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Technical Efficiency Of Poultry Egg Production In Oyo State Of Nigeria: A Stochastic Frontier Approach

Ajiboye Abiodun

Osundare F.O.

Oluwatusin F.M.

Toluwase S.O.W.

Adekunmi A.O.

Abdu-Raheem K.A.

Department of Agricultural Economics and Extension Services Ekiti State University, Ekiti State, Nigeria

Abstract: ***The study investigated the technical efficiency of egg producers in Oyo State of Nigeria and explored their determinants. Primary data were collected from 120 poultry egg producers. Descriptive statistics was used to explain the socioeconomic and the enterprise characteristics of the respondents. The stochastic frontier approach was employed in analyzing the efficiency indices and their determinants. It was found that majority of them were within their productive ages of less than 50 years old. The study underscored the important need of women involvement in egg production. Only a handful of the respondents (3%) were illiterate which should be a boost to managerial abilities of the egg producers. Most of the farmers adopted the deep litter rather than the battery cage system because of issues relating to production cost. The mean stock size was 1334 which stipulated that most of them were small scale egg producers. The strategies adopted towards risk avoidance helped some of the farmers a lot to maintain low mortality rates though many were not proactive enough to take advantage of these strategies so as to improve performance. Three of the efficiency correlates were significant. These are stock size, labour and feed though one of them had a negative correlation with efficiency. The overall results showed that fairly high inefficiencies were established in many of the farms and improvement of these was very possible if the poultry farmers making up this number adopted the techniques of more efficient farms in the area.***

Keywords: Technical Efficiency, Poultry Egg, Stochastic Frontier

I. INTRODUCTION

Since the Nigerian independence in 1960, there have been flurries of literature (Aromolaran 1999, Mbanasor 2002, Nworgu 2002, Oteku et al., 2006), indicating a dearth of animal protein in the diet of majority of Nigerian households. The per capita consumption level had persistently been below the standard daily FAO requirement of 35 - 45g for an adult of 60kg body weight which is less than 20 percent of this minimum daily requirement and helps to explain the country's widespread malnutrition. This daily animal protein consumption in Nigeria is less than 8g per person, (Obioha, 1992). This arises from the sluggish trend in the productivity and growth of the livestock industry which like agricultural productivity, is below the population growth rate put at 3.2% (NPC, 2006) and in effect of which the existing potential can only meet 50% of the per capita demand for animal protein (Nworgu, 2002 and Mafimisebi et al., 2006). The slow growth rate is however fuelled by the prevalence of pest and diseases among other plethora of factors such as lack of government funding, lack of credit facility, high cost of feeding ingredients, increasing cost of medications, marketing, lack of

storage facility, severe nutritional deficiencies due to stiff competition with the need for human food, certain drugs and feed contaminations with pesticide and mycotoxins, faulty handling and storage conditions after eggs are laid, and the effects of other natural hazards like floods, fire and inclement weather conditions which culminate in inefficient resource use. According to Adene and Oguntade (2006), the extent of this slow growth cannot be accurately ascertained in figures because of lack of current or recent data reporting poultry productivity in Nigeria.

Amidst all these, the Nigerian Livestock Industry, according to Mafimisebi et al., (2006), is required to witness a significant improvement in productivity in order to bridge the animal protein consumption gap for the teeming population. In meeting this challenge, the poultry egg industry has been identified as the fastest means of bridging the animal protein deficiency gap. (Ikpi and Akinwumi, 1979 Obi and Sonaiya 1995 and Oteku et al., 2006). However, poultry eggs and its products such as ice creams, cake e.t.c are still considered as luxury foods among many Nigerians. In the rural areas where household incomes are significantly below the national average, consumption of poultry egg is reserved for special occasions meals. Even in the urban Areas where incomes are relatively higher, consumption of poultry egg among members of some families is still occasional. Yet it is commonly reported in virtually all the media that an individual should eat an egg per day. This low consumption can be attributed to the short fall in poultry egg supply. Although there are hundreds of commercial poultry farms producing eggs in Nigeria, however, many of them have ceased production while some of the remaining ones, are operating at less than full capacity.

