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Profit Efficiency among Nigerian Poultry Egg Farmers: A Case Study of Aiyedoto Farm Settlement, Nigeria

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Abstract: Production inefficiency is usually analysed by its two components- technical and allocative efficiencies. This study provided a direct measure of production efficiency of the Nigerian poultry egg farmers using a stochastic profit frontier and inefficiency model. The primary data collected, using a structured questionnaire, includes four conventional inputs and socio-economic factors affecting production. The result showed that Profit efficiencies of the sampled farmers varied widely between 29.1% and 99.3% with a mean of 84% suggesting that an estimated 16% of the profit is lost due to a combination of both technical and allocative inefficiencies in the poultry egg production. The mean profit inefficiency decreased over time. Study further observed that only level of education positively influenced profit efficiency while on the contrary access to credit led to a decrease in profit efficiency. This implies that profit inefficiency in poultry egg production can be reduced significantly with improvement in the level of education of sampled farmers.

Key words: Profit, efficiency, poultry egg, farmers, socio-economic factors

INTRODUCTION

Agriculture plays an important role in the economic development of Nigeria. It provides food for the growing population, employment for over 65 percent of the population, raw materials for industries and foreign exchange earnings for the government[3]. Agriculture has the potential to improve the Nigeria economy, if well harnessed. This will depend, to a large extent, on the encouragement given to the agricultural sector. While the Nigeria population growth rate is about 3.5 percent per annum, the rate of increase in food production is only about 2.5 percent per annum[2]. There is also apparent disparity between the rate of food production and demand for food in Nigeria[15]. One of the greatest problems of Agriculture in Nigeria is the inability to produce required amount of animal protein in the diets of the populace especially those in the rural areas who constitute about 70 percent of the population[15]. Animal protein is an essential part of human nutrition because of its biological significance. Animal proteins are more “biologically complete” than vegetable proteins with regards to their amino acid composition[9]. Of all the livestock produced in Nigeria, poultry can go a long way to reduce effectively the inadequacy of animal protein in the diets of Nigerians because

- There are no geographical restrictions to its production.
- The meat is tender and has a high palatability.
- The egg is a complete protein with excellent quality. It has the highest biological value for any single food protein[9].
- The egg is easily affordable by the common man than other sources of protein[15].

The egg industry is the main livestock industry in the southwestern region of Nigeria. Apart from providing employment and a livelihood to thousands of people, it also provides a remarkably high quality nutritious food. The egg is a complete protein with excellent quality; one egg will give 6g of protein. Egg-white protein has a biological value of 100, the highest biological value of any single food protein[9].

Table 1: Output of Eggs Produced

Year	Output (Metric tonnes)
1997	246,564
1998	369,764
1999	383,844
2000	352,016
2001	387,374
2002	396,331

Source: FAO 2004

Egg has a number of uses apart from domestic consumption in households. It is used in confectionaries, bakeries, making of ice cream and cosmetics; the eggshell is a good source of calcium.

Despite the growth in the egg production industry since year 2000 in Nigeria (see Table 1), local demand has not been matched by local supply. Egg imports totaled 730 million in 2000, which was down slightly from 732 million eggs imported in 1999[12].

The objective of this study is to estimate economic efficiency of poultry farmers in Aiyedoto farm settlement in Lagos state, Nigeria.

This study analyses the profit efficiency among sampled poultry farmers and identifies farm-specific characteristics that explain variation in efficiency.

The hypotheses are:

- The farmer’s egg production decisions are consistent with profit maximization.
- Profit inefficiency differs across households and it is related to farmers’ socio-economic characteristics.

The measurement of efficiency remains an important area of research both in developing and developed countries. The measurement of efficiency goes a long way

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to determine profitability of an enterprise and agricultural growth is linked to profit[1]. The relationships between efficiency, market indicators and the household characteristics have not been well studied in Nigeria. An understanding of these relationships could provide the policy makers with information to design programmes that can contribute to measures needed to expand the food production potential of the country[16] and better measures that can enhance agricultural efficiency can be implemented. The significance of such policies in the face of increasing competition between domestic and imported agricultural products cannot be overemphasised[1].

