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ANALYSIS OF PROFITABILITY AND TECHNICAL EFFICIENCY OF BROILER PRODUCTION IN NORTH-CENTRAL, NIGERIA.

[1]Umar, H.S., [1]Luka, E.G., [1]Alu, E.S. and [2]Peter, E.

[1]Department of Agricultural Economics and Extension, Nasarawa State University, Keffi, PMB 135 Shabu-Lafia Campus, Nigeria

[2]Department of Agriculture and Environmental Sciences, University of Nottingham, England, United Kingdom

*Corresponding Author's Email: emmanuel.peter@nottingham.ac.uk; immapeter@yahoo.com.

Phone: +447443974014

ABSTRACT

The study was carried out to determine the profitability and technical efficiency of broiler production in North-central, