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Productivity and Technical Efficiency of Poultry Egg Production in Nigeria

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Abstract: The study examined the Productivity and Technical Efficiency of Poultry egg production in Nigeria using the stochastic frontier production function analysis. Primary data were collected using a set of structured questionnaire from two hundred poultry egg farmers who were selected using multi stage sampling techniques, from five Local Government Areas (LGA) of Osun state, Nigeria. Results showed that poultry egg production was in the rational stage of production (stage II) as depicted by the Returns to Scale (RTS) of 0.771. The variables of interest, stock of birds, operating costs, and other costs were effectively allocated and used, as confirmed by each variable having estimated coefficient value between zero and unity. The Technical Efficiencies of the farmers varied widely between 0.239 and 0.933 with a mean of 0.763 and about seventy nine percent of the farmers had T.E. exceeding 0.70. This study further observed that only location of farm (nearness to urban centre) positively affected T.E while increase in the other socio-economic variables, age, experience and education led to decrease in T.E.

Key words: Productivity, technical efficiency, stochastic frontier production, Nigeria

Introduction

In Nigeria, the production of food has not increased at the rate that can meet the increasing population. While food production increases at the rate of 2.5%. Food demand increases at a rate of more than 3.5% due to the high rate of population growth of 2.83% (FOS, 1996). The apparent disparity between the rate of food production and demand for food in Nigeria has led to:

i a food demand supply gap thus leading to a widening gap between domestic food and total food requirement
ii an increasing resort to food importation
iii high rates of increase in food prices.

As a result of the above, widespread hunger and malnutrition are evident in the country.

Apart from Nigeria's agriculture not meeting up in its food production to meet the food requirement of the increasing population (FMAWRRD, 1988), its greatest problem is that of inadequate animal protein in the diets of a large proportion of the population especially in the rural areas which constitute over 70% of the Nigerian population. Animal protein is essential in human nutrition because of its biological significance. In realization of the importance of animal protein the various governments in Nigeria have been pursuing programmes at national, state and community levels to boost the mass production of livestock products, to ensure the attainment of Food and Agriculture Organization (FAO) recommendation of thirty-five grams per caput of animal protein per day. Some of these programmes include the farm settlement scheme, Agricultural Development Project (ADP), Better life Programme, Micro credit scheme for livestock production and lately, the United Nation Development Programme (UNDP) is sponsoring the establishment of livestock parent/foundation stock at community level in Nigeria with the following objectives:

* To train farmers on improved livestock breeds for the gradual upgrading of local breeds.
* To train farmers on improved and modern rearing and production methods of livestock.
* To increase the production of livestock products and consequently farmers income.

Poultry production is an example of such community level livestock programmes. Poultry keeping has the following advantages over other live stocks:

* Poultry birds are good converters of feed into useable protein in meat and eggs.
* The production cost per unit is low relative to other types of livestock and the return to investment is high, thus farmers need just a small amount of capital to start a poultry farm.
* Poultry meat is very tender. So its palatability and acceptability to consumers are very high.
* It has a short production cycle (pay back period) through which capital is not tied down over a long period.
* Egg, which is one of the major products of poultry production, is one of the most nutritious and complete foods known to man. Chicken egg protein has biological value of 1.0 and so shares with human protein the distinction of being a perfect protein (Orji *et al.*, 1981).
* Egg is more easily affordable by the common man than other sources of animal protein. An average boiled egg costs about N15 (O.11 US dollars), hence boiled eggs are being sold (hawked) freely at motor parks, railway stations, market places, roadsides and schools in Nigeria.

Of recent, there has been a recorded improvement in poultry production sub sector in Nigeria with its share of the Gross Domestic product (GDP) increasing in absolute terms. Poultry Eggs and meat contribution of the livestock share of the GDP increased from 26% in 1995 to 27% in 1999 (CBN, 1999). This significant improvement in poultry production has been sustained by availability and use of improved vaccines, which curtailed mortality rates in birds, reduction in the tariff on imported day old chicks and parent stock (CBN, 1999), and the relative ease of compounding efficient feed using easily available local feedstuffs (Ojo and Afolabi, 2000).

This improvement could further be sustained with a proper analysis of the productivity of factors involved in the production process of poultry products as well as the factors affecting the technical efficiency of the poultry farmers. This paper therefore analyses the productivity and technical efficiency of poultry egg production in Nigeria with a view to identifying the importance of each factor and detecting if there is presence of technical inefficiency in the production process of poultry egg production.