The measurement of efficiency has received considerable mention in economic literature. Farrell (1957) defines efficiency as the ability to produce a given level of output at a lower cost. This traditional definition of efficiency as defined by Farrell has three components: technical, allocative and economic. Technical efficiency is defined as the ability to achieve a higher level of output, given similar levels of inputs. Allocative efficiency deals with the extent to which farmers make efficient decisions by using inputs up to the level at which their marginal contribution to production value is equal to the factor cost. Technical and allocative efficiencies are components of economic efficiency. It is possible for a firm to exhibit either technical or allocative efficiency without having economic efficiency. Therefore, both technical and allocative efficiencies are necessary conditions for economic efficiency. Economic efficiency is equal to the product of technical and allocative efficiencies. According to Farrell (1957), technical efficiency is associated with the ability to produce on the frontier isoquant, while allocative efficiency refers to the ability to produce at a given level of output using the cost-minimizing input ratios. Alternatively, technical inefficiency is related to deviations from the frontier isoquant and allocative inefficiency reflects deviations from the minimum cost input ratios. Thus, economic efficiency is also defined as the capacity of a firm to produce a predetermined quantity of output at minimum cost for a given level of technology.

Production functions have traditionally been used to examine efficiency of farmers in Africa[8]. Studies conducted by Ojo[15] and Ajibefun and Daramola,[4] on egg production in Nigeria utilized this traditional approach. Ojo[15] estimated the productivity and technical efficiency of egg production among 200 poultry farmers in Osun State, Nigeria and found that egg production was in the rational stage of production (stage II) as depicted by the Returns to Scale of 0.771. Technical efficiencies of the farms varied widely between 23.9% and 93.3% with a mean of 76.3% and about 79% of the farmers had Technical efficiency exceeding 70%. He further observed that only location of farm (nearness to urban center) positively affected Technical efficiency. Ajibefun and Daramola[4] used a stochastic frontier production function to determine the sources of technical inefficiency in poultry egg production amongst farmers in Ondo State, Nigeria. Their results indicated that the technical efficiency varied widely across farms, ranging between 49% and 85%. However production function approach fails to capture inefficiencies associated with different factor endowments and different input and output prices across farms. Under such conditions, farms may exhibit different 'best–practice' production functions and operate at different optimal points. Lau and Yotopoulos[13] popularized the use of the profit function approach in which farm specific prices and levels of fixed factors are incorporated in the analysis of economic efficiency. When input and output prices are exogenous to farm household decision making, they can be used to explain input used and output supplied[1].

MATERIALS AND METHODS

This survey was carried out in Ojo Local Government Area, Lagos State. Lagos is one of the 36 states of the Federal Republic Nigeria. It is situated in the South West of the country. Lagos state has twenty local government areas of which Ojo Local Government is the most populous. According to the 1991 census figures, Ojo Local Government contained 17.8% of Lagos state's population,

The survey was carried out during the months of November 2004 and June 2005. Data were collected from sampled poultry farmers in the Aiyedoto farm settlement in Ojo local government area.

The Aiyedoto farm settlement is run as a government outfit. It was created in 1980 by the state government and handed over to the farmers who now operate the farm settlement as a cooperative society although it is still under the supervision of the state government.

There were 87 farmers on the settlement all of which were livestock farmers; 74 of them were poultry farmers, out of this, 70 were into egg production while the remaining 4 raised cockerels, pullets and broilers.

The sampling technique used was multistage. The first stage involved purposively selecting Ojo Local Government based on the fact that it has a farm settlement (Aiyedoto farm settlement) located in it. The Aiyedoto farm settlement was chosen due to the large number of egg poultry farms present therein. The second stage involved purposively selecting egg poultry farms in the farm settlement. The third stage involved a random selection of forty nine from a population of seventy egg poultry farmers. The data used in the survey were obtained from the selected farmers through repeated visits to the farmers using a structured questionnaire. Data were collected on socio-economic characteristics of the respondents and on prices and quantities of inputs and output.

The Stochastic Profit Frontier Function: Production inefficiency is usually analysed by its two components – technical and allocative efficiency. Recent developments combine both measures into one system, which enables more efficient estimates to be obtained by simultaneous estimation of the system[19]. The popular approach to measure efficiency – the technical efficiency component – is the use of frontier production function[17,18]. However, it has been argued that a production function approach to measure efficiency may not be appropriate when farmers face different prices and have different factor endowments[6]. This led to the application of stochastic profit function models to estimate farm specific efficiency directly[6,19].

The profit function approach combines the concepts of technical and allocative efficiency in the profit relationship and any errors in the production decision are assumed to be translated into lower profits or revenue for the producer[5].

Profit efficiency, therefore, is defined as the ability of a farm to achieve highest possible profit given the prices and levels of fixed factors of that farm and profit inefficiency in this context is defined as loss of profit for not operating on the frontier[6].

Battese and Coelli[7] extended the stochastic production frontier model by suggesting that the inefficiency effects can be expressed as a linear function of explanatory variables, reflecting farm-specific characteristics. The advantage of this model is that it allows the estimation of farm specific efficiency scores and the factors explaining the efficiency differentials among farmers in a single stage estimation procedure. Following Rahman[16], this study utilises the Battese and Coelli[7] model by postulating a profit function, which is assumed to behave in a manner consistent with the stochastic frontier concept. The stochastic profit function is defined as

$$\pi_j = f(P_{ij}, z_{kj}).\ \mathrm{Exp}\ e_j \tag{1}$$

π_j = normalized profit of the jth farm and it is computed as gross revenue less variable cost divided by the farm specific output price P.

Pij is the price of *j*th variable input faced by the *i*th farm divided by output price;

Zik is level of the *k*th fixed factor on the *i*th farm;
e_i is an error term;
and $i = 1, \ldots, n$, is the number of farms in the sample. The error term e_i is assumed to behave in a manner consistent with the frontier concept[6], i.e.,

$$e_i = v_i - u_i \tag{2}$$

v_i is the symmetric error term and it is assumed that it is an independently and identically distributed two sided error term representing the random effects, measurement errors, omitted explanatory variables and statistical noise.

u_i is the one sided error term. It is a non-negative one-sided error term representing the inefficiency of the farm. Thus it represents the profit shortfall from its maximum possible value that will be given by the stochastic profit frontier.

In the inefficiency effects model, the u_i terms in equation (2) are assumed to be a function of a set of non-negative random variables that reflect the efficiency of the farm. They are assumed to be independently distributed, such that efficiency measures are obtained by truncation of the normal distribution with mean, $\mu = \delta_o + \Sigma_d \delta_d Z_{dj}$ and variance $ó_\mu^2$ where Z_{di} is the *d*th explanatory variable associated with inefficiencies on farm *i* and σ_o and σ_i and are the unknown parameters.

The profit efficiency of the farm *i* in the context of the stochastic frontier profit function is defined as

$$\mathrm{EFF}_i = E\left[\exp(-u_i) \mid e_i\right] = E\left[\exp\left(-\delta_o - \sum_{d=1}^{D} \delta_d Z_{di}\right) \mid e_i\right] \tag{3}$$

Where, *E* is the expectation operator. The method of maximum likelihood is used to estimate the unknown parameters, with the stochastic frontier and the inefficiency effects functions estimated simultaneously. The likelihood function is expressed in term of the variance parameters, $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$ [7].

Empirical Specification: The functional form of the stochastic profit frontier was determined by testing the adequacy of the Cobb-Douglas (which is usually fitted and highly restrictive) to the less restrictive translog. Thus, the frontier models estimated are defined as:

$$y_i = \beta_0 + \sum_{i=1} \beta_i x_i + v_i - u_i \tag{4}$$

and

$$y_i = \beta_o + \sum_{i=1}^{4} \beta_i x_i + \sum_{i=1}^{4} \sum_{i=1}^{4} \beta_{ij} xx_{ji} + v_i - u_i \tag{5}$$

Where

$$u_i = \delta_o + \sum_{d=1d}^{D} \delta_d Z_{di} + e_i \tag{6}$$

In these equations,

- y = Normalized profit (gross margin)
- X_1 = normalized wage rate.
- X_2 = normalized feed cost per kg.
- X_3 = Farm size (heads of adult layers).
- X_4 = Drugs.
- u_i = Farmer specific characteristics related to production efficiency.
- v_i = Statistical disturbance term.

$$u_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 \tag{7}$$

where

- Z_1 = Age of farmer (years)
- Z_2 = Formal education, measured in years
- Z_3 = Status of farmer (1 – full time, 0 – part time)
- Z_4 = Household size
- Z_5 = Off farm income (1 – off farm income, 0 – otherwise)
- Z_6 = Access to credit (1 – access, 0 – no access)
- Z_7 = Experience in egg production, measured in years.

β_o, β_i, δ_o, δ_i are the parameters to be estimated.

Age of the farmer is an important factor in agriculture. It determines the level of active involvement on the individual's farm; it affects human physical energy which is required in traditional farming activities. As a result, the age of an individual may affect the level of efficiency at farm level. The level of education of farmers also influences efficiency in agricultural production in terms of quality and quantity as well as the speed at which farmers adopt new technology and rationalize input to enhance output. Education represents human capital and it is hypothesized to have a positive impact on efficiency[14].

