Saliu et al.: Nigerian Journal of Agricultural Economics (NJAE). Volume 6(1), 2015: Pages 40-52

Production Efficiency of Poultry Egg (Layer) Production in Chikun and Igabi Local Government Areas of Kaduna State, Nigeria.

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Abstract
This study examined production efficiency of poultry egg production in Chikun and Igabi LGAs of Kaduna State, Nigeria. Multi-stage sampling procedure was adopted to select 49 poultry egg producers through the use of structured questionnaire. A Stochastic frontier production functions was used to analyse the technical efficiency (TE), allocative efficiency (AE) and economic efficiency (EE) of egg farmers. The results of the maximum likelihood estimate (MLE) of the stochastic frontier production showed poultry egg farmers recorded technical efficiency of 54%, allocative efficiency of 52% and economic efficiency of 34%. Flock size ($p < 0.05$) and drug ($p < 0.10$) significantly influenced poultry egg production while labour, dosage of vaccine and feed were not significant. However, all these variables were significant at ($p<0.01$) in allocative efficiency model. For the inefficiency model, the result also revealed that educational level ($p<0.01$), household size ($p<0.01$) and main occupation ($p<0.01$) were the socio-economic and institutional factors that significantly increased technical efficiency while farming experience ($p<0.01$) increased technical inefficiency. The return to scale was 1.18 (increasing returns to scale). The low AE and EE in poultry egg production can be attributed to the inflexible responses of poultry farmers to changes in market prices or to their applying inputs mainly on experience. The study recommended among others that poultry farmer in the study area should create better market information systems for efficient input procurement and output disposal.

Keywords: Production efficiency, Stochastic production frontier, Poultry egg production, Return to scale, Kaduna.

Introduction

Poultry refers to all birds of economic value to man as source of meat, egg and fibre (such as feathers which can be used in making pillows, mattresses, shuttle cork (bridle) for badminton (Saliu, 2013). The types of poultry that are commonly reared in Nigeria are chickens, ducks, guinea fowls, turkeys, pigeons and more recently ostriches and Japanese quail. Those that are of commercial or economic importance given the predominant trade or operation is poultry (such as chickens, guinea fowls and turkeys, amongst which the chickens predominate (Laseinde, 2000)). However, egg production involves the use of layer birds for the table egg production (Ogunlade and Adebayo, 2009).

Farm production efficiency is the ability of a farm to produce a given level of output with the lowest amount of resources. The efficient method of producing a product is the one which uses the least amount of resources to get a given amount of output. Efficient farms make better use of existing resources to produce maximum output or incur the lowest cost, thus, achieving the food security objective. There are six features of efficient farm: zero waste, least cost, minimum risk, maximum output, best quality produce and maximum profit (Rahman, 2013). But Khai and Yabe, (2011) observed that productive efficiency refers to the amount of possible output gain without any additional inputs or new technologies. The measurement of efficiency is to determine output gain because this improves the performance of agricultural production with available technologies. In the short-term, improvement in agricultural production with pre-existing technologies is better than the implementation of new technologies.

Component of production efficiency: Three types of efficiency according to Battese and Coelli (1995) are technical, allocative and economic efficiencies. Technical efficiency is defined as the producers, ability to avoid waste during production. Measuring technical efficiency means to use inputs and output quantity without introducing their price, allocative efficiency is determined by the combination of inputs and output in the optimum level in terms of considering market prices and economic efficiency is a product of technical and allocative efficiencies. This indicates that cost per unit of resources efficiency (Khai and Yabe, 2011).

Research Problem

Ali (2002), observed that Nigeria's poultry production is expanding but not keeping pace with rapidly increasing domestic consumption requirements. The domestic demand according to Adene and Oguntade, (2006) are 88million broilers and 30million layers to produce 170, 000 metric tonnes of meat and 350, 000 metric of eggs per annum. But annual production is estimated by the Federal ministry of Agriculture at around 93million per annum. Therefore, the domestic supply shortfall is estimated at 25, 000 metric tonnes per annum. This Scenario implies that egg production have to be increased to a sustainable level.

