NON-PARAMETRIC ANALYSIS OF PRODUCTION EFFICIENCY OF POULTRY EGG FARMERS IN DELTA STATE, NIGERIA.

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ABSTRACT

The study examined the non-parametric analysis of production efficiency of poultry eggs farmers in the Delta State Nigeria. Data used for the study were obtained using structured questionnaires administered to 120 randomly selected poultry farmers in four Local Government Areas of the State. Data envelopment analysis and Cobb- Douglas production function were used to analyze the data. The result showed that 30% of the poultry farmers in the study area were operating at frontier and optimum level of production with mean technical efficiency of 1.00. This implies that 70% of the poultry farmers in the study area can still improve on their level of efficiency through better utilization of available resources, given the current state of technology. The results of the Cobb-Douglas analysis of factors affecting the output of poultry farmers showed that stock capacity (number of birds), feed and medication cost positively and significantly affected the output of the poultry egg farmers in the study area. This indicated that a unit increase in these inputs led to increase in the gross output of poultry egg farmers in the study area by 49.12%, 46.99% and 20.74% respectively. The study further showed that most of the poultry farms could reduce total expenditures on the number of birds purchased, feed, labour, medication and capital inputs by 20.43%, 3.20%, 3.53%, 7.10%, and 31.80% respectively without reducing their current level of production. It is recommended that poultry egg farmers in the study area should form cooperative societies so as to enable them have access to productive inputs that will enable them expand. It is further recommended that enhanced research, extension delivery and farm advisory services should be put in place for farmers to learn the best farm practices carried out on the robustly efficient farms. This will go a long way to increase the efficiency level of the poultry farmers in the study area.

Keywords: DEA, efficiency and poultry production

Received: 2012/08/14.

Accepted: 2013/10/10

INTRODUCTION

Poultry has become one of the most effective sources of protein for human consumption. Poultry meat and eggs have become very important means of bridging the protein supply gap in Nigeria. Thus, many Nigerians in the recent times, have developed interest in poultry production as a result of awareness of the nutritional value and the great opportunities for making profits. According to Chukwuji *et al.*, (2006), poultry production is attractive because birds are able to adapt easily, have high economic value, rapid generation time and high rate of productivity that result in production of meat within eight weeks and first egg within 18 weeks of first chick being hatched. He further stressed that poultry is an important source of animal protein, income, employment, industrial raw materials, manure, financial security etc. Gona, (2009) recorded that the internal supply of livestock products is in such insuffucient quantities and that the totaal supply of livestock products still fall short of the overall demand. In some cases, the domestic production production and importations are altogether still not enough to meet more than 60% of the actual demand (Mbanasor and Nwosu, 2000).Given the fact that Nigeria is faced with a great challenge as far as the inadequacy of the livestock sub-sector is concerned, it then becomes imperative to quantitatively measure the current level of and determinants of efficiency and policy options available for raising the present level of efficiency given the fact that efficiency of production is directly related to the overall productivity of agricultural sector vis-a vis the poultry sub-sector. From the foregoing, there is a crucial need to raise agricultural productivity as such growth is the most dfficient means of achieving food security and alleviating poverty.

Effiong (2004) stated that livestock production could be significantly boosted through improving efficiency of farms by utilizing resources as well as introducing improved technology. Efficiency is concerned with relative performance of the processes used in transforming given inputs into outputs (Ohajianya and Onyenweaku, 2001). Production efficiency means attainment of production goal without waste (Ajibefun and Daramola, 2003). An increase in efficiency would lead to an improvement in the welfare of farmers and consequently, a reduction in their poverty level and food insecurity (Effiong, 2004). To increase the efficiency of the farm, owners require a good knowledge of the variation in the current level efficiency in various livestock enterprises. This will provide a success indicator and performance measure for the rapid growing of poultry sector of the economy. Moreso, the ability to quantify efficiency and its joint determinants, provide decision makers with a control mechanism with which to monitor the performance of the enterprise. This study is aimed at assessing the production efficiency of poultry egg farmers in Delta State, Nigeria The specific objectives of this study are to:

- determine the technical efficiency of the poultry egg farmers in the study area.
- analyze the determinants of poultry egg farmers’ output in the study area

Concept of Data Envelopment Analysis [DEA]: This is a non-parametric approach of measuring efficiency initiated by the seminar work of Charnes, Cooper and Rhodes (1978). DEA uses mathematical linear programming techniques in order to find the set of weights for each firm β_1, β_2, β_k that maximizes its efficiency score greater than 100 percent at those weights. DEA builds up an "envelope" of observations that are most efficient at each set of weights. A firm can be shown to be inefficient if it is less than another firm at the set of weights that maximizes its relative efficiency. For an inefficient firm at least one other firm will be more efficient firm.