Table 2: Description of quantitative variables

	Minimum	Maximum	Mean	Standard Deviation
Gross Margin per	(1153.33)	129746.67	53850.93	32446.10
Price per crate	307.20	388.92	325.93	15.75
Wage	11.46	47.62	27.89	8.48
Feed cost	32.00	2363.67	81.03	329.40
Farm Size	150.00	2500.00	1089.60	535.91
Drugs	8870.00	68430.00	17557.20	8563.40
Age	23.00	56.00	37.82	8.30
Education	12.00	18.00	15.42	1.40
Household Size	1.00	10.00	5.28	1.82
Experience	2.00	19.00	5.80	3.43

Experience has a positive influence on efficiency with farmers having more experience expected to have highest profit efficiency. The expectation of farmers who have off farm employment will be that of reduced efficiency, this is not always the case and as noted by Huffman[11], "increased non-farm work reduces financial constraints, particularly for resource-poor farmers and thus enables them to purchase productivity enhancing inputs". Access to credit provides the farmer with a means of expanding and improving his farm. It also determines the ease with which he adopts new practices and technologies in his enterprise. Hence, lack of credit facility will have a negative effect on profit efficiency. Wozniak[20] corroborates this fact by reporting that, "Credit, therefore, increases the net revenue obtained from fixed inputs, market conditions and individual characteristics, while credit constraint decreases the efficiency of farmers by limiting the adoption of high-yielding varieties and the acquisition of information needed for increased productivity."

The maximum likelihood estimates of the parameters in the Cobb-Douglas and translog stochastic frontier production function models defined by (4) and (5) respectively, given the specification for the technical inefficiency effects defined in (6), were obtained using FRONTIER 4.1. The unknown parameters of the stochastic frontier and inefficiency effects are estimated simultaneously.

Hypothesis tests based on the generalized Likelihood Ratio (LR) test was conducted to select the lead functional form.

The Likelihood Ratio test was carried out using the following formula:

$$\lambda = -2(l_R - l_U) \qquad (8)$$

Where, l_R = log likelihood of the restricted equation (Cobb-Douglas model)

l_U = log likelihood of the unrestricted equation (Translog model)

but λ has a χ^2 distribution with h degrees of freedom.

h is the number of restrictions in this case the number of restrictions imposed on the Cobb-Douglas model.

The null hypothesis is that the Cobb-Douglas is an adequate representation of the data. The LR test indicates that the null hypothesis could not be rejected because the value of λ is less than the critical value of χ^2 at the 0.05 level of significance with 10 degrees of freedom. This means that the Cobb-Douglas form fits these data better.

Table 2 presents the description of the quantitative variables included in both profit and inefficiency functions.

RESULTS AND DISCUSSIONS

MLE Values for Stochastic Function Profit Frontier: The profit function maximum likelihood estimates in Table 3 below, show the relative importance of the variable inputs in egg production. The coefficients of the variables X_1, X_2, X_3 and X_4 are interpreted as the elasticities of the variables. All the coefficients are correctly signed. The elasticity estimates of wage rate, farm size and the cost of drugs are statistically significant at 5%, 1% and 10% levels respectively; while the estimate of feed cost is not significant at all conventional levels. The farm size (X_3) with a coefficient of 0.85 appears to be the most important variable determining profit efficiency. This means that for a 10% increase in the farm size, the profit obtainable from egg production will increase by 8.5%. The estimated coefficients for mean profit with respect to wages (X_1), feed cost (X_2) and drug cost (X_4) are -0.582, -0.261 and – 0.220 respectively. This also implies that a 10% increase in the wages, feed cost and cost of drugs will result in a decrease in profit of 5.82, 2.61 and 2.20 percent, respectively.

Inefficiency Function: The parameter estimates of the relationship between profit inefficiency and farm household characteristics, which are defined by equation (7), are shown under the inefficiency function section of Table3. This section explains the relationship between farmer specific factors and their effects on inefficiency. The results show that the level of education measured in years and farmer's access to credit have a significant impact on profit inefficiency. The negative and significant coefficient of education variable indicates that higher levels of education reduce profit inefficiency. This finding is consistent with the review of Lockheed *et al.*,[14]. It is also in line with the findings of Abdulai and Huffman[1] and Ali and Flinn[6].