The crux of the problem of growth in agriculture in developing countries is how to increase output per unit input. One way of approaching the problem of increasing production is to examine how efficient the farmers are using their resources, if resources use is inefficient, production can be increased by making adjustment in the use of factors of production in optimal direction. In case it is efficient, the only way for increasing production would be the adoption of modern inputs and improved technology of production (Olasunkanmi *et al*, 2006). To increase egg production in Nigeria, the present level of productivity and technical efficiency in the poultry industry should be examined for the purpose of improvement. It is for this reason that this research tried to address the following research questions as to whether production resources used in poultry egg production efficiently utilized and what are the factors that influence technical efficiency in poultry egg production in the study area?

Therefore, economics study that will assist poultry egg producers to get the most appropriate information on how to allocate and utilize resources for their production to meet local demands and if possible have surplus for export to earn the country the much needed foreign exchange, is highly indispensable.

Methodology

The Study Area**:** The study was conducted in Kaduna State, Nigeria. Kaduna state is located at the centre of Northern Guinea savannah as shown in figure 3. It lies between latitudes $9^{0.}10^{1}$**-**$11^{0}30^{1}$ North and longitude 6^{0}-$9^{0.}$ 10^{1} East. It has a total area of about 67,000 square kilometres (KADP, 2007) with a population of 6,066,562 people comprising of 3, 112, 028 males and 2, 954, 534 females (NPC, 2006). The total arable land of the state is estimated to be about 2,148,700 hectares. There are two distinct climatic seasons in the state, namely wet and dry seasons. The wet season spans the period between April/May to September/October while the dry season spans the period between October/November to March/April. The average annual rainfall in the state is about 1,482.99mm. The highest mean temperature occurs between the month of March to May and the range is between 35^0c to 36^0c. The minimum air temperature is usually recorded during the harmattan period which occurs between Novembers to February with the range between 18^0c to 23^0c. The total annual evapo- transpiration rate varies from 1.560mm in the north to 1.490mm in the south (KADP, 2007). The state shares boundaries with Niger State to the west, Zamfara, Katsina and Kano states to the north, Bauchi and Plateau States to the east and FCT Abuja and Nassarawa state to the south. The state consists of 23 local government areas. Agriculture is the main stay of the economy of Kaduna state with about 80% of the people actively engaged in farming (KADP, 2007). The people engaged in such activities such as crop and livestock production and poultry keeping as well as marketing of their products.

Sampling Procedure and Sample Size**:** A Multistage sampling procedure was adopted. The first stage involved the selection two Agricultural Development programme (ADP) zones (that is, Lere and B/Gwari) out of four (4) ADP zones in Kaduna State. These zones were purposively selected based on high concentration of poultry farms. The second stage also, involved a purposive selection of one Local Government Area each. (Igabi LGA from Lere zone and Chikun LGA from B/Gwari zone) were chosen based on high concentration of poultry farms in the areas as contained ADP, (2007) report. The third stage involved a purposive selection of five villages in both of the two selected Local Government Areas of the state. These are Kakau, Sabo Gaya, and Sabo Tasha villages from Chikun LGA while Mando and Gidan Dogo villages were selected from Igabi LGA based on high concentration of poultry farms in the area. The fourth stage involved selection of 49 poultry egg farmers through the simple random selection procedure, using sampling frame (list of egg producing farmers) consisting 194 poultry egg farmers representing 25% of the population by the use of random digits (numbers). The total number of poultry egg farmers selected according to LGA are: 12 poultry egg farmers from Kakau, 10 from Sabo Gaya, 10 Sabo Tasha (in Chikun LGA) while 10 poultry egg farmers were selected from Gidan Dogo and 7 from Mando (in Igba LGA). The difference in sample size between the two LGAs is because of the unequal population of poultry farmers in the two LGAs.