For the present situation to be properly addressed, target must be tailored towards the achievement of sustainable production of egg through a systematic expansion within the commercial poultry industry. The concern of the Nigeria government in shaping the poultry industry to an acceptable end resulted in the enactment of some policies in the past years and several reviews by successive governments. According to FMARD, (2001), the key features of the new agricultural policy as affecting the livestock industry include: evolution of strategies that will ensure self sufficiency and improvement in the level of technical and economic efficiency in food and livestock production; reduction of risks and uncertainties in agriculture. The first is to be achieved through expanding resource base or increasing productivity of the existing resources through systematic improvement of the production system, while the second is stipulated to be achieved through the introduction of a more comprehensive agricultural insurance scheme to reduce natural hazard factors militating against agricultural production and security of investments. However, the question that is of paramount importance here is: whether or not the present efforts of the Nigeria government will be jeopardized by the traditionally known agricultural constraints in the commercial egg industry. Presently more than 50% of livestock in Nigeria is chicken (Alabi et al. 2006). And a substantial proportion of this is layers.

The production of egg meat in Nigeria is currently dominated by the large scale integrated commercial farms in terms of strategic position in the industry, product range and volume of operations. These are largely private sector driven with the government providing policy support. However on the individual assessment, these farms are not automatically immune to the constraints that face their counterparts in the backyard sector in the country and in other African countries .Inability to overcome these set of constraints has resulted in the collapse of many commercial egg-producing farms in Nigeria. According to Onyenweaku (2005) and NISER (2001), some of the constraints inhibiting agricultural performance in Nigeria can be categorized into technical, resource, socio-economic and organizational constraints. These are all together formidable to steady and consistent increase in agricultural production resulting from technical inefficiency of the farmers.

In the light of the aforementioned, this study endeavoured to estimate the technical efficiency differentials among poultry egg producers in Ekiti State Nigeria. Specifically, we estimated the level of technical efficiency of commercial egg producers, identified and analysed the variables affecting these technical performances.

II. MATERIALS AND METHOD

A. THE DATA

The study was carried out in Oyo State, south west Nigeria. The State covers approximately a land area of 28,584 square kilometres and a population of 5,591,589 (Wikipedia, 2008). It lies between the latitude of $2^{0}38^{1}$ and $4^{0}35^{1}$east of the Greenwich meridian. The major occupation in the state is the cultivation of export crops amongst which are maize, yam, cassava, rice, millet e.t.c. The climate is tropical with distinct dry and rainy seasons high in relative humidity. The dry season spans through November to April. Annual mean rainfall can be as high as 300mm and a daily temperature that ranges from 25^{0} to 36^{0}c .Six local government were select through a multistage sampling technique which led to selection of five communities from each local government in the second stage through a random sampling technique . Four poultry farmers per community were randomly selected for interview in each community with the assistance of the Agricultural Development Programme (ADP) official at the last stage. This amounted to a total of 120 poultry egg producers.

B. STOCHASTIC PRODUCTION EFFICIENCY FRONTIER

The analytical frame work guiding the paper can be represented in the manner of Battese et al; (1996) who proposed the use of stochastic frontier specifications which incorporated models for the technical inefficiency effects and simultaneously estimate all the parameters involved. In this case the U_is that account for technical inefficiency in production are assumed to be random variables which are independently distributed as truncations at zero of a normal distribution with mean m and variance S^2 where M_1= f (z_i, d) and z_i is a vector containing farm specific factors and a constant, d is a vector of parameters to be estimated and f (x)

is a suitable functional form, usually assumed to be linear. (Ajibefun and Daramola, 1999)

A production function can be specified for cross-sectional data with an error term containing two components, one that account for technical inefficiency (v_i) and a second one that accounts for random effects (v_i) the frontier production function proposed by Aigner et:al; (1977) is as follows

$$y_i = f(x,\beta) + E \quad i = 1,2.....N \qquad (1)$$

Where y_i is the output quantity of the i^{th} farm; x_i is a (K x 1) vector of quantities of input employed by the i^{th} farm in the production of y; and B is a vector of unknown production function parameters to be estimated e_i is an error term made up of two components.

$$E_i = v_i - u_i \qquad (2)$$

The v_i`s are assumed to be independently and identically distributed random errors having a normal distribution with mean zero and variance σ_v^2 thus, the v_i accounts for measurement errors and other factors that are beyond the farmers control. The v_is are assumed to be independent of the u_is which are non-negative random errors (u_i >0, ∇_i). The u_is are assumed to account for technical inefficiency in protection and assumed to be independent and identical distributed exponential or half- normal variables.

