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Technical Efficiency of Poultry Egg Producers in Oyo State of Nigeria

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Abstract: The study analyzed the Technical Efficiency (TE) of poultry egg producers in Oyo state of Nigeria using a Cobb-Douglas stochastic production frontier function. The data for the study were collected using structured questionnaire administered on random samples of 51 poultry egg producers. The results showed that, the TE of farmers varied between 0.10 and 0.99 with a mean of 0.823. About 90% of the farmers surveyed had technical efficiency score of >0.70. The analysis showed that stock of birds is the most important determinant of poultry egg production while years of experience, management system, educational level and family size are the socioeconomic characteristic influencing the farmers' technical efficiency. The findings show that further productivity gains linked to the improvement in TE may still be realized in poultry egg production in Nigeria.

Key words: Technical efficiency, stochastic frontiers, poultry egg, Oyo state Nigeria, JEL classification: Q13, Q18, C21, R30

INTRODUCTION

Modern commercial poultry egg production started in Nigeria in the early 1960s. Ever since, it has assumed relatively important position in the Nation's livestock economy. Nutritionally, eating an egg per day is a good way of putting proteins, fats, vitamins and minerals in human diet. Egg contains not only a trace of carbohydrate, but it was also adjudged to be a replacement for meat as it contains all essential amino acids, in adequate proportion required by the body for general body growth and repair. It is also a source of vitamin A, which protects against night blindness and prevents skin infections. Other vitamins such as B1, B2 and D with minerals such as Ca, Fe and P are all present in poultry egg. Hence, it is suitable for complementing carbohydrate in diets (Adetimirin, 2000). It also serves as a source of income to the poultry egg producers and major ingredients in some food industries such as the confectionaries and cocoa powder (Adetimirin, 2000).

The enterprise, perhaps because of its importance and relatively low start-up capital, compare to other livestock, has attracted the attention of Nigerian governments. In the 1960's, Nigerian government were supplying poultry egg productivity-increasing inputs at subsidized rates to farmers. The largesse was stopped in 1986 following the introduction of Structural Adjustment Programme (SAP) policy. The aftermath has been a sharp increase in the cost of inputs needed for poultry egg production. The farmers are therefore required to be resource efficient under the supervision of the ADP extension officers. Although, many studies have been carried out on poultry egg production in Nigeria (Tonye *et al.*, 1997; Akinwumi *et al.*, 1979; Omotosho and Ladele, 1988) studies in Oyo state are rare. The objective of this study therefore is to provide empirical information on the farm level technical efficiency of poultry egg producers in Oyo state of Nigeria, using the stochastic frontier analytical approach with a view of deriving policy implications for proper policy recommendations.

MATERIALS AND METHODS

The study area: Data for this study were collected from a cross-sectional survey of poultry egg farms in Oyo state, Nigeria. It is located in the southwestern part of the country. Oyo state covers approximately a land area of 28, 584 square kilometers and a population of 5,591,589 (Wikipedia, 2008). It lies between latitude 2°38[1] and 4°35[1] east of the Greenwich meridian. The major occupation in the state is agriculture and it is suited for the cultivation of export crops such as cocoa, cashew, palm tree. Arable crops, such as maize, yam, cassava, millet and rice are also cultivated. Other occupations include trading, hunting and civil service. The climate is tropical with distinct dry and wet seasons with relatively high humidity. The dry season lasts from November to March while the wet season starts April and ends in October. The annual mean rainfall is 300 mm. Average daily temperature ranges between 25 and 35°C almost through out the year.