Source and Types of Data Collected**:** The data used for this study were collected from primary source. The data were collected using structured questionnaire through interview scheduled with a trained enumerator. Data were collected on output, inputs, prices of outputs and inputs, some major socio-economic characteristics and constraints faced by the farmers in the study area, among others.

Method of Data Analysis: Stochastic production frontier function was used to analyse data collected.

Stochastic Production Efficiency

A number of empirical studies (Battese and Coelli,1995) have estimated stochastic frontiers and predicted firm-level efficiencies using these estimated functions, and then regressed the predicted efficiencies upon firm-specific variables (such as managerial experience, ownership characteristics, etc) in an attempt to identify some of the reasons for differences in predicted efficiencies between firms in an industry. The Battese and Coelli (1995) model specification may be expressed as:

$Y_{it} = x_{it}\beta + (V_{it} - U_{it})$ .... (1)

Where;

,$i = 1,...,N$
Y_i = Production (or the logarithm of the production) of the i-th firm;
x_i = $k\times1$ vector of (transformations of the) input quantities of the i-th firm;
β = Vector of unknown parameters;
V_i = Random variables which are assumed to be $N(0,\sigma v^2)$, and independent of the
U_{it} which are non-negative random variables which are assumed to account for technical inefficiency in production and are assumed to be independently distributed as truncations at zero of the $N(m_{it},\sigma_U{}^2)$ distribution; where:

$m_{it} = z_{it}\delta$, ...(2)

Where;

z_{it} is a $p\times1$ vector of variables which may influence the efficiency of a firm; and
δ is an $1\times p$ vector of parameters to be estimated.

Cost Functions

All of the above specifications have been expressed in terms of a production function, with the U_i interpreted as technical inefficiency effects, which cause the firm to operate below the stochastic production frontier. If we wish to specify a stochastic frontier cost function, we simply alter the error term specification from $(V_i - U_i)$ to $(V_i + U_i)$. For example, this substitution would transform the production function defined by (1) into the cost function:

$Y_i = x_i\beta + (V_i + U_i)$.. (3)

Where;

$i=1,...,N$,
Y_i is the (logarithm of the) cost of production of the i-th firm;
x_i is a $k\times1$ vector of (transformations of the) input prices and output of the i-th firm;
β is an vector of unknown parameters;
V_i are random variables which are assumed to be $N(0,\sigma v^2)$, and independent of the
U_i which are non-negative random variables which are assumed to account for the cost of inefficiency in production, which are often assumed to be $[N(0,\sigma_U{}^2)]$.

In this cost function the U_i now defines how far the firm operates above the cost frontier. If allocative efficiency is assumed, the U_i is closely related to the cost of technical inefficiency. If this assumption is not made, the interpretation of the U_i in a cost function is less clear, with both technical and allocative inefficiencies possibly involved.

Stochastic production frontier function for poultry egg production
The dependent variable; egg outputs in crates was specified as a function of five independent variables (that is, flock size, labour, vaccine, drug/vitamin and feed). The stochastic production frontier for poultry egg production can be written as:

$$\ln Y_i = \ln\beta_o + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + V_i - U_i \quad (4)$$

Where;

Subscript i refer to the i^{th} farmer in the sample.

In denoting the natural logarithm (base e):

Y	=	Quantity of eggs produced per production cycle (number of crates)
X_i	=	Flock size (unit numbers)
X_2	=	Labour (man-day)
X_3	=	Dosage of Vaccine in ₦
X_4	=	Quantity of Drug/Vitamin in ₦
X_5	=	Quantity of feed in (Kg)
β's	=	Vector of unknown parameters
V_i	=	Random error
U_1	=	Technical inefficiency effects, that is what is left for farmer to do to reach the outer bound production frontier.