If we combine equation 1 and 2, assuming a Cobb-Douglas specification, the stochastic frontier production for this study could be rewritten as follows.

$$\ln y_i = \beta_o + \sum_{i=1}^{m} \beta_j \ln x_{ij} + v_i - u_i \quad i = 1,2,.....N \qquad (3)$$

Where y_i is the output of farm i, X_{ij} is the amount of input j used by farm i, β_j are parameters to be estimated. The output values are bounded above by the stochastic variable,) $\exp(x_i\beta + v_i)$. The random error, V_i, can be positive or negative. Therefore stochastic frontier technical efficiency can be written as

$$TE_i = \frac{y_i}{\exp(x_i\beta)} = \frac{\exp(x_i\beta - u_i)}{\exp(x_i\beta)} = -\exp(u_i) \qquad (4)$$

Where y_i is the observed output and $\exp(x_i\beta)$ is the estimated value of frontier output. This is called an output-oriented Farell measure of technical efficiency. Technically efficient farms are those that operate on the production frontier and the level by which a farm lies below the production frontier is regarded as the measure of technical efficiency.

C. THE MODEL

The model proposed for the analysis of egg production, involving stochastic production function is presented as follows.

$$\ln(Y_i) = \beta_o + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \beta_4 \ln x_4 + v_1 - u_i$$

Where ln denotes natural logarithm (logarithm to base e) the subscript i refers to the 1^{th} farmer in the sample; i =1, 2,……N, where N is the number of poultry farms. Y_i represents a weighted output of poultry egg produced in kilograms per period; X_1 stocking capacity per period; X_2 represent the total number of labour in mandays, X_3 represents the total quantity of feed (in kilograms) per period; X_4 represent veterinary services (the total of all variable expenses on vaccine and other drugs). The β_s are the unknown parameters for the production function of the i^{th} farm. The V_is are random errors associated with measurement errors in broiler production, or combined effects of input variables not included in the production function. The V_is are assumed to be identically and independently distributed $N(0,\sigma_v^2)$ random variables. The μ_is are non-negative random variable, associated with technical inefficiency of production, assumed to be identically and independently distributed, such that the technical inefficiency effect for the i^{th} farms, μ_i, is obtained by truncation (at zero) of the normal distribution with mean, μ_i, and variance σ^2, (Battese and Hassan, 1998). Such that

$$\mu_i = \delta_0 + d_1\delta_1 + \delta d_2\delta_2 + d_3\delta_3 + d_4\delta_4 \qquad (6)$$

Where δ_1 denotes the experience of farmers in years; δ_2 denotes the management system in years; δ_3 represent educational level; $\delta 4$ household size and σ_s and σ^2_s are unknown parameters to be estimated. The parameters of the stochastic frontier production function was be estimated using the programme frontier 4.1

III. RESULTS AND DISCUSSION

Variables	Frequency	Percentages
Age		
<30	15	12.2
31-40	24	20.3
41-0	52	43.3
1-60	19	16.3
>60	10	8.0
Total	120	100
Sex		
Male	93	77.7
Female	27	22.3
Total	120	100
Marital status		
Married	91	75.8
Single	19	15.8
Divorced	0	4.2
Widowed	0	4.2
Total	120	100
Household size		
1-2	42	35.0
3-	30	25.0
6-8	28	23.3
>8	20	16.7
Total	120	100
Educational status		
No education	04	3.3
Adult education	13	10.8
Primary	27	22.5
Secondary	20	16.7
Tertiary	56	46.7

Total	120	100
Occupational status		
Full-time	85	70.8
Part-time	35	29.2
Total	120	

Table 1: Socioeconomic distribution of the respondents

The table 1 display the socioeconomic characteristics of the respondents of the farmers. The table revealed that majority of them were found within their productive ages of less than 50 years old. This accounted for about 90 percent of the sample while the remaining 10 % are above 60 years old. Its evidence that age is a contributory factor to productiveness in any farming operation because it is a direct correlate of physical strength. Distribution according to sex revealed that more than 77 % of the respondents was male thus, underscoring the important need for women involvement in this kind of enterprise. This will go a long way in improving the nutritional need of the society and also improve the livelihood and wellbeing of many households. Many of our unemployed female graduates here have a wide window of opportunities opened for them if the enabling environment is put in place by government. The size of the family, as shown in the table revealed a range of 3-8 family size constituting the largest group of 60 %. The remaining 40 % were families with members greater than 8 people. Family labour endowment depends on family size and the number of able adults in the family. Families with lager number of people therefore have a lot of advantages in converting their members to undertake some tasks which could have made them incur a higher cost in the poultry operation. The educational status has a direct link to the rate at which the respondents will adopt innovation or access information that will be useful for more productiveness. Farmers who are illiterate will not find it as easy as possible to access such innovation or adopt such information. The table revealed that only a handful of the respondents (3%) were illiterate, though some of them (11 %) had only adult education. The remaining 88% had primary, secondary and tertiary education. Amongst these, those that had tertiary education were 45%. This record of high education of the poultry farmers might be due to the fact that poultry keeping involves a lot of technicalities and high risk which need good managerial ability to handle. It also attest to the fact that white collar job is fizzling out in our labour market. This is justified by the fact that majority are poultry farmers who are full timers and did not have other supportive enterprise as another means of livelihood. Fortunately a big chunk of this full time poultry farmers are tertiary institution certificate holders .Distribution according to years of experience showed that majority of them were not new entrants at all into the poultry business. Over 35% of them have been in the business since upwards of a decade while those that have spent more than 10 years amounted to 64.9 % of them this wealth of experience is expected to be an added advantage toward efficiency growth.. In terms of management method, the choice of the poultry housing was made between deep litter and battery cage as this is the only common method of poultry rearing in this clime. More than half of them used deep litter while the remaining used either battery cage or a combination of both systems. Most of them adopted the deep litter system because of issues relating to cost of production due to the high price of battery cage in the poultry input market. The mean stock size was 1334 which stipulated that most of them are small scale egg producers. Some had up to 500 birds while only 15 % had above 2000 birds. The distribution according to mortality rate per cycle showed that for those that operated less than 500 birds, 11 birds per cycle was recorded while for those who operated more than 200 birds, a mortality rate that was greater than 40 birds was experienced. This really indicated that the poultry keepers have really manned the situations and management practices that ensured such a low mortality. This can be clearly seen in the risk avoidance strategy compiled together in table 2. This include regular feeding, prompt medication and vaccination, proper cleaning and removal of droppings, isolation of sick birds etc. All these strategies helped the farmers a lot to ward off risks and maintain low mortality rate.

Strategies	Frequency	percentage
Proper cleaning and management	83	69.2
Prompt medication and vaccination	95	79.2
Adequate feeding of birds	98	81.6
Raising of different bird species	48	40.0
Stocking birds from reputable hatcheries	40	33.3
Contract marketing of poultry eggs	32	26.7
Netting/ fencing of the poultry	16	13.3
Use of security guards on farm	20	16.7
Isolation of infected birds	75	62.5

Table 2: distribution of risk avoidance strategies among the poultry egg producers

The distribution according to the strategies embarked upon to minimize loss are tabulated above. From the table it is clear that many of the egg producers were not proactive enough to take advantage of these risk avoidance strategies so as to increase productivity.

Variables		Coefficients	T-ratio
Efficiency parameters			
Constant	β_o	4.36	2.37**
Stock Size	X_1	1.01	4.44***
Labour (mandays)	X_2	0.27	8.90***
Feeds (kg)	X_3	-0.84	-1.86*
Veterinary services	X_4	-0.10	-8.61
Inefficiency parameters			
Constant	δ_0	-2.98	-2.09**
Experience	δ_1	-7.53	-2.03**
Management system	δ_2	-0.70	-0.72
Educational level	δ_3	4.18	4.36***
Household size	$\delta 4$	2.90	3.37***
Diagnostic			

Statistics			
Sigma-squared	$\delta^2 = \delta_u^2 + \delta_v^2$	3.77	4.12***
Gamma	$\gamma = \delta_u^2 / \delta^2$	0.99	19.10***
Log likelihood		-16.09	
LR Test		8.07	

****, ** and * means significant at 1%, 5% and 10% levels respectively.*

Table 3: The result of the maximum likelihood estimate (MLE) of stochastic production frontier function of egg producers

The result of the Maximum livelihood estimate of stochastic frontier production function of poultry farmers in Oyo state is presented in table 3 below. The table revealed the estimate of the parameters for this function and the variance parameters of the model. The variance parameter sigma was 3.79 and was significant at 1% level of probability. This indicated a good fit. The value of gamma was estimated to be 0.99 and was highly significant at 1% level of probability. This is in tandem with the theoretical underpinning that correct value of gamma must be greater than zero. This means that 99 % of the variations in the output of the poultry farmers emanated from the farmers inefficiency. This is because these factors were within the scope of the farmers control and thus reducing the influence of the effects of gamma will highly enhance the technical efficiency of the egg producers and improve their yields. The log likelihood function value was -16.09 which exceeds the critical chi square value of 8.07 at 1 % level of significance. The values imply that inefficiencies existed in the data set. This value represents the value that maximizes the joint densities in the estimated model. The coefficient of the stock of birds was 1.006 and it was significant at 1 % level, meaning that farms could still increase their egg production substantially by increasing their stock. Quantity of feed intake was significant at 10 % and had a coefficient of -0.84. This means that the more the birds consumed the less the Technical Efficiency of the farms. Farmers should therefore know the limits for which feed intake should be administered to the birds; otherwise the excess would always amount to a waste of resources. Cost of veterinary has a value of -0.101 and significant at 1 % which shows that the more the spending on veterinary services, the less the efficiency. This also means that not every time that medication cost will be an advantage in terms of production performance. Farmers should therefore administer veterinary services to their flock when only necessary. The extra money could be used for other things in the poultry business. The value of the coefficient of labour is positive at 0.270 and significant at 1% level, showing that increase in manday of labour would improve the efficiency of production. The inefficiency parameters considered in this study include the poultry farmer's experience, management practices, educational level and household size. According to the table, educational level of the respondents had a positive coefficient of 4.18 and significant at 1% level. This stipulates that an increase in the educational level of the respondents leads to an increase in the inefficiency and vice versa. This result is contrary to expectation because it downplayed the connection between educational endowment and technical know-how. Education means knowledge and it is expected to reflect in the manner that enterprises such as poultry is manned. However the results prescribed that theory is not always in harmony with reality especially where there are other factors that are quietly operating behind the scene. Likewise, household size has a positive coefficient of 2.89 and significant at 1%. Household size should in reality be proportional to family labour endowment and is expected to move in the same direction as efficiency. This result is however not so. This might be that most of those that constitute the household numbers are practically unproductive and not enterprise-compliant .Management system is not significant and thus shows that the decision to use either battery cage or deep litter system is immaterial in determining productivity of poultry egg production. This is particularly so if proper hygiene is carried out ad libitum in the pen in either of the chosen method. Experience has a negative coefficient of 0.7% and significant at 5% level. Thus in this study, year of experience is directly proportional to efficiency level.

Efficiency Indices	Frequencies	Percentages
<0.20	**07**	**5.80**
0.20-0.39	**03**	**2.50**
0.40-0.59	**08**	**6.70**
0.60-0.79	**22**	**18.30**
>/0.80	**80**	**66.70**
Min = 0.10		
Max = 0.99		
Mean =0.80		

Table 4: distribution of the technical efficiency indices

The results of the TE estimates demonstrated that substantial inefficiency existed among the poultry egg producers. Some of the farmers demonstrated poor efficiency as indicated by the indices such as 5.8 % and 2.5 % .These had low efficiency of less than 20 % and between 20-40 % respectively. However majority of them, 66.7 % had very high efficiency of above 80 %.

IV. CONCLUSION AND RECOMMENDATION

The study investigated the technical efficiency of egg production in Oyo state of Nigeria using a stochastic frontier approach. The results showed that fairly high inefficiencies were established in many of the farms and improvement of these is very possible if the poultry farmers making up this number were more proactive. Highly inefficient farms could take the advantage of across-farm comparative advantages. This means that improved performance would be experienced if they adopted the techniques of more efficient farms.

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