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Measurement of Farm Level Efficiency of Broiler Production in Uyo, Akwa Ibom State, Nigeria

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Abstract: The technical efficiency of broiler farms in urban city was investigated using the stochastic frontier production function which incorporates a model for the technical inefficiency effects. Farm level survey data from 100 broiler farmers were obtained using well structured questionnaire. The parameters were estimated simultaneously with those of the model of inefficiency effects using the maximum likelihood estimation technique. Asymptotic parameter estimates were evaluated to describe efficiency determinants. Findings reveal a mean efficiency index of 0.62 implying that output from broiler production could be increased by 38 percent using available technology.

Key words: Technical · Efficiency · Broilers · Farms · Nigeria

INTRODUCTION

Poultry is by far the largest livestock group and is estimated to be about 14,000 million consisting mainly of chickens, ducks and turkey [1,2]. Poultry is the most commonly kept livestock and over 70% of those keeping livestock are reported to be keeping chickens [2-4]. Poultry is raised for various reasons. Specifically, the roles of poultry in providing the much needed animal protein for the increasing population cannot be overemphasized. As noted by FOS [1] Etim and Udoh [2] poultry production is of considerable significance to the rural as well as the national economy and is also an important source of animal protein. Urban dwellers are also known to be involved in poultry production as means of generating additional income to cope with the rising cost of living [5-7].

Effiong and Onuekwusi (2006) however reported that poultry business has changed from subsistence to commercial poultry farming. Broiler production like any other economic venture is dependent on resources inputs. As noted by Nayer [7], the maximum poultry production depends partly on the environment, technical know-how and the quality of resources employed in the production process. But to optimize production and ensure sustainability there is need for judicious management of the resources employed in the broiler enterprise. Recent and empirical studies by Udoh and Akintola [8], Idiong *et al* [9] Etim *et al* [10], Etim and Udoh [2,4] Udoh and Etim [2,4] suggest that farming in general has to use available inputs as efficiently as possible to maximize production and farmers being primary managers of productive resources need to manage problems arising from deteriorating natural resources [11]. Inefficiency of resource use and utilization can seriously jeopardize and hamper food production, availability and security [2,4]. This study therefore aims at measuring farm level technical efficiency and examining the effect of socio – economic characteristics of households on broiler farmers' technical efficiency.

The term efficiency of a farm can be defined as its ability to provide the largest possible quantity of output from a given set of inputs. The modern theory of efficiency dates back to the pioneering work of Farell [12] who proposed that the efficiency of a farm consist of technical and allocative component and the combination of these two components provide a measure of total economic efficiency (overall efficiency). As noted by Farell [12] technical efficiency, which is the main focus of this study, is the ability to produce a given level of output and can be measured either as input conserving oriented technical efficiency or output-expanding oriented technical efficiency. Output-expanding oriented technical efficiency, which is the concern of this study, is the ratio

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of observed to maximum feasible output, conditional on technical and observed input usage [13,14].

In recent times, econometric modeling of stochastic frontier methodology associated with efficiency estimation has been important aspect of economics research. Both time varying and cross-sectional data based on Cobb-Douglas and transcendental production function or cost functions have been used by Bagi and Hunag [15]; Bagi [16], Aigner, *et al* [17], Apezteguia and Garate [18], Kumbhaker and Lovell [19], Udoh and Akintola [8]; [20], Udoh [21], Etim *et al* [10], Etim and Udoh [22] Udoh and Etim [22,23] [23]; Udoh and Etim [24] to estimate individual firm efficiency. This study estimates technical efficiency of broiler farms by assuming a stochastic nature of production based on Cobb-Douglas production function.

MATERIALS AND METHODS

The Study Area, Sampling and Data Collection Procedure: The study was conducted in Uyo Local Government Area, the capital city of Akwa Ibom State, Nigeria. Uyo is situated 55 kilometers inland from the coastal plain of South-East Nigeria. It has an estimated population of 309,573 [25]. The area lies within the humid tropical rainforest zone with two distinct seasons - the rainy and short dry season. The annual precipitation ranges from 2000 - 3000mm per annum which according to Etim and Ofem [26], this rainfall regime received in most parts of the state encourages farming throughout the year. The area is located between latitude 5°17' and 5°27' N and longitude 7°27' and 7°58' E and covers an area approximately 35 square kilometers. The occupation of the inhabitants reflects the economic activity of the residents. The settlement pattern in Uyo is nucleated and being an administrative headquarters, majority of civil and public servants and political office holders reside there. Etim *et al.* [24] documented that these people engage in part-time farming activities and other commercial ventures within and around their urban homes as a way of augmenting and supplementing family income and food supplies.