The inefficiency function is specified as:

$$U = \delta_o + \delta_1 z_{1i} + \delta_2 z_{2i} + \delta_3 z_{3i} + \delta_4 z_{4i} + \delta_5 z_{5i} + e \quad (5)$$

Where;

U	=	Inefficiency
z_1	=	Age of farmers (Year)
Z_2	=	Education level (Dummy variable)
Z_3	=	Years of experience (Year)
Z_4	=	Household size (Unit number)
Z_5	=	Main occupation (Dummy variable)
δ's	=	Vector of parameters to be estimated

Stochastic cost frontier function for poultry egg production: The cost frontier is based on the duality of the production frontier and estimated for calculating *allocative efficiency* to capture a farmer's ability to apply the inputs in optimal proportions with respective price (Khai and Yabi, 2011). The function includes independent variables that are the price of inputs for poultry egg production (P_{xik}) and the total poultry egg output $\ln(Y_i^*)$ that is adjusted for any statistical noise. The model is specified as:

$$\ln(C_i) = \sigma_o + \sigma_1 \ln P_{X1i} + \sigma_2 \ln P_{X2i} + \sigma_3 \ln P_{X3i} + \sigma_4 \ln P_{X4i} + \sigma_5 \ln P_{X5i} + \gamma \ln(Y_i^*) + \varepsilon_i \quad (6)$$

Where;

C_i	=	Minimum cost of poultry egg production per farm in ₦;
P_{x1i}	=	Cost of flock size in ₦/number;
P_{x2i}	=	Cost of labour in ₦/man-day;
P_{x3i}	=	Cost vaccine of a in ₦/dose;
P_{x4i}	=	Cost of drug/vitamin in ₦/g;
P_{x5i}	=	Cost of feed in ₦/Kg; and
$\ln(Y_i^*)$	=	Poultry egg output adjusted for any statistical noise.

ε_i = Composite error term; and
σs = Parameters to be estimated.

Economic efficiency for poultry egg production: Lastly, economic efficiency is the multiplication of technical efficiency and allocative efficiency. It was estimated using the following equation:

$EE_i = TE_i * AE_i$ .... (7)

Where:
EE = Economic efficiency;
TE = Technical efficiency; and
AE = Allocative efficiency.

Elasticity and Returns to Scale
In Cobb-Douglas equations, the regression coefficients are the elasticities of the dependent variables with respect to the independent variables with which the coefficients are associated (Olayemi, 1998). This was used to determine elasticity values.

Results and Discussion

Estimates of Parameters of the Stochastic Production Frontier Function.
The maximum likelihood parameter estimate (MLE) of the stochastic production frontier model, which were specified as Cobb Douglas frontier production function for poultry egg producers are presented in Table1.

The estimated sigma squared (σ^2) for the poultry egg producers was 0.075 and significant different from zero at 1% (0.01) level. This value is large and significantly different from zero. This indicates a good fit of the model and the correctness of the specified distributional assumption. The significant value of the sigma squared σ^2 shows the presence of inefficiency effects in poultry egg production. The estimated gamma (γ) parameter of the poultry egg producers is 0.99 and significant at 1%. This can be interpreted to mean that the differences between actual (observed) and frontier output are dominated by technical inefficiency. The results suggest that about 99% of the variation in poultry egg output among the poultry egg farmers in the study area was due to the differences in their technical efficiencies while only 1% would be due to random effects. This result is consistent with the findings of Ajibefun *et al* (2002), Ajibefun and Aderirola (2004) and Olasunkanmi *et al*; (2006).

Table 1 reveals that, the significant variables affecting poultry egg production include flock size ($p<0.05$) and drug ($p<0.10$). The implication of the above findings is that in the study area, regardless of the activities of the poultry egg farmers, the major limiting factors of poultry egg production were flock size and drug. The positive and significant sign of the coefficients are in line with the findings of Ashagidigbi *et al* (2001). The productive inputs that greatly impact on chicken egg output of farmers were the drug/vitamin (to curtail the adverse economic effects of diseases and to boost the nutrient status of the poultry); Among the above major inputs, flock size has the highest coefficient with a value of 0.775 and therefore, it appears as the most limiting factor that greatly determine egg output in the study area.