Data collection: The data for this study were primary data collected from 51 poultry producers selected from two ADP zones (Ibadan/Ibarapa and Oyo) with the highest concentration of poultry producers in the state. The sampling method used for this research is multistage sampling technique. The first stage, involved a purposive sampling of the 2 ADP zones based on the population of poultry egg producers, size and availability of market for the poultry products. The second stage involved a simple random selection of 51 poultry egg producers from the list of membership of commercial egg producers association of Nigeria (CEPAN). Data were collected with the use of a structured questionnaire, which was designed to collect information on egg output, inputs, inputs prices and prices of outputs and some major socio economic characteristics of the respondents in the study area. Information was collected on stock of birds, feed intake (in kilogramme) labour used, cost of veterinary services, number of eggs produced and socio-economic characteristics of respondents such as years of experience, management techniques, educational status and family size of the respondents.

Analytical techniques: The data obtained were analyzed using both descriptive and inferential statistics. Means, standards deviations, percentages and frequencies were used in analyzing the socioeconomic characteristics of the farmers, input and output variables and the distribution of technical efficiency levels. A stochastic production frontier function that incorporated inefficiency factors was estimated using Maximum Likelihood Estimate (MLE) technique to obtain farm specific technical efficiencies as well as their determinants. A generalized likelihood ratio test was carried out, to ascertain whether the poultry egg producers were fully technically efficient.

Model specification: The stochastic production frontier function was specified as

$$Y = f(X_1, a)\exp(e_i) \quad (1)$$

Where,

Y = egg output in ith farm (measured in physical terms of number of eggs).

X_i = Vector of inputs used by the ith farmer.

α_i = vector of unknown parameters.

e_i = V_i - U_i (Composite error term).

Where,

V_i = Random variable assumed to be independently distributed N(0,1) and independent of u_i.

U_i = Random variable that accounts for technical inefficiency and assumed to be independently distributed as truncation of the normal distribution with mean μ and variance, $\sigma^2 = \sigma^2_u$ $(N(\mu_i, \sigma^2_u)^2$

$$\mu = AK \quad (2)$$

Where,

A = I × e Vector of farm/farmers characteristics that may cause inefficiency.

K = e × I Vector of unknown parameter to be estimated.

The farm level stochastic production frontier functions that represents the maximum output possible (Y*) can then be represented as:

$$Y^* = f(X; a)\exp(V_i) \quad (3)$$

Where,

Y* = The frontier output.

Using Eq. 3 to rewrite Eq. 1 we with have

$$Y = Y^* \exp(U) \quad (4)$$

Therefore, technical efficiency of an individual farmer can be obtained as:

$$TE = \frac{f(X_i, a_i)\exp(V_i - U_i)}{f(X_i, a_i)\exp(V_i)}$$

$$TE = \frac{Y}{Y^*} \quad (5)$$

That is the difference between observed output (Y) and frontier output (Y*) is embedded in U_i when U = 0, then production is in the frontier (i.e., Y = Y*) and the farmer is technically efficient. However, if U >0, the farmer is inefficient since production will lie below the frontier (Idiong, 2006). The Maximum Likelihood Estimates (MLEs) of the parameters of the model and the technical efficiency predicted were obtained using the computer programme Frontier 4.1 developed by Coelli (1994).

The variance parameters σ^2_u and σ^2_v are expressed as

$$\sigma^2 = \sigma^2_u + \sigma^2_v \quad (6)$$

$$D = \sigma^2_u / \sigma^2_v \quad (7)$$

Where, D ranged from 0 - 1. When D = 1, it indicates that all deviations are due to technical inefficiency (Idiong, 2006). As shown by Idiong (2006) a Cobb-Douglas production function, was fitted to the stochastic frontier function and estimated. The Cobb-Douglas functional form has, been consistently used in related efficiency studies (Xu and Jeffrey, 1995). A more flexible form such as translog production function might be used also. However, functional forms have been shown to have limited effect on empirical efficiency measurement (Belbase and Grabowski, 1995).

The specified production functions was

$$\ln Y = \ln a_0 + a_1 \ln X_1 + a_2 \ln X_2 + a_3 \ln X_3 + a_4 \ln X_4 + e_i \quad (8)$$

Where,

Y = Number of eggs.

X_1 = Labour (man-days).