Data used for this study are mainly primary and were obtained from the broiler farmers in 2006 using well structured and pre-tested questionnaire. Specifically, 100 broiler farmers were randomly selected (25 farmers each from *Oku, Etoi, Offot* and *Ikono* clans) in Uyo Local Government Area.

The Empirical Model: The study utilized stochastic production frontier, which builds hypothesized efficiency determinants into the inefficiency error components [27]. Assuming we specified an output transformation function as,

$$Y = f(X_i; \beta) + e_i \quad (1)$$

Where:

- y: Represents quantity of output,
- X_i: Represents the vector of input required in the transformation process,
- β: Represents the vector of parameter to be estimated and
- e_i: Is a composite stochastic term which has two components, V_i and U_i. Accordingly, V_i is the pure white error term which captures unexplained and uncontrollable factors not specified in the model while U_i is the inefficiency term relative to the stochastic frontier. Thus $U_i = 0$ for farm output that lie on the frontier (i.e. 100% technical efficient in resource use) and $U_i < 0$ for farm output below the frontier.

Empirical formulation of (1) requires functional specification that would adequately represent the nature of transformation process in the presence of inefficiency. Based on the theoretical, econometric and statistical underpinnings, Cobb-Douglas production functional form is therefore assumed. Hence the empirical model is as follow

$$Ln(Qty) = \beta o + \beta_1 Ln(STOD) + \beta_2 Ln(ORC) + \beta_3 Ln(MED) + \beta_4 Ln(FEEDS) + \beta_5 Ln(CAP) + Vi - Ui \quad (2)$$

Where:

- Qty Is the value of output in Naira;
- STOD Is the stocking density measured as the total number of birds stocked by the farmer,
- ORC Is the other running cost, which include cost of water, lighting, labour, etc measured in naira;
- MED Is the value of drugs measured in naira,
- FEEDS Is value of concentrates measured in naira,
- CAP Is the depreciation value of the fixed farm items measured in Naira, Vi is a symmetric element previously defined with $V_i \sim N(O, \sigma V^2)$; and

$$e^{-ui} = \delta o + \delta_1 (Age) + \delta_2 (EXP) + \delta_3 (Edu) + \delta_4 (Tech) + zi \quad (3)$$

Where Age is the age of the farmers in years, Exp is farming experience in years, Edu is the level of educational attainment of the farmers in years, Tech is the Technical assistance (dummy) and zi is an error term assumed to be randomly and normally distributed. The values of the unknown coefficients in equations (2) and (3) are jointly estimated by maximizing the likelihood function [27,28] Kumbhaker and Lovell [19], Udoh and Akintola [8,20] Etim *et al* [10], Etim and Udoh [22,23] Udoh and Etim [23].

RESULTS AND DISCUSSION

The model specified was estimated by the maximum likelihood (ML) Method using a FRONTIER 4.1 software. Result on Table 1 shows ML estimates and inefficiency determinants. The sigma square 0.4407, is statistically significant and different from zero at $\alpha = 0.05$. This result indicates a good fit and the correctness of the specified distribution assumption of the composite error term. The variance defined as λ is estimated to be high as 72.22%; meaning that the systematic effect that are unaccounted for, by the production frontier function are the dominant sources of stochastic random errors. That is about 72.22% variation in the output level of the broilers raised could be attributed to the presence of technical inefficiency in resource use. The results of the diagnostic statistics therefore confirm the relevance of stochastic parametric production function and maximum likelihood estimation.

The result of production function estimates is quite revealing and adequate to explain the descriptive statistics pertaining to the sample characteristics of the variables examined as presented in Table 2. The relative relevance of resource input is shown in the production estimates. Except for capital, the coefficients of other productive inputs are statistically significant and have the expected signs and magnitude. All the estimated coefficients show inelastic relationship between the productive inputs and the output level. Therefore, considering the nature of elasticities of the factors and the quasi function of about 1.1201, the returns to scale for input use could be said to be fairly constant; as the sum of factor elasticities does not differ significantly from unity. According to Udoh [29], the presence of constant returns to scale in small farm business may be caused by the use of labour intensive simple technology in production. It therefore suggests that the benefits of technical economies of scale may not be realized at the present level of broiler production in the study area. Feed appears to be the most important factor of production with an elasticity of 0.5575. This is in line with the concept of weight gain in broiler production and physiology of feed conversion in poultry production. Broilers that are well fed *ad libitum* gain weights faster and attain marketable weights early and are sold at higher unit prices. Other running cost appears to be the second most important factors of production with an elasticity of 0.4409. This result confirms the importance of water, proper lighting and labour in broiler production. This is closely followed by medication with an elasticity of 0.3374. For intensive poultry production to be successful, routines of drugs and vaccinations as part of health