Socio-economic factors affecting technical efficiency of the poultry farmers

This section explains the relationship between farmer specific-factors and their effects on technical efficiency. These are derivable from the analysis of the inefficiency model in Table 1. Negative sign of the estimated parameters in the inefficiency estimate means that the variable increases technical efficiency while positive sign increases technical inefficiency. The result shows that the estimated coefficients of age, educational level, years of experience, household size and primary occupation have significant implications on the farmer's technical efficiency (Ojo, 2003).

Formal education, this was measured in level of education. The result of inefficient model presented in Table 1 reveals a negative and statistically significant at ($p<0.01$). This result indicates that poultry farmers with formal schooling exhibited higher levels of TE. It implies that poultry farmers with formal education tend to be more technically efficient in poultry egg production, this is due to their enhanced ability to acquire technical knowledge.

Experience: Years of experience was significant at ($p<0.05$). The implication is that farmers with more years of experience tend to be more efficient in poultry egg production. Continuous practice of an occupation for a long period presumably makes a person more experienced and more productive in practice. This agrees with Ojo, (2003) who reported that experience leads to increase in poultry farmers' technical inefficiency or decrease the T.E. of poultry egg production in the study area.

Household size: The coefficient of household size is negative and statistically significant at ($p<0.01$). This negative relationship signifies that as the household size increases farmers technical efficiency and reduces technical inefficiency. This agrees with Okike, (2000) who reported that family size have negative influence on the farmers' productivity. In a situation where the family size is large and only a small proportion of farm labour is derived from it, then the inefficiency effect are expected to be greater.

Main occupation: The coefficient of primary occupation is negative and statistically significant at ($p<0.01$). This revealed that this factor led to increase in technical efficiency of the poultry egg production in the study area.

Production Elasticity of Inputs (Input Elasticity) in Poultry Egg Production

The Production elasticity indicates the percentage change in output relative to a percentage change in input if other factors are held constant. The reason behind determining the aggregate elasticity of input was to determine the degree or the extent to which the input considered in the model affected output. From the nature of the Cobb-Douglas production function fitted, the regression coefficient which is also known to be the estimated parameters of each variable in Table 1 is the elasticity of the production of the variables. Table 2 shows the elasticity of production with respect to the explanatory variables. From the result, the elasticity of farm size was 0.77465 meaning that 10% change in the total farm size will bring about 7.75% change in the poultry egg production if other factors are held constant. Labour has an elasticity of 0.25708 meaning that for 10% change in labour input; poultry eggs production output will change by 2.57%. The same goes for vaccine input with an elasticity of -0.1238 meaning that a 10% change in vaccine input will bring about a less than 1% (-1.238%) change in the output of chicken egg production. The drugs/vitamins have an elasticity of 0.2408 meaning that a 10% change in the drugs input will bring about 2.408% change in the output of poultry egg production. Feed input has an elasticity of 0.0270 meaning that for 10% change in feed input; output of chicken egg will change by 0. 27% in the study area with other factors held constant. This implies that flock size, labour, drugs, and feed inputs influence the output by increasing at decreasing rate, indicating the variables allocation and use were in the stage of economic relevance of the production function (stage II). The elasticity of vaccine used was negative. This implies that vaccine influences that output at decreasing rate, indicating over use of this variable (vaccine).

Some insight was also gained into the nature of returns to scale (RTS) in poultry egg production in the study area. The sum of all elasticities obtained from Table 2 was 1.178 and this was found to be statistically higher than unity thereby indicating positive increasing returns to scale and that chicken egg production was in stage I of the production region.