Analytical framework: The stochastic frontier production function in efficiency studies is employed in this study. The modeling, estimation and application of stochastic frontier production functions to economic analysis assumed prominence in econometrics and applied economic analysis during the last two decades. Early applications of stochastic frontier production function to economic analysis include those of Aigner *et al*. (1977) in which they applied the stochastic frontier production function in the analysis of the U.S agricultural data. Battese and Corra (1977) applied the technique to the pastoral zone of Eastern Australia. And more recently, empirical applications of the technique in efficiency analysis have been reported by Battese *et al*. (1993); Ajibefun and Abdulkadri (1999); Ojo and Ajibefun (2000). The stochastic frontier production function model is specified as follows:

$$\ln Y_1 = \ln \beta_0 + \sum \beta_j \ln X_{ji} + V_i - U_1$$

Where Y is output in a specified unit, X_j denotes the actual vector; β_j is the vector of production function parameters.

The frontier production function F (X_j β_j) is a measure of maximum potential output for any particular input vector X_j. The V_i and U_i cause actual production to deviate from this frontier. The V_i is the systematic component, which captures the random variation in output, which are due to the factors that are not within the influence of the producers (e.g. temperature, moisture, natural hazards). The V_i is assumed to be independently, identically distributed with zero mean and constant variance ($0, \sigma_v^2$) and independent of U_i. The U_i is a non-negative term representing the deviations from 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. N ($0, \sigma_u^2$)The stochastic frontier production function model is established using the maximum likelihood estimation procedure (MLE) - a maximization technique (Olowofeso and Ajibefun, 1999). The technical efficiency is empirically measured by decomposing the deviation into a random component (V) and an inefficiency component (U). The Technical efficiency of an individual firm is defined in terms of the observed output (Yi) to the corresponding frontier output (Yi*) given the available technology, that is,

$$TE = Yi/Yi^*$$

$$TE = \frac{\ln \beta_0 + \sum \beta_j \ln X_{ji} + V_i - U_i}{\ln \beta_0 + \sum \beta_j \ln X_{ji} + V_i}$$

So that, $= 0 \leq TE \leq 1$

Materials and Methods

Study Area: The data used in this study were collected from a cross-sectional survey of poultry egg farmers in Osun State, Nigeria. The State is one of the 36 States in Nigeria. It is located in the south western part of the country. The state has a land area of 8802 squared kilometers and a population of 2.2 million (FOS, 1996). The State is agrarian, and well suited for the production of permanent crops such as cocoa and oil palm and arable crops (maize, yam and cassava) because of favourable climatic conditions. The annual rainfall is between 1000mm and 1500mm with high daily temperature of about 30 ^{0}C The people are predominantly peasant farmers cultivating food and cash crops. They also embark on small, medium and large-scale livestock production such as rearing of goats, sheep, pigs, rabbits and poultry as well as marketing of their products. The people live mostly in organized settlements, towns and cities. The important towns and cities are Osogbo (the state capital), Ilesa, Ile- Ife, Ede and Ikirun.

Data Collection: The data for this study were primary data collected from 200 poultry farmers selected from five Local Government Areas (Osogbo, Ede, Ife central, Ikirun and Ilesa) of Osun State, Nigeria. The sampling method used was multistage sampling technique. The first stage involved a purposively sampling of the five local government areas based on the population of poultry farmers, size and availability of market for the poultry products. Osogbo, Ilesa and Ife central are more densely populated than Ede and Ikirun LGA. The second stage involved a simple random selection of 40 respondent farmers from each local government area. Data were collected with the use of a structured questionnaire designed to collect information on output, inputs, prices of outputs and inputs, and some major

Table 1: Summary Statistics of Variables of Poultry Egg Farms in Nigeria

Variable	Mean	Standard deviation
Value of egg (₦)	6263105.90	10577404.45
Stock of birds (₦)	2746	4058
Feed Consumed (kg)	974559.99	149806.64
Operating expenses ₦	321672.81	515070.59
Other Costs ₦	14413.07	26004.55
Experience (years)	9.67	10.23
Years of schooling	15.56	4.28
Age of farmers (yrs)	45.14	10.94

socio-economic characteristics of the farmers in the study area.

Information was collected on the following key economic and socio-economic variables.

Value of output: This was obtained by adding cash receipts from the sale of eggs produced and value of eggs consumed by the farmers' households with those given out as gifts.

Inputs: Inputs were categorized into four groups: stock of birds (farm size), feed intake (kilogram), operating expenses (Naira) and other cost (depreciation values on the farm implements).