A DEA model not only allows the weights attached to each performance indicator to vary across firms, but is also able to accommodate non-linear relationships between cost and outputs – that is, variable returns to scale (VRS). In this respect, DEA may be viewed as an extension of simple index numbers. For a detailed procedural discussion, interested readers are referred to Seiford and Thrall (1990); Lovell (1993); Fare, Grosskopf, and Lovell (1994); and Chakraborty and Mohapatra (1997). Coelli, (1996) and Sarafidis, (2002).

DEA Estimation: The theoretical definition of a production function has been based on expressing the maximum amount of output obtainable from given input bundles. This is regarded as estimating average production function. This definition assumes that technical inefficiency is absent from the production function. In calculating technical efficiency, it is better to introduce DEA via ratio form. For each DMU, we would like to obtain a measure of the ratio of all outputs over all inputs, such as $u_i y_i / v_i x_i$, where u is an M X_i vector of output weights and v is a KX_i vector of input weights. To select optimal weights, we specify the mathematical programming problem:.

$\mathrm{Max}_{u,v}$ $(u_i y_i / v_i x_i)$,

Subject to:

$u_i y_j / v_i x_j \leq 1$, j = 1,2….,N, (1)

u,v $\geq$ 0.

This involves finding values for u and v, such that the efficiency measure of the *ith* DMU is maximized, subject to the constraint that all efficiency measures must be less than one. However, one problem with this particular ratio formulation is that it has an infinite number of solutions. To avoid this, one can impose the constraint:

$v_i x_i = 1$, which provides,

Maxu,v.$(\mu_i y_i)$

Subject to:

$\nu_i x_i = 1,$ (2)

$\mu_i y_j - \nu_i x_j \leq 0$, j = 1,2,…,N,

$\mu, \nu \geq 0$.

Where the notation change from *μ* and *v* reflects the transformation. This model has been automated in the computer programme*, 'Data Envelopment Analysis.*

However, the DEA approach suffers from criticisms that it takes no account of the possible influence of measurement errors and other noise data that are common in agriculture, since all observed deviations from estimated frontier are assumed to be the result of technical inefficiency (Coelli and Battese, 1996). However, Banker (1996) and Fare and Grosskopf (1995) proposed several statistical tests which have subsequently made DEA a powerful tool for efficiency analysis Despite its limitations, DEA is surely a competitor with the stochastic production frontier in efficiency analysis. Several researchers such as Dalton (2004), Reig-Martinez and Picazo-Tadeo (2004), Abdulwadud (2000), Ogunyinka et al (2004), Helfand (2003), Yusuf and Malomo (2007) and Hussaini *et al* (2010) have used DEA for estimating technical efficiency in agriculture.

METHODOLOGY

Study area: The study was conducted in Delta State, Nigeria. The State covers a landmass of about 18,050 km^2 of which more than 60% is land. The State lies approximately between Longitude 5°00 and 6°.45' East and Latitude 5°00 and 6°.30' North. Delta is state of Nigeria situated in the region known as the Niger Delta, South-South Geo-political zone with a population of 4,098,291 (Males: 2,674,306 Females: 2,024,085 (Nigeria Bureau of Statistics, (2007). It is bounded in the North by Edo State, the East by Anambra State, South-East by Bayelsa State, and on the Southern flank is the Bight of Benin which covers about 160kilometres of the State's coastline. Delta State is generally low-lying without remarkable hills. The State has a wide coastal belt inter-lace with rivulets and streams, which form part of the Niger-Delta. The State is predominantly rural, and is traversed by flowing streams and rivers that empty into the western coast of the Niger Delta. The vegetation of the area ranges from mangrove swamps along the coast to freshwater swamp forests, and a derived savannah in the northern extremities. The average rainfall is about 266.5mm in the coastal areas and 190.5mm in the extreme north. Rainfall is heaviest in July. Temperature increases from the south (average of 30^{o}C) to the north (average of 40^{o}C). The prevailing climatic and hydrographic conditions favour a fishery and an agricultural economy. In fact, agriculture and fishing are the major occupations of the people of Delta State, Nigeria.

Sampling technique and sample size

The data mainly from primary sources were collected using a multi-stage sampling technique. The first stage involved the purposive selection of four Local Government Areas (Okpe, Udu, Sapele and Ughelli south) in the State. This is based on the population of poultry farmers in the local government area and availability of market for the poultry products. The second stage involved a simple random selection of 30 respondents from each local government area making atotal of 120 poultry egg farmers sampled for this study.