X_2 = Feed (kg).
X_3 = Stock of birds.
X_4 = Veterinary costs (Naira).
In = Natural logarithm.
α_i = Parameters to be estimated.

Where,
I = 0 - 4.
e = Composite error term defined as V -U in Eq. 1.

Some farmers' characteristics were incorporated into the frontier function, as it is believed that they have direct influence on efficiency.
The efficiency function in specified as

$$R = b_0 + b_1Z_1 + b_2Z_2 + b_3Z_3 + b_4Z_4 + e \quad (9)$$

Where,
R = Technical inefficiency.
Z_1 = Years of experience.
Z_2 = Management system.
Z_3 = Educational status.
Z_4 = Family size.

RESULTS AND DISCUSSION

Descriptive statistics: The summary of the descriptive statistics for egg production is presented in Table 1. The result indicated that the mean egg production in the study area is 355284 egg which is about 11, 843 trays of eggs. This also translates to, about 226 eggs/bird/year (about 93% of expected yearly output). The mean number of stock of birds kept by the producers was 1571. This implies that the average egg production in the state was largely in the medium scale category given the classification of Omotosho and Ladele (1988). Their classification showed that small-scale poultry farm contains <1000 birds medium scale farms had between 1000 to <5000 birds and large-scale poultry farms starts from 5000 birds. The average feed used by the farmers in the study area was 58845.42 kg while the cost of veterinary service on the average stands at about N145, 198:00K ($1230.50) throughout the production season. The average labour use was 392.47 man-days. An average poultry farm owner in the study area has just spent about 2 years in the business with an average family size of about 7 persons. Although, the respondents' large household size is above the recommended average of 4 per family in Nigeria (Sonaiya, 2000) the large family size is relevant to poultry production because family labour constitutes the buck of labour supply in poultry production in Nigeria. The result also shows that an average farm owner in the study area is well educated.

Table 1: Summary of descriptive statistics of poultry egg production in Oyo state

Input variables	Mean	N	Min.	Max.
Labour (man-days)	392.47	51	23	5160
Feed (kg)	58845.42	51	4200	383000
Stock of birds	1571	51	150	10000
Cost of veterinary service($)	1251	51	40.1	8879.3
Eggs output	355284	51	12000	2250000
Management technique	1	51	0	1
Deep litter = 0				
Battery cage = 1				
Educational level	4	51	2	4
No formal education = 1				
Primary education = 2				
Polytechnic = 3				
University = 4				
Years of experience	2	51	1	6
Family size	6.37	51	1	12

Source: Data analysis

Likelihood estimates, partial elasticities and return to scale: The result of the maximum likelihood estimate of stochastic frontier production function in Oyo state is presented in Table 2. The result showed that, the value of the generalized likelihood-ratio statistics was 23.03. This value exceeds the critical chi-square value of 20.74 at 5% significant level. Thus, the Cobb- Douglas functional form is an adequate representation of the data. The value of the gamma (γ) statistics was 0.855. This implies that 85.5% of the changes in egg output are attributable to inefficiency factors. It also confirms the presence of the one sided error component in the model; this rendering the use of ordinary least squares (OLS) estimation techniques inadequate in representing the data. The sigma square (σ^2) on the other hand was 0.643 and significant, indicating the correctness of the specified assumption of the distribution of the composite error term.

The coefficient of the stock of bird is 0.671 and it is significant at 1% level. The result shows that farms can still increase their egg production substantially by increasing their stock of birds. The quantity of feed used

Table 2: Maximum likelihood estimates Maximum Likelihood Estimates (MLE) of the stochastic production frontier function

Variable	Coefficient	T-ratio
Constant	5.5479	7.5568
Labour	0.106	1.186
Feed	0.150	1.744*
Stock of birds	0.671	6.477***
Cost of veterinary service	0.021	0.246
RTS	0.948	
Diagnostic statistics		
Gamma (γ)	0.855	12.01
Sigma square, (σ^2)	0.643	4.236
Log likelihood function	-23.03	
LR Test	20.74	