Socio economic characteristics: These variables include age of farmers (years), experience of farmers in poultry production (years), years of schooling of farmers and location of farm (dummied as urban = 1, rural area = 0). The socio-economic variables were considered to see their influence on the estimated technical efficiencies of the poultry farmers.

Method of Analysis: Descriptive statistics (mean, standard deviation) and stochastic frontier production function were used to analyze the socio-economic characteristics, productivity and Technical Efficiency respectively. The production technology of the farmers was assumed to be specified by the Cobb - Douglas frontier production function (Tadesse and Krishnamoorthy, 1997), which is defined by

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

Where

Y = Value of eggs produced per annum(naira)
X_1 = Stock of birds (number)
X_2 = Feed Intake (kg)
X_3 = Operating expenses (Costs) of labor, drugs and transportation) in naira
X_4 = Other cost (depreciation costs) in naira
V_i = Random errors as previously defined.
U_i = Technical inefficiency effects as previously defined.

The Technical inefficiency effects U_i is defined by

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

Where: Z_1, Z_2, Z_3, and Z_4 represent, years of experience, years of schooling, age of farmers and location of farm respectively. These are included in the model to indicate their possible influence on the technical efficiencies of the farmers.

The βs, δs 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 estimates for all the parameters of the stochastic frontier production function and the Inefficiency model are simultaneously obtained using the program frontier version 4.1 (Coelli, 1994).

For this study, two different models were estimated.

Model 1 is the traditional response function in which the inefficiency effects are not present. It is a special case of the stochastic frontier production function model in which the total variation of output from the frontier output due to technical inefficiency is zero, that is, $\gamma = 0$.

Model 2 is the general model where there is no restriction and thus $\gamma \neq 0$.

The two models were compared for the presence of technical inefficiency effects using the generalized likelihood ratio test which is defined by the test statistic, Chi-square (X^2)

$X^2 = -2 \ln \{H_o/H_a\}$

Where, X^2 has a mixed chi - square distribution with the degree of freedom equal to the number of parameters excluded in the unrestricted model. H_o is the null hypothesis that $\gamma = 0$. It is given as the value of the likelihood function for the frontier model and Ha is the alternative hypothesis that $\gamma \neq 0$ for the general frontier model.

Results and Discussion

Summary statistics: Table 1 presents the summary statistics of variables for the frontier estimation. The mean value of eggs produced was ₦6263105.9 per farmer which when compared with a mean total cost of ₦2,158,162.53 showed that egg production was very profitable in the study area. This was further confirmed by a net returns of ₦1498.88 per bird.

The mean farm size (stock of birds) was 2746 birds with a standard deviation of 4058 birds. This shows that egg production was in the medium scale category in the study area. This agreed with the classification of Omostosho and Ladele (1988), which classified small scale poultry farm as having up to 1000 birds, medium scale farm has between 1001 to 4999 birds and large scale farm has above 5000 birds. The study revealed that about 61% of the poultry farmers were in the categories of medium and large-scale ventures Feed consumption constituted the major components of poultry production cost in the study area. It represented

Table 2: Maximum Likelihood Estimates of the Stochastic Frontier Production Function for Poultry Egg Production in Nigeria

Variable	Parameter	Model 1	Model 2
General model			
Constant	β_0	4.051	3.819
		(6.592)	(8.77)
Stock of birds	β_1	*0.569	*0.525
		(2.87)	(3.18)
Feed Consumed	β_2	-0.084	-0.091
		(-1.25)	(-0.56)
Operating expenses	β_3	0.166	0.242
		(1.92)	(1.51)
Other costs	β_4	0.113	0.095
		(1.09)	(1.16)
Inefficiency model			
Constant	δ_0	0	-3.68
			(-0.56)
Experience	δ_1	0	0.02
			(0.22)
Years of schooling			
Age of farmers	δ_2	0	0.31
			(0.40)
	δ_3	0	0.01
Location of farmers			
	δ_4	0	-0.34
Sigma squared	σ^2		(-0.44)
Gamma	γ	0.382	0.55
Log likelihood	Llf	*0.60	*0.83
function		-60.005	-56.82

Figure in parentheses are t-ratios. *Estimate is significant at 5% level of significance.

about 80% of production cost. The commercial poultry farmers were experienced with about 9.67 years experience. They were well educated with about 15.56 years in school. This accounted for the high standard of management of the existing poultry farms and thus the large profit from the enterprise. The farmers were relatively young with mean age of about 45 years with 11 years standard deviation.

The location of farm distribution showed that about 67% of the farms were located in urban centres where market for eggs is readily available due to the large population of enlightened people who see eggs in their diet as a necessity and not a luxury.