Table 1: Maximum likelihood estimates and inefficiency function

Variable	Coefficients	Asymptotic t-value
Production function		
Constant (β_0)	4.0845	3.9663***
Stocking density (β_1)	0.2310	2.3079**
Other running cost (β_2)	0.4409	1.8628*
Medication (β_3)	0.3374	2.7972***
Feeds (β_4)	0.5575	4.5385***
Capital (β_5)	-0.2181	-1.5431
Diagnostic statistics		
Sigma-square (δ)	0.4407	2.4676**
Gamma (λ)	0.7222	2.0321**
Ln(likelihood)	39.6063	
LR test	8.1613	
Quasi function	1.1201	
Number	100	
Inefficient function		
Intercept (δ_0)	0.7436	-0.5426
Age (δ_1)	0.6113	1.5700
Experience (δ_2)	-0.3897	-2.0679**
Education (δ_3)	-0.6277	-0.7501
Technical assistance (δ_4)	0.5631	1.8603*

SOURCE; computer print out of frontier 4.1

Note: All explanatory variables are in natural logarithms. A negative sign of the parameter in the inefficiency function implies that the associated variables have a positive effect on technical efficiency and a positive sign indicates the reverse is true. Asterisk indicate significance *** 1%, ** 5%, * 10% random errors

Table 2: Mean values of output and explanatory variables

Description	Unit	Mean value	Min. value	Max. value
Output	Naira	58,210	54084	60,184
Stocking Density	Number	120	85	241
Other running cost	naira	1,679	900	3,525
Medication	Naira	2,800	2,000	4,975
Feeds	Naira	10,000	8,000	20,892
Capital	Naira	800	480	1,525
Age	Years	44	21	58
Experience	Years	19	10	27
Education	Years	6	3	13

Source : Field Survey, 2007

Table 3: Farm specific technical efficiency

Efficiency Class	Frequency	Percentage
0.01-0.12	3	3
0.13-0.39	30	30
0.40-0.66	40	40
0.67-0.93	23	23
>0.94	4	4

Mean value = 0.62minimum = 0.03Maximum value = 0.96

management have to be administered. It therefore follows that under proper medication the broiler farmers in the study area would increase their output by 3.3 units. Stocking density with the elasticity of 0.2310 also shows the importance of optimal stocking of farms with adequate and healthy day old chicks.

The estimated coefficients of the inefficiency function provide some explanations for the relative technical efficiency levels among the individual farms. Except for age and education, the coefficients of other inefficiency variables were significant at five and ten percent levels. This implies that experience and technical assistance to farmers positively affect the farm level technical efficiency effect. These results are quite plausible: more years of experience enables farmers to acquire and process relevant information and knowledge more effectively and thus higher level of technical efficiency. This result agrees with the findings of Parikh ***et al.*** [30] and Udoh [21].

Table 3 presents the farm-specific resource-use efficiency indices. The frequency distribution of the efficiency indices shows a rather somewhat normal distribution. The mean efficiency value is 0.62 leaving inefficiency gap of 0.38. This implies that about 38% higher production could be achieved without additional resource, or input use could be reduced to achieve the same output level. The result indicates that for average broiler farmer to attain the technical efficiency level of their most efficient partner, they would realize about 35.4% [i.e. 1-(0.62/0.96)] cost savings in broiler production. On the other hand, the least technical efficient broiler farmers in the study area will have about 96.8% [i.e. 1- (0.03/0.96)] cost savings.

The rather low degree of technical inefficiency suggests that very little marketable broiler product is sacrificed to resource waste. But the inability of any of the farmers to operate on the frontier could be attributed to certain factors. Specifically, scare inputs may be allocated to various uses on the basis of their marginal shadow values preventing the farmers from reaching the efficiency frontier.

Concluding Remarks: The research focused on the use of survey data on inputs and output by broiler farmers in a metropolis to measure farm-level technical efficiency terms through stochastic parametric estimation method. Cobb-Douglas production frontier was estimated by maximum likelihood estimation to obtain ML estimates and inefficiency determinants. The parameters obtained were found to be asymptotically efficient and consistent. The diagnostic statistics confirmed the superiority of stochastic production function and the ML estimation method over deterministic function and OLS estimation method. Feeds, medication, stocking density and cost of lighting and water were estimated to have inelastic relationship with the broiler production in the city. On the average, the producers were relatively efficient in resource use although none of them attained optimal production level, given their technology and capacity. Increased animal production policy framework of the government should adequately address the issue of constant availability of feeds and medication. Specifically, provision of input subsidies and effective technical assistance in form of extension services could go a long way in thrusting the producers to the frontier of production.

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