NB*** indicates significant at 1% level, *indicate significant 10% level in feeding the birds has a coefficient of 0.150 and it is statistically significant at 10% level. The positive and significant sign of the coefficient is in line with the findings of Oji and Chukwumah (2007). This result indicates that, the higher the feed intake, the greater the TE of the farmers. Feed intakes have a constant marginal efficiency until a maximum egg output per hen is attained (Olayide and Heady, 1982). With constant feed-egg transformation rate, the limit of hen's capacity to produce eggs lies in its ability to assimilate feed. Cost of veterinary service has an elasticity value of 0.021. The variable, is however not significant statistically. Ojo (2003) also obtained an insignificant value for the parameter of operating costs, of which cost of medication is an important part. The value of the coefficient of labour is also positive at 0.106 but not significant. The return to scale RTS is 0.948 indicating a positive return to scale and that egg production was in stage II of production region.

Determinants of technical efficiency: The MLE result of the determinants of the TE of the egg producers are presented in Table 3. All the variables have the expected negative sign. Educational status of the respondents has a coefficient of -1.391 and it is significant at 10%. This implies that as the education level of the respondent increases, the technical inefficiency decreases. This is because education aids in the adoption and use of improved technological innovations. This result is in line with the ones obtained by Weir (1999) and Oji and Chukwumah (2007). The coefficient of family size is -0.143 and it is significant at 10%. Family labour is a good way of providing labour for the farm. Hence, we expect the productivity of egg producers to increase with the availability of labour (family). The management system adopted by the farms has expected negative coefficient of -2.633, but it is not significant statistically. This implies that, poultry birds will do well in the study area whether they are managed under the deep litter or battery cage system. Years of farming, experience has a negative but insignificant coefficient of -0.484. This implies that years of farming experience is not a major determinant of TE among the poultry producers in the study area. This could be understood if we consider the fact that an average farmer from our table 1 has just spend about 2 years in the business which might not be enough to have master the enterprise considering its risky nature.

Technical efficiency indices: The frequency distribution of the TE of the respondents is shown in Table 4. The result shows that 56.86% of the respondents have efficiency class of between 0.81-0.90, while 17.65% have efficiency class of between 0.91-1.00; this suggests that about 74.51% of the poultry farms in the study area are operating close to the frontier. The mean technical efficiency of the farms is 0.823 indicating substantial efficiencies in poultry egg production. This signifies that there exists 17.7% potential for poultry farms to increase their production vis-à-vis their income at the existing level of technology. The foregoing also means that by being efficient, poultry farms in the study area can increase their production by 17.7% at the current level of technology and resources.

Table 3: Determinants of The technical efficiency

Variable	Coefficient	T-ratio
Constant	4.502	1.684
Year of experience	-0. 484	-1.322
Management system	-2.633	-1.472
Family size	-0.143	-1.848*
Educational status	-1.391	-1.963*

NB * indicates significant at 10% level

Table 4: Distribution of technical efficiency of poultry egg producers on Oyo state

Technical efficiency class	No of farmers	Percentage
<0.50	1.000	1.96
0.51- 0.60	1.000	1.96
0.61- 0.70	3.000	5.88
0.71- 0.80	8.000	15.69
0.81- 0.90	29.00	56.86
0.91- 1.00	9.000	17.65
Total	51.00	100.00
Mean	0.823	
Minimum	0.107	
Maximum	0.945	

Conclusion: The study observed that the technical efficiency of farms varied due to the presence of technical inefficiency effects in the poultry egg industry in Oyo state of Nigeria. Educational level and family size increases the technical efficiency of the respondents significantly farms should therefore pay close attention to these factors and always harness them towards increasing them technical efficiency. Increasing the stock of birds and feeding these with quality feed *ad-libitum* will also help move the technical efficiency of the poultry farmers in the study area towards the frontier.

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