Estimates of the stochastic frontier production function parameters: The Maximum likelihood estimates of the stochastic frontier production function for poultry egg production in Nigeria are presented in Table 2. There were presence of technical inefficiency effects in egg production in the study as confirmed by a test of hypothesis for the presence of inefficiency effects using the generalized likelihood ratio test. The chi-square computed is 6.364 while the critical value of the chi-square at 95% confidence level and 6 degree of freedom, X^2 (0.95,6) = 1.635. The null hypothesis of no inefficiency effects in egg production, $\gamma = 0$, was strongly rejected. Thus model I was not an adequate representation of the data, hence model 2 was the preferred model for further econometric and economic analyses. The estimated gamma parameter (γ) of model 2 of 0.83 indicates that about 83% of the variation in egg output among the farmers was due differences in their technical efficiencies.

The estimated elasticities of the explanatory variables of the general model (Table 3) shows that stock of birds, operating expenses and other costs were positive decreasing functions to the factors, indicating the variables allocation and use were in the stage of economic relevance of the production function (stage II). The elasticity of feed consumed was negative decreasing function to the factor indicating over use and in stage III. This was due to the *ad-libitum* mode of feeding poultry. The return to scale (RTS) was 0.771 indicating a positive decreasing return to scale and that egg production was in stage II of the production region. The productivity of the factors could be improved by expanding the farm size at the existing level of feeding so that the variable of feed consumed could move from stage III to stage II of the production surface.

Table 3: Elasticity of Production and Returns to Scale (RTS)

Variable	Elasticities
Stock of birds	0.525
Feed consumed	-0.091
Operating Expenses	0.242
Other costs	0.095
RTS	0.771

Table 4: Decile Range of Frequency Distribution of T.E. of Poultry Egg Farmers

Decile Range of T.E.	Frequency	%
0.20 - 0.29	1	0.5
0.30 - 0.39	1	0.5
0.40 - 0.49	5	2.5
0.50 - 0.59	14	7.0
0.60 - 0.69	21	10.5
0.70 - 0.79	65	32.5
0.80 - 0.89	84	42.0
0.90 - 0.99	9	4.5

Technical Efficiency Analysis: The predicted farm specific technical efficiencies (T.E.) ranged between 0.239 and 0.933, with a mean of 0.763. Thus, in the short run, there is a scope for increasing egg production by about 23.7% by adopting the technology and techniques used by the best-practiced poultry farms. One of such measures is addressing the issue of negative elasticity of feed consumed.

The decile range of the frequency distribution of the TE is presented in Table 4. It shows that about 79% of the farmers had TE exceeding 0.70 and about 21% had TE ranging between 0.239 to 0.69.

Technical Inefficiency Analysis: The analysis of the inefficiency model (Table 3) shows that the signs and significance of the estimated coefficients in the inefficiency model have important implications on the TE of the farmers. The coefficients of years of school, age and experience of farmers were positive, indicating that these factors led to increase in technical inefficiency or decrease in T.E. of poultry egg production in the study area. The priori expectation is that T.E. should increase with increase in years of schooling and experience since education and experience are expected to be positively correlated to adoption of improved technology and techniques of production (Ojo and Ajibefun, 2000). This result may be due to the fact that the more educated and experienced the farmers, the less time they had for efficient supervision of their farms because of their involvement in other societal activities such as politics and other occupations as a way of diversification. Educated Nigerian farmers are involved in other enterprises and occupations due to the unhealthy state of Nigerian economy.

Age contributed positively to inefficiency because the older the farmer the less efficient supervision-wise.

However the coefficient of location of the poultry farm is negative implying that technical efficiency increases the nearer the farm is to the urban centres where the population is large and effective demand for eggs is assured. The T.E. for rural areas decreases due to sparse population and relatively low demand for eggs as a result of low-income base of people in the rural areas and presence of substitutes for animal protein in their diets. The rural people have access to bush meat such as grass cutter, rodents, rats, snails, fish and even crabs. Thus, the study observed that the nearer the poultry farm to urban centre the higher the T.E.

Conclusion and Recommendation: The study observed that T.E. of poultry egg farmers varied due to the presence of technical inefficiency effects in poultry egg production in Nigeria. The variables of years of schooling, experience and age of the poultry farmers decrease the farmers T.E. while the location of the poultry farms increases the farmers T.E.

Farmers should therefore be encouraged to have more time to supervise their poultry farms to improve on their T.E. while adequate enlightenment programmes on the benefit of egg consumption should be introduced to the rural areas to stimulate the consumption of eggs.

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