Allocative efficiency (Price efficiency)

Table 3 show result of stochastic cost frontier model estimates for the poultry egg farmers in the study area. The result revealed that the performance of the model in terms of gamma (γ) and sigma square (σ^2) are large and significant at 1%. The magnitude of gamma (γ) estimates was 0.99 implied that 99% of the variations in the cost of poultry egg production in the study area are accounted for by the differences in the allocative efficiency of the farmers. The sigma square (σ^2) was 0.74 and significant at 1% level. This indicates goodness of fit and correctness of the specified assumptions of the distribution of the compound error term.

The result further revealed that, all the variables take a positive signs. The coefficient of flock size (Px_1), Labour (Px_2), Vaccine (Px_3), Drug/Vitamin Px_4, Feed (Px_5) and output (Y) adjusted for statistical noise were all significant 1%. This implied that these variables are the major determinants in allocative efficiency of poultry egg production in Kaduna State. A similar result of direct effect of output on the cost of production was obtained by Khai and Yabe, (2011).

Technical efficiency Predictions among poultry egg farmers in Kaduna state

Table 4 shows the predicted technical efficiency estimates for the poultry egg farmers in the study area. The predicted poultry egg farmers' specific technical efficiency (T.E) ranged from a minimum of 13% to a maximum of 88%, with a mean of 54%. Thus, in the short run, there is a scope for increasing egg production by about 46% by adopting the technology and techniques used by the best practiced poultry egg farms. One of such measures is addressing, the issue of negative elasticity of vaccine. It indicates that the average poultry egg farmers in the area could save 38.6% (that is, [1-54/88]) of costs and the most technically inefficient could realize a 85% cost saving (that is, [1-13/88]) compared with the TE level of his most efficient counterpart. In addition, the highest TE level ranging from 50% to 89% comprises of 31 poultry farms which 63.27% of the total. The lowest TE score ranging from 1% to 49% comprises of 18 poultry farms or 36.73%. This indicates that majority of poultry farms in the sample achieve rather high technically efficiency production.

Allocative efficiency Predictions among poultry egg farmers in Kaduna state

The mean of allocative efficiency is only 52.5%, with the lowest 6.4% and the highest 87. 8%. Thus, in the short run, an average poultry farmer in Kaduna state have tendency of increasing their poultry production cost 47.5% by adopting the technology and techniques used by the most allocative efficient poultry farmers in Kaduna state. this also means that if the average poultry farmer in the sample was to achieve the AE level of its most allocative efficient counterpart, then the average poultry farmer could realized a 40% cost saving that is (1-[52.5/87.8]). A similar calculation for the most cost inefficient poultry farmer reveals cost saving of 93% cost inefficient (that is, (1-[6.4/87.8]) of most cost efficient counterpart. In addition, the highest AE level ranging from 50% to 89% comprises of 26 poultry farms, which is 53% of the total. The lowest AE level ranging from 1% to 49% comprises of 23 poultry farms which is 47% of the total. The reason for too low an allocative efficiency score could be explained by poultry farmers in the sample deciding the amount of inputs for production only based on their experience, not using inputs flexibly according to markets.

Economic efficiency Predictions among poultry egg farmers in Kaduna state

The combined effect of technical and allocative efficiencies shows that the mean economic efficiency level for this sample is 34%, meaning that poultry farmers in the study area were poorly economically efficient in the use of scare resources, with a low of 4.6% and a high of 68.5%, because the poultry farmers use inputs with low allocative efficiency. Thus, in the short run, an average poultry farmer in Kaduna state have the tendency of maximizing profit by about 66% by adopting the technology and techniques used by the most economic efficient poultry farmers in Kaduna state.

Conclusion and Recommendations

The findings of this research have shown that poultry farmers in the study area are not fully technically, allocatively and economically efficient in the transformation of inputs to output. The variables that significantly affected their technical efficiency include educational level, experience, household size and main occupation. Also, the returns to scale (RTS) was positive increasing returns to scale which means that poultry production in the study area was in stage I of the production region, hence, resources and production were inefficient utilized.