Method of data collection

The data were collected with the use of structured questionnaire designed in line with the objectives of the study. The data collected include data on quantity of eggs produced (Naira), stock of birds (Number), feed intake (Kg), operating expense (Naira), other cost (Naira), family and hired labour (naira and man-day). The data collected also include the socio-economic characteristics of the farmers such as farmer’s age, years of schooling, household size, number of contact with extension agents, accessibility to credit etc.

Method of Data Analysis

Data Envelopment Analysis (DEA): The key construct of a DEA model is the envelopment surface and the efficient projection path to the envelopment surface (Charnes *et al*., 1995). The envelopment surface will differ depending on the scale assumptions that underline the model. The efficiency projection path to the envelopment/surface will differ depending on if the model is output-oriented or input oriented. The choice of model depends upon optimization production process characterizing the firm. Input oriented DEA determines how much the mix for a firm would have to change to achieve the output level that coincides with the best practice frontier. Output-oriented DEA is used to determine a firm’s potential output given its inputs mix if operated as efficiently as firms along the best practice frontier. For this study input-oriented DEA will be used to determine how much input mix the farmers would have to change to achieve the output level that coincides with the best practice frontier. For this study, technical efficiency was used to estimate the production efficiency of the farmers in the study area. Measurement of technical efficiency is important because it is a success indicator of performance measure by which production units are evaluated (Ajibefun, 2008).

DEA is a relative measure of efficiency where the general problem is given as:

$$\text{Max TE} = \frac{\sum_{r=1}^{s} \alpha_r Y_{ro}}{\sum_{r=1}^{m} \beta_i X_{i0}} = \frac{q}{q^*} \qquad (3)$$

Subject to :

$$\frac{\sum_{r=1}^{s} \alpha_r Y_{rj}}{\sum_{r=1}^{m} \beta_i X_{ij}} \leq 1,\ j = 1, \ldots\ldots, n \qquad (4)$$

α_r, $\beta_i \geq 0$; r = 1, -----, s; i = 1, …., m

Where X_{ij} and Y_{ij} respectively are quantities of the i^{th} input and *rth* output of the j^{th} firm and α_r, $\beta_i \geq 0$ are the variable weights to be determined by the solution to this problem

Inputs: Stock capacity (number of birds), Feed (kg), Labour (manday), cost of drug and medication(Naira) and capital cost (depreciation value naira).

Output: This was obtained in crates of eggs produced.

The aim of this study is not just to estimate the efficiency score of the DMUs, but to classified the respondents into efficient and inefficient farmers, and also to determine the factors affecting their farm outputs.Based on this, a non-parametric analysis (DEA) was used to classify the farmers to categories. The ordinary least square regression analysis (Cobb-Douglas production function) was further applied to determine the factors affecting the output of each category of the farmers

RESULTS AND DISCUSSION

The summary DEA result on the classification of the farmers into efficient and inefficient farmers is shown in Table 1. The result shows that 30% of the sampled poultry farmers in the study area were operating at frontier and optimum level of production with mean technical efficiency of 1.00. This shows that 70% of the poultry farmers in the study area can still improve on their level of efficiency through better utilization of available resources, given the current state of technology.

Production Analysis: The results of production analysis of the factors affecting output of the efficient and inefficient poultry farmers are presented in Table 2. The size of the adjusted coefficients of multiple determination suggests that the major part of the interfarm variation in output is explained by the observed inputs (0.6571 in the first case, 0.7140 in the second case and 0.7675 in the third case). The results showed that stock capacity (number of birds), feed and medication cost positively and significantly affected the output of the poultry farmers in the study area. This implies that a unit increase in each of these variables will lead to increase in the poultry output in the study area. The negative coefficients of capital inputs in the first and second cases implies that a unit increase in this variable will lead to decrease in the poultry output in the study area.

Under perfect competition, the sum of Cobb-Douglas regression coefficients measures returns to scale. In the result, in the three cases the sum of regression coefficients is greater than one (1.1615 in the first case, 1.2663 in the second case and 1.2736 in the third case). This means that the farms operated under increasing returns to scale. This is an expected result since there are a priori theoretical reasons to believe that variable returns to scale will prevail.

Farms and Their Counts Appearing as Peers for Other Farms in the Study Area

Table 3 reports the number of counts a farm appeared as a peer for other farm(s) in the study area. Farms appearing more frequently as a peer for other farms are termed robustly efficient. They are robustly efficient because their production practices are such that these farms were frequently used to form the efficient frontier for the inefficient farms in the data. As observed from Table3, farms 16, 31 and 44 with peer count of 28, 29, and 48 farms respectively were identified as robustly efficient farms in the study area. Other poultry farms could learn more of better production practices from these farms.