Table 3: Maximum Likelihood Estimates (MLE) of Stochastic Frontier Profit Function

Variable	Parameter	Coefficient	t-ratio
Constant	β_0 (intercept)	1.8528	1.203
Wage rate (X_1)	β_1	-0.5822	-2.272**
Feed cost (X_2)	β_2	-0.2612	-1.060
Farm size (X_3)	β_3	0.8547	6.977***
Drugs (X_4)	β_4	-0.2200	-1.585*
Inefficiency Function			
Variable	Parameter	Coefficient	t-ratio
Intercept	δ_0	0.1974	0.230
Age	δ_1	-0.0093	-0.847
Education in years	δ_2	-0.0985	-2.291**
Status	δ_3	0.0374	0.646
House-hold size	δ_4	0.1972	0.321
Non farm activities	δ_5	0.0002	0.0003
Access to Credit	δ_6	0.7522	3.629***
Experience	δ_7	0.0009	0.053
Diagnosis Statistics			
Sigma-square ($\sigma^2 = \sigma_v^2 + \sigma_u^2$)	σ^2	0.149	4.541***
Gamma ($\gamma = \sigma_u^2 / \sigma_u^2 + \sigma_v^2$)	γ	0.026	0.147
Log likelihood		-22.776	
LR Test		15.62	
Average Efficiency		0.843	

* Significant at 10% level** Significant at 5% level *** Significant at 1% level.

Source: Data Analysis

Note: A negative sign of the parameters in the inefficiency function means that the associated variable has a positive effect on the economic efficiency and vice versa.

Table 4: Frequency Distribution of Farmer-Specific Profit Efficiency Estimates

Efficiency estimate (%)	Frequency	Percent	Cumulative Percent
0 < 29.99	2	4.1	4.1
30 < 39.99	0	0.0	4.1
40 < 49.99	2	4.1	8.2
50 < 59.99	1	2.0	10.2
60 < 69.99	4	8.2	18.4
70 < 79.99	3	6.1	24.5
80 < 89.99	13	26.5	51.0
90 < 100	24	49.0	100.0
Total	49	100	

Source: Field Survey, 2005

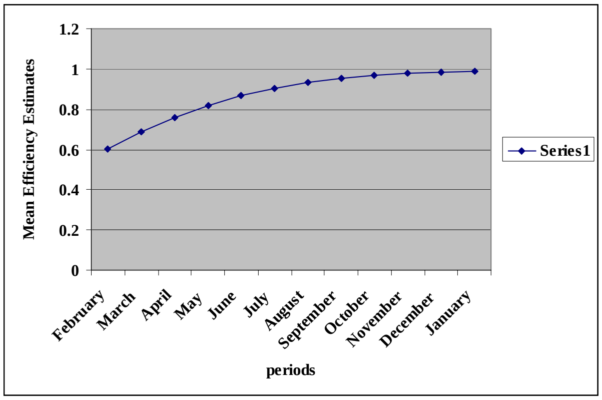

Fig. 1: Line Graph of Mean Profit Efficiency Estimates vs. Time Periods for Aiyedoto Farm Settlement

A positive and statistically significant relationship is also found between access to credit and profit inefficiency. This indicates that farmers who have access to credit tend to exhibit higher levels of profit inefficiency. This is against the *a priori* expectation and it might be as a result of credit received being misused (or diverted to other uses).

Table 4 shows that farm profit efficiencies vary widely from a minimum of 29.11% to a maximum of 99.27%. The average efficiency estimate is 84.34% and this suggests that, on the average, about 15.66% of the profit is lost to economic inefficiency. This value of 15.66% represents the gap that can be made up by the farmers if they improve their technical and allocative efficiencies.

Relationship between Mean Profit Efficiency of Farmers and Time Periods: Figure 1 depicts the trend in the mean profit efficiency of sampled farms over twelve months. The figure illustrates the relationship between mean profit efficiency and time. It shows an increasing trend in profit efficiency over time. This implies that the mean profit moves closer to the frontier with time. This could be as a result of an increase in efficiency of layer birds as from point of lay.

Conclusions: The study used stochastic profit frontier function to analyse the efficiency of sampled poultry egg farmers in Nigeria. Using detailed survey data obtained from 49 poultry egg farms, the study showed that profit inefficiency varied widely among sampled farmers. It ranged from 29% to 99% with a mean of 84%. The mean level of efficiency indicates that there exists some room to increase profits by improving technical and allocative efficiency. The decrease in profit inefficiency observed over time is perhaps due to the expected increase in technical efficiency of layer birds from the point of lay until the peak is reached. The farm-specific variables used to explain inefficiency indicate that those farmers who have higher level of education tend to be more efficient while those who have access to credit tend to be less efficient. The policy implication of these findings is that inefficiency in poultry egg production can be reduced significantly by improving the level of education among the farmers.

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