The recommendations of this study based on major findings include:

To efficiently utilize the farmers in the study area, there is a need to use their available input intensively and rationally so as to produce better output and be technically efficient.

The low AE and EE in poultry egg production can be attributed to the inflexible responses of poultry farmers to changes in market prices or to their applying inputs mainly on experience. To solve these problems, the poultry farmers should look at opportunity to create better market information systems for input sourcing and output disposal.

Poultry egg production in the study area should continue to be managed by better educated farmers, who will be able to adopt the new and improved technologies which are both labour and cost-saving in nature bearing in mind the goals of maximizing the use of endowed resources of feed, labour, capital and others inputs in the study area.

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Table 1: Maximum likelihood estimates (Technical Efficiency) of the production function and factors affecting efficiency of poultry egg farmers in Kaduna State.

Variable Description	Parameter	Coefficient	T-ratio
General model			
Constant	β_0	3.655***	20.162
Flock size	β_1	0.775**	2.306
Labour	β_2	0.257	1.066
Vaccine	β_3	-0.124	-0.813
Drug/vitamin	β_4	0.241*	1.280
Feed	β_5	0.027	0.512
Inefficiency Model			
Constant	δ_0	0.676***	2.658
Age of farmers	δ_1	0.004	0.605
Educational level	δ_2	-0.016***	-2.616
Year of experience	δ_3	0.359***	3.645
Household size	δ_4	-1.644***	-2.676
Main occupation	δ_5	-0.831***	12.071
Variance Parameters			
Sigma squared	$\sigma^2 = \sigma^2_v + \sigma^2_u$	0.075***	5.495
Gamma	$\gamma = \sigma^2_u / \sigma^2_v$	0.999**	1.870

Note: ***=p<0.0l; **=p<0.05; *=p<0.10%.

Table 2: Elasticity of poultry egg production and return to scale

Input variables	Elasticity
Farm size	0.775
Labour	0.257
Vaccine	-0.124
Drug/vitamin	0.241
Feed	0.027
Return to Scale (RTS)	**1.178**

Table 3: Maximum likelihood estimates of the stochastic cost frontier function (Allocative Efficiency) for poultry egg production in Kaduna State.

Variable Description	Parameter	Coefficient	T-ratio
General model			
Constant	λ_0	3.573***	3.662
Flock size	λ_1	0.099***	6.155
Labour	λ_2	0.801***	51.871
Vaccine	λ_3	0.007***	6.539
Drug/vitamin	λ_4	0.011***	5.257
Feed	λ_5	0.048***	5.480
Output	γ	8.505***	14.496
Variance Parameters			
Sigma squared	$\sigma^2 = \sigma^2_v + \sigma^2_u$	0.737***	2.956
Gamma	$\gamma = \sigma^2_u / \sigma^2_v$	0.996***	5.290

Note: ***=p<0.0l; **=p<0.05; *=p<0.10%.

Table 4: Technical, allocative and economic efficiency prediction of poultry farmers.

Efficiency Level (%)	Technical Efficiency Frequency	Percent	Allocative Efficiency Freq.	percent	Economic Efficiency Frequency	Percent
0.10 – 0.19	2	4.08	0	0	7	14.29
0.20 – 0.29	4	8.16	4	8.16	11	22.49
0.30 – 0.39	5	10.20	6	12.25	14	28.57
0.40 – 0.49	7	14.29	13	26.53	13	26.53
0.50 – 0.59	7	14.29	12	24.49	3	6.12
0.60 – 0.69	11	22.45	9	18.36	1	2.04
0.70 – 0.79	9	18.37	4	8.16	0	0
0.80 – 0.89	4	8.16	1	2.04	0	0
	49	100	49	100	49	100
Mean (%)		54%		52.5		34.0
Minimum (%)		13%		6.4		4.6
Maximum (%		88%		87.8		68.5