increased shelf life, are easier to transport and market and are more palatable. Fresh cassava roots cannot be stored for long because they rot within 3 – 4

days after harvest. They are bulky, with about 70% moisture content. Processing can increase the efficiency of land use by releasing land after harvest for other crops or for fallow to sustain soil productivity, also reduces food losses and stabilizes seasonal fluctuation in supply of the crop.

This study seeks to evaluate the technical efficiency of cassava processing methods employed and compare.

2. Methodology

The study was based on cross sectional data collected from cassava processors from Ogun, Ondo and Oyo States in the south-west, Nigeria.

Sample was selected using a multistage sampling technique. The first stage was the purposive selection of the three states because of the preponderance of cassava farms, products and processors in those states. The second stage was the random selection of three local government areas (LGA) per state and the selection of three villages per LGA and finally the random selection of twenty cassava processors per village. The sample size was 540 but only 373 respondents presented analyzable data.

Data were collected with the use of a well structured questionnaire to collect input – output data of the processors. Information was collected on the different types of processing methods used as well as input-output data. The input data include: depreciation, raw material (₦), labour (man – days), operating expenses, energy used

(\mathbb{N}) and some socio – economic characteristics such as age, processing experience, household size and sex.

Analytical Techniques: Descriptive statistics and the stochastic frontier production function analysis were used. The stochastic frontier production function (SFPF) in efficiency studies were employed in this study. In the SFPF, the error term is assumed to have two components parts V and U. The V covers the random effects (random errors) on the production and they are outside the control of the decision unit while the U measures the technical inefficiency effects, which are behavior factors that come under the control of the decision unit. They are controllable errors if efficient management is put in. The stochastic frontier approach is generally preferred for agricultural research for the following reasons. The inherent variability of agricultural productions due to interplay of weather, soil, pests, diseases and environmental failures and many firms are small family-owned enterprises where keeping of accurate records is not always a priority hence available data on production are subject to measurement errors (Ojo and Ajibefun, 2000).

The stochastic frontier production function model is specified as:

$$Y_i = f(X_{ab}) + \varepsilon_i$$

Where, Y is output in a specified unit, X_a denotes the actual input vector, β is the vector of production function parameters and ε_i is the error term that is decomposed into two component parts, V and U. The V is a normal random variable that is independently and identically distributed (iid) with mean zero and constant variance (σ^2). It captures the white noise in the production, which are due to factors that are not within the influence of the producers. It is independent of U. The U is a non-negative one-sided truncation at zero with the normal distribution (Battese and Coelli, 1993). It measures the technical inefficiency relative to the frontier production function, which is attributed to controllable factors (technical inefficiency). It is half normal, identically and independently distributed with zero mean and constant variance. The variances of the random errors (σ_v^2) and that of the technical inefficiency effects (σ_u^2) and overall model variance (σ^2), are related thus:

$\sigma^2 = \sigma_u^2 + \sigma_v^2$ and the ratio: $\gamma = \sigma_u^2 / \sigma^2$ is called gamma. It measures the total variation of output from the frontier, which can be attributed to technical inefficiency (Aigner, et al, 1992).

The Technical Efficiency (TE) of an individual firm is defined in terms of the observed output (Y_i) to the corresponding frontier output (Y^{*}). The Y^{*} is maximum output achievable given the existing technology and assuming 100 % efficiency. It is denoted as:

$$Y_i^* = f(X_i b) + V_i, \text{ that is,}$$

$$TE = Y_i / Y_i^*$$

Also the TE can be estimated by using the expectation of U_i conditioned on the random variable (V-U) as shown by Battese and Coelli (1993), that is

$$TE = \frac{f(X_i b) + V_i - U_i}{f(X_i b) + V_i}$$

And that $0 \leq TE \leq 1$.

Model Specification: For this study, the processing technology of the cassava processors was assumed with a Cobb-Douglas production function of the form:

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} \\ + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + V_i - U_i$$

Where Y = Revenue from processing in naira

X₁ = Depreciation

X₂ = Cost of Raw material

X₃ = Labour (man – days)

X₄ = Operating expenses

X₅ = Energy (naira)

X₆ = Age (years)

The inefficiency model (U_i) is defined by:

$$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i}$$

Where, Z₁, Z₂, Z₃, Z₄ and Z₅ represent; education, experience, ownership, membership of cooperative and source of raw material respectively. These socio – economic variables are included in the model to indicate their possible influence on the technical efficiencies of the cassava processors. The β s, and δ s are scalar parameters to be estimated. The variances of the random errors, σ_v^2 and that of the technical inefficiency effects σ_u^2 and overall variance of the model σ^2 are related thus:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2$$

and the ratio $\gamma = \sigma_u^2 / \sigma^2$, measures the total variation of output from the frontier which can be attributed to technical inefficiency (Battese and Corra, 1977). The estimate for all the parameters of the stochastic frontier production function and the inefficiency model are simultaneously obtained using the program **FRONTIER VERSION 4.1c** (Coelli, 1996).

Also, for this study, two different models were estimated in the final MLE. Model 1 is the traditional response function of OLS in which the inefficiency effects are not present. It is a special form of the stochastic frontier production function model in which the total variation of output due to technical inefficiency is zero that is $\gamma = 0$. Model two is the general model where there is no restriction and thus $\gamma \neq 0$.

3. Results and Discussion

3.1. Summary Statistics of Variables

The summary statistics of variables used in the stochastic frontier production function estimation is presented in Table 1. The study revealed there were 319 processors that used local method (Group A) and 54 processors used modern method (Group B). The study revealed that Group B processor's mean age, labour used, operating expenses, depreciation and cost of energy used were statistically different from that of the Group A processors at 5 percent and that their mean processing experience, cost of raw materials, and Revenue were not statistically significant at 5 percent.

3.2. Stochastic Production Function Analysis

The estimates of the SFPF models are presented in Table 2. The choice of model for further econometric and economic analyses was based on the test for presence of technical inefficiency effects using the generalized likelihood ratio test. The test confirmed that there were technical inefficiency effects in cassava processing using both local and modern methods. This is confirmed by the

gamma coefficients (γ) of the two processing methods' models that were statistically different from zero ($\gamma \neq 0$) as confirmed by the computed test statistic, chi-square (χ^2) that was greater than the tabulated chi square at 5 percent level of significance. Therefore, model 2 was chosen for further econometric and economic analyses.

Table 1. Summary Statistics for Variables

Variables	Local Method		Modern Method	
	Mean	Std dev	Mean	Std dev
Processors	319		54	
Age	42.38	9.30	46.61	9.00
Experience	12.68	8.00	13.05	9.86
Labour (md)	210.45	132.82	311.73	212.93
Raw material (N)	366425.1	238958.00	350222.20	279444.4
Energy (N)	35156.24	27680.03	45804.44	33975.45
Operating Exp	18873.86	10028.38	26555.56	9755.27
Depreciation	2068.89	1189.89	2890.76	1275.21
Revenue	778184.2	1271982.00	939384.4	1036775.00

Table 2. Estimates of the Stochastic Frontier Functions of Local and Modern Methods of Cassava Processing

Variables	Local method		Modern method	
	Model 1	Model 2	Model 1	Model 2
General Model				
Constant	-3.28 (0.77)	-1.89 (0.89)	1.11 (3.13)	0.04 (4.87)
Depreciation	0.04 (0.05)	0.09 (0.06)	0.28 (0.20)	0.26 (0.17)
Raw material	0.95 (0.05)	*0.94 (0.04)	1.09 (0.17)	*1.06 (0.14)
Labour	0.17 (0.05)	*0.18 (0.05)	0.07 (0.16)	0.12 (0.12)
Operating Exp	0.22 (0.04)	*0.19 (0.05)	-0.12 (0.24)	-0.03 (0.23)
Energy	-0.03 (0.03)	-0.03 (0.03)	-0.45 (0.17)	*-0.43 (0.16)
Age	0.39 (0.11)	0.06 (0.12)	0.56 (0.39)	0.76 (0.40)
Inefficiency Model				
Constant	0	0.22 (0.71)	0	-0.01 (3.84)
Education	0	-0.01 (0.01)	0	*0.04 (0.02)
Experience	0	*-0.02 (0.01)	0	0.01 (0.01)
Ownership	0	0.22 (0.71)	0	0.20 (0.32)
Coop member	0	*-0.62 (0.07)	0	0.21 (0.16)
Source Raw material	0	0.04 (0.05)	0	0.03 (0.13)
Variance Parameters				
Sigma squared	0.18	0.16 (0.01)	0.29	0.21 (0.04)
Gamma	0	0.001 (0.001)	0	0.01 (9.5)
Log LF	-171.68	-156.15	-39.08	-34.52
Technical Efficiency				
Mean TE		0.82		0.53
Min. TE		0.65		0.33
Max. TE		1.00		0.73

Figures in parentheses are standard errors, * Estimate is significant at 5% level of significance.

3.3. Productivity Analysis

The estimated coefficients in the general model of model 2 (Table 2) were used for the productivity (resource use efficiency) analysis. The estimated coefficients of the included variables (depreciation, cost of raw materials, labour used, and age of respondents) in the Local method model and (depreciation, cost of raw materials, labour used, operating expenses and age of respondents) in the modern method were positive and each was between zero and unity. This implies a direct relationship between output and each of the variable inputs and that the

allocation of the variable inputs was in the stage of efficient allocation in the production function, except the coefficient of cost of raw material in the modern method that was greater than unity that was in stage one of the stage of positive inefficient allocation of resources. This finding corroborated the a-priori assertion that resources allocation is efficient in small-scale agricultural production in the developing countries (Ojo and Ajibefun 2000). However, the return to scale analysis (Table 3) showed that the return to scale of cassava processing methods was greater than unity for both methods of processing thus implying that cassava processing was in

stage one of the production surface for both methods in the study area and thus a very wide room for improvement.

Table 3. Elasticity of Production and Return to scale

Variable	Elasticity of Production	
	Local method	Modern method
Depreciation	0.09	0.26
Raw material	0.94	1.06
Labour	0.18	0.12
Operating expenses	0.19	-0.03
Energy	-0.03	-0.43
Age	0.06	0.76
RTS	1.43	1.74

3.4. Technical Efficiency Analysis

The TE of the cassava processing under local and modern methods varied significantly between 0.65 and 1.00 with a mean TE of 0.82 for the local processing method. The TE was between 0.33 and 0.73 with a mean of 0.73 for the modern processing method. The study further revealed a significant statistical difference between the TE of the local and modern methods of cassava processing, that is, the processors that used local method were more efficient than those using modern method. The technical inefficiency analysis (Table 2) showed that respondents level of education, experience in cassava processing and cooperative membership led to increase in TE for processors using local method while all the socio economic variables decreased TE for processors using the modern method.

4. Conclusion

The study showed that cassava processing under local and modern methods in the study area was in stage one of the production surface and thus needs more efforts to move to the efficient stage. Also, the study observed that the local method of processing was more technically efficient than the modern method of processing because the processors are yet to understand the technicalities involved with modern machinery used in modern method of processing cassava into its bye products.

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