Table 4 shows input slacks for poultry farms in the study area. A slack variable represents the amount of excess expenditure on an input, i.e., the amount by which the expenditure on a particular input could be reduced without altering the production level. It is evident that 16 poultry farms together could reduce total expenditures on the number of birds purchased by 20.43% without reducing their current level of production. Similarly, excess expenditures on feed, labour, medication and capital inputs are estimated at 3.20%, 3.53%, 7.10%, and 31.80%, involving 20, 17, 25, and 27 farms, respectively.

Table1: DEA Summary results

Models	Sample (Number of farms)	Percentage	Mean Technical Efficiency
Model I	120	100.0	0.771
Model II	84	70.0	0.673
Model III	36	30.0	1.00

Source: Field survey, 2011

Table 2: Cobb-Douglas Analysis Results

	All farms (n = 120)	Inefficient farms (n = 84)	Efficient farms (n = 36)
Variables	Coefficients & T values	Coefficients & T values	Coefficients & T values
Constant	-3.9632	-4.5095	-5.6795
	(-4.24)***	(-2.39)**	(-3.76)***
Stock capacity	0.4912	0.7566	0.2963
	(5.70)***	(6.08)***	(2.81)***
Feed (kg)	0.4699	0.4207	0.4837
	(3.94)***	(2.53)**	(3.44)***
Labour (manday)	0.0784	-0.0202	0.0501
	(0.91)	(-0.17)	(0.48)
Medication cost	0.2074	0.1902	0.3987
	(2.13)**	(2.56)**	(3.19)***
Capital Inputs	-0.0854	-0.0810	0.0448
(Deprciation)	(-2.24)**	(-2.79)***	(2.19)**
R^2	0.6715	0.7312	0.8007
Adjusted R^2	0.6571	0.7140	0.7675
F-Ratio	46.61***	42.43***	24.11***
Return to scale (RTS)	1.1615	1.2663	1.2736

Numbers in parenthesis are t values
*** = Significant at 1% level of probability, ** = Significant at 5% level of probability.
Source: Field Data Analysis, 2011

Table 3: Farms and their peer counts

Farms	peer count:	Farms	peer count:
4	7	50	10
6	24	51	9
7	21	58	7
9	18	59	1
10	19	65	2
11	6	74	8
16	28	80	25
19	1	86	2
22	1	93	2
23	2	100	7
28	24	101	11
31	29	102	3
32	3	103	2
35	17	104	14
36	2	106	22
40	5	109	1
41	3	116	1
44	48		

Source: Field survey, 2011

Table4:. Summary of Input slacks

Input	Number of farms	Mean Slack	Mean input Used	Excess Input use (%)
Stock capacity	16	272.298	1332.729	20.43
Feed (kg)	20	220.473	6894.167	3.20
Labour (manday)	17	5.30	150.30	3.53
Medication cost	25	31391.519	441935.3	7.10
Capital Inputs (Deprciation)	27	329626.263	1036549	31.80

Source: Field survey, 2011

CONCLUSION AND RECOMMENDATIONS

The empirical study is on non-parametric analysis of production efficiency of poultry eggs farmers in Delta State, Nigeria. The DEA result on the classification of the farmers into efficient and inefficient farmers showed that 30% of the sampled poultry farmers in the study area were operating at frontier and optimum level of production with mean technical efficiency of 1.00. This shows that 70% of the poultry farmers in the study area can still improve on their level of efficiency through better utilization of available resources, given the current state of technology. The results of the Cobb-Douglas analysis of factors affecting the output of poultry farmers showed that stock capacity (number of birds), feed and medication cost positively and significantly affected the output of the poultry farmers in the study area. This indicated that a unit increase in these inputs led to increase in the gross output of poultry farmers in the study area by 49.12%, 46.99% and 20.74% respectively . The findings in the study also indicated that most of the poultry farms could reduce total expenditures on the number of birds purchased, feed, labour, medication and capital inputs by 20.43%, 3.20%, 3.53%, 7.10%, and 31.80% respectively without reducing their current level of production.

In view of the above findings, it is therefore recommended that poultry farmers in the study area should form cooperative societies so as to enable them have access to productive inputs that will enable them expand. This will as well increase efficiency of resource utilization. Also, since few farms were robustly efficient, an enhanced research, extension delivery and farm advisory services should be put in place for farmers to learn the best farm practices carried out on the robustly efficient farms. This will go a long way to increase the efficiency level of the farmers in the study area

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