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Technical Efficiency of Cassava Farmers in South Eastern Nigeria: Stochastic Frontier Approach

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Abstract: This study examined the technical efficiency of cassava farmers in south Eastern Nigeria employing the stochastic frontier production function procedure. Data collected from a random sample of 160 farmers from two states in the region using well-structured questionnaire and interview schedules was used for the study. The result of the study reveals that the technical efficiency of the farmers ranges from 52-95% with a mean of 77%. This indicates ample opportunities for the farmers to increase their productivity through improvements in their technical efficiency. Education, farmers' experience, membership of farmers association, credit, household size, improved cassava variety and farm size were found to be significantly related to technical efficiency while age and extension contact were not significantly related to technical efficiency.

Key words: Technical efficiency, stochastic frontier, extension, productivity

INTRODUCTION

Relative productivity of workers in agriculture has declined as the share of agriculture in Gross Domestic Product (GDP) has steadily gone down, whereas the proportion of labour force dependent on agriculture has not changed much (Chatterjee, 1995). Africa's socio-economic development is mainly agrarian and about 70% of the labour force (and 80% of its poor people) are directly or indirectly engaged in agriculture, live in rural areas and depend on agriculture for their livelihood (NEPAD, 2004). It noted that agriculture still remains the mainstay of the economy of most African states, yet current estimate indicate that some 200 million or 28 % of Africa's population are chronically hungry. According to Olagunju (2005) the agricultural sector is an engine room for sustainable growth of Nigerian economy.

High population growth rate which leads to increase in the demand for agricultural product, natural and human disasters such as drought, floods and land degradation, as well as civil conflicts in some parts of Africa contribute to his alarming situation and accounts for high imports and dependence on food aid by most African countries thereby posing a huge problem of food insecurity (NEPAD, 2004) and poverty. Cassava has been identified as a very powerful poverty fighter by driving down the price of food to millions of consumers. In Nigeria for example, during the diffusion of the IITA's high yielding TMS (Tropic Manioc Selection) cassava varieties from1984-1992, inflation adjusted cassava prices fell sharply by 40% from the price level (NEPAD, 2005). Nigeria is the largest producer of cassava in the world. Its production is currently put at about 34 metric tonnes a year (FAO, 2004). Total harvested area of the crop in 2001 was 3.125 million ha with an average yield of 10.83 t ha^{-1}. It is majorly produce by small-scale farmer in rural communities of the country and is primarily produced for food especially in the form of garri, fufu with little or no use in the agribusiness sector as an industrial raw material. However, the crop can be processed into several secondary products of industrial value such as chips, pellets, flour, adhesives, alcohol and starch, which are essential raw materials in the livestock, feed, alcohol/ethanol, textile, confectionery, wood, food and soft drink industries. They are also equally tradable in the international markets.

Cassava is noted as the cheapest source of calories of all staple food in Africa because it is easy to grow. IITA (2002) noted that cassava is widely grown in Africa by large number of smallholders across several ecological zones because it is a robust crop that can be grown under stress conditions. The Nigerian experience illustrates that measures that will drive down the cost of production, harvesting, processing and marketing will transform cassava to generate income for millions of farmers, processors, traders and industrialists while cutting the price of millions of consumers.

Between 1998 and 2000, more than a quarter of the population of Africa was chronically undernourished (202 million people). In Sub-Saharan Africa, it is expected that the number of undernourished people will increase from 180 million in 195/97 to 184 million by 2015

(Ijeoma, 2004). This stands in sharp contrast to the Millennium Development goals of halving hunger and poverty by 2015. Poverty reduction in Africa will not be possible without rapid agricultural growth. Nigeria spends billions of dollars importing sugar for sort drinks and feed stock (Anuforo, 2005). He noted that this can only change when the country take a revolutionary step at the production of sugar/glucose from cassava. It is against this background that it has become necessary and indeed imperative to assess the efficiency of cassava which provide data for farm planning, policy formulation and implementation and will guide towards the industrialization and commercialization of cassava. This will inter alia reduce the unacceptable level of hunger and poverty particularly in Nigeria and in Africa as a whole.

MATERIALS AND METHODS

Theoretical and analytical framework: Technical efficiency results when maximum output is obtained from a given combination of resources (ability to produce at the production frontier). The production technology of a farm is represented by a stochastic production frontier as:

$$Y_i = f(X_i;\beta_i) \exp(V_i - U_i),\ i = 1,2, \ldots, n \qquad (1)$$

Where,

Y_i = Output of the ith farm.

x_i = Vector of input quantities used by the ith farm.

βi = Vector of unknown parameters to be estimated.

$f(X_i;\beta_i)$ = Production function (Cobb-Douglas, translog, etc.)

V_I = Random error which accounts for the random variations in output by factors which are beyond the control of the farm such as diseases outbreak, weather, measurement errors and is assumed to be independently and identically distributed (V_i~N $[0,\sigma^2_v]$) independent of the U_i.

U_i = Non-negative random variable, associated with technical inefficiency in production and is assumed to be independently and identically distributed as half normal, U_i~ $[N|(0,\sigma^2_u)]$.

The technical efficiency of an individual farmer is defined in terms of the ratio of the observed output to the corresponding frontier output, given the available technology. The technical efficiency:

$$(TE) = Y_i / Y_i^*, = f(X_i;\beta_i) \exp (V_i - U_i), / f(X_i;\beta_i) \exp(V_i) = \mathrm{Exp}(-U_i) \qquad (2)$$

Where,

Y_i = Observed output

Y_i^* = Frontier output

The parameters of the stochastic frontier production function are estimated using the Maximum Likelihood Estimation (MLE) method.

Data and study area: This study was conducted in south Eastern Nigeria. The South Eastern Nigeria comprises of five states; Abia, Anambara, Ebonyi, Enugu and Imo States. Multi-stage sampling technique was adopted in selecting the sample. Two states, Abia and Imo, were randomly selected and from each state, 2 Local Government Areas were randomly selected. Five communities in each Local government were randomly selected and from which 8 cassava farmers each were chosen using simple random sampling procedure. In all, 160 respondents were used for the study. Information on the socio-economic characteristics of the farmers and farm production activities (inputs, outputs and their prices) were collected using well-structured questionnaire and interview schedules. The data relates to the 2005 cropping season.

Empirical model: The Cobb-Douglas frontier production function was used in the study. Taylor and Shinkwiler (1986) noted that as long as interest rests on efficiency measurement and not on the general structure of the production technology, the Cobb-Douglas production function provides an adequate representation of the production technology. It is widely used in farm efficiency analysis both in developing and developed countries (Battese, 1982; Bravo-Ureta and Pinheiro, 1993; Onyenweaku *et al.*, 2004; Onyenweaku and Ohajianya, 2005). The specific model estimated is given by:

$$\mathrm{In}\ Y_i = \beta_0+\beta_1\mathrm{In}X_1+\beta_2\mathrm{In}X_2+\beta_3\mathrm{In}X_3+\beta_4\mathrm{In}X_4+\beta_5\mathrm{In}X_5+V_i-U. \qquad (3)$$

Where:

Y_i = Output of cassava (₦) from the ith farm.

X_1 = Size of cultivated farm land (ha).

X_2 = Labour (mandays).

X_3 = Value of stem cuttings (₦).

X_4 = Fertilizer and other agrochemicals (₦).

X_5 = Capital (₦) and consists of interest on loans, depreciated value of farm assets.

β_0 = Intercept.

β_i = (I = 1,2, ...,5) regression coefficients estimated while V_i and U_i are as defined earlier and In is the natural logarithm.

In order to determine the factors that contributed directly to technical efficiency, the following model was formulated and estimated jointly with the stochastic frontier model in a single stage maximum likelihood estimation procedure using the computer software frontier Version 4.1 (Coelli, 1996):

$$TE = \delta_0+\delta_1 Z_1+\delta_2 Z_2+\delta_3 Z_3+\delta_4 Z_4 +\delta_5 Z_5+\delta_6 Z_6+\delta_7 Z_7+ \delta_8 Z_8 + \delta_9 Z_9 \quad (4)$$

Where:

TE = Technical Efficiency of the ith farmer.
Z_1 = Education level of the farmer.
Z_2 = Age of the farmer (year).
Z_3 = Farming experience (years).
Z_4 = Membership of farmers association (a dummy variable which takes the value of unity if yes and zero if otherwise).
Z_5 = Extension contact (a dummy variable which takes the value of unity if the farmer had contact and zero if otherwise).
Z_6 = Access to credit (which takes the value of unity if yes ad zero if otherwise).
Z_7 = Household size.
Z_8 = Improved cassava variety (which takes unity if used and zero if otherwise).
Z_9 = Farm size (hectares), while δ_0, δ_1, δ_2, δ_3, δ_4, δ_5, δ_6, δ_7, δ_8 and δ_9 are parameters to be estimated.

RESULTS AND DISCUSSION

Table 1 presents the maximum likelihood estimates of the stochastic frontier production function. All the parameter estimates have the desired signs and are all statistically significant. The results are similar to the findings of Bravo-Ureta and Evenson (1994), Onyenweaku *et al.* (2004) and Onyenweaku and Ohajianya (2005). The null hypothesis that gamma (γ) = 0, is rejected at the 5% level of significance confirming that inefficiency and are stochastic. The estimated value of γ is 0.87 which implies that 88% of the total variation in cassava output is due to technical inefficiency.

The distribution of the technical efficiency of the farmers (Table 2) reveals that the technical efficiency indices range from 52-95% for the farms. The average technical efficiency was 77%. The implication is that for the average farmer to achieve the technical efficient of its most efficient counterparts, then that farmer could realize a 19% cost savings (1-77/95). For the most technically inefficient farmer, he has to achieve a 45% cost savings (1-52/95), to become the most efficient farmer.

Table 1: Maximum Likelihood (ML) parameter estimates of the stochastic frontier production function

Variables	Parameter	Coefficient	t-ratio
Intercept	β_0	5.9***	0.177
Farm size (X_1)	β_1	0.56***	0.073
Labour (X_2)	β_2	0.39***	0.040
Cuttings (X_3)	β_3	0.06**	2.146
Fertilizer and other agrochemicals (X_4)	β_4	0.79***	3.531
Capital (X_5)	β_5	0.24***	0.048
Sigma-Squared	δ^2	0.22***	0.044
Gamma	γ	0.87**	0.379
Log likelihood function	μ	-19.40	
LR-Statistic	χ^2	13.38	

Source: Computed from survey data (2005), ***: Significant at 1% (p<0.01), **: Significant at 5% (p<0.05)

Table 2: Distribution of technical efficiency

Efficiency (%)	Technical efficiency
> 95	10
90≤95	3
85≤90	13
80≤85	6
75≤80	16
70≤75	17
65≤70	13
60≤65	6
55≤60	6
50≤55	10
45≤50	0
40≤45	0
35≤40	0
30≤35	0
25≤30	0
≤25	0
Mean (%)	77
Minimum (%)	52
Maximum (%)	95

Source: Computed from survey data (2005)

Table 3: Estimated determinants of technical efficiency

Variables	Parameter	Coefficient	t-ratio
Intercept	δ_0	0.621***	5.132
Education	δ_1	0.002**	2.143
Age	δ_2	0.207	1.489
Farming experience	δ_3	-0.008**	-2.211
Membership of association	δ_4	0.115***	4.002
Extension contact	δ_5	-0.144	-1.356
Credit	δ_6	0.065*	1.880
Household size	δ_7	0.150***	4.595
Improved cassava variety	δ_8	0.012**	2.275
Farm size	δ_9	0.582**	2.623

Source: Computed from survey data (2005), ***: Significant at 1% (p<0.01), **: Significant at 5% (p<0.05), *: Significant at 1% (p<0.10)

The estimated determinants of technical efficiency are summarized and presented in Table 3. Education, farming experience, membership of farmers association, credit, household size, improved cassava variety and farm size are all significant. Education is positively related to technical efficiency implying that farmers with more years of education exhibited higher level of technical efficiency.

This result conforms to the findings of Weir (1999), Weir and Knight (2002), Onyenweaku *et al.* (2004) and Onyenweaku and Ohajianya (2005). Farming experience is negatively related to technical efficiency. This result agrees with those of Onu *et al.* (200) in cotton production in Nigeria but departs markedly with those of Onyenweaku *et al.* (2004) and Onyenweaku and Ohajianya (2005) who found appositive relationship between farming experience and technical efficiency in yam production and rice production, respectively.

Membership of farmers association is positively and significantly related to technical efficiency. This is consistent with that of Gover (1984), Okike (2000) and Onyenweaku and Ohajianya (2005). Specifically, Gover (1984) noted that farmers that are members of association can be very valuable for small-scale operations because it facilitates access to markets and increases income and employment. In addition it provides them with a secure market for their crops as well as some technical assistance: Source of farmers' efficiency. Credit is positively and significantly related to technical efficiency. The result is consistent with Lingard *et al.* (1983) in Phillippines, Bravo-Ureta and Evension (1994) in Eastern Paraguay Onyenweaku *et al.* (2004) in Northern Nigeria and Onyenweaku and Ohajianya (2005). The importance of credit in agricultural productivity can not be over-emphasized. It increases the ability off poor household with little or no savings to acquire inputs. Delgado (1995) and Zeller *et al.* (1997a, b) noted that easing capital constraints through the granting of credit reduces the opportunity cost of capital-intensive assets relative to family labour, thus encouraging adoption of labour-saving, high yielding technologies and therefore increasing land and labour productivity, a crucial factor in encouraging development, particularly in most African countries.

Household size is positively related to technical efficiency. This implies that household labour has the potential of enhancing productivity and efficiency of resource use in production. The larger the household size, the better. Improved cassava variety is significantly and positively relate to technical efficiency. This result agrees with Hussain (1989). Improved cassava varieties are high yielding, early maturing and disease resistant and thus enhance the productivity and efficiency of the farmers. Farm size is positively and significantly related to technical efficiency. This result is consistent with Onyenweaku *et al.* (2004), Onyenweaku and Ohajianya (2005) but differs from Bravo-Ureta and Evension (1994), Bravo-Ureta and Pinheiro (1997).

Age is positive but not significantly related to technical efficiency. Extension contact is negative and also not significant. This agrees with Feder *et al.* (2004). Although agricultural extension an farmer education programmes are important to improving productivity, they are being hampered by bureaucratic inefficiency and some generic weaknesses inherent in public operated, staff intensive information delivery systems leading to their poor performance.

CONCLUSION

The result of the study, reveals that the technical efficiency of farmers ranges from 52-95% with a mean technical efficiency of 77%. This implies that ample opportunities exist for the farmers to enhance their productivity and income through more efficient resource utilization. The result also reveals that education, farming experience, membership of farmers association, household size, credit, improved cassava varieties and farm size are important factors contributing to technical efficiency. Farmers with higher educational attainment, that belong to farmers association, have access to credit, larger household size, uses improved variety and with larger farm land tends to be more efficient. Farming experience and extension contact have a negative influence on technical efficiency.

Therefore, policies that will enable the farmers to improve on their education, grant them increased access to credit, improved cassava variety and farm size should be vigorously pursued. They are important for increasing the farmers' efficiency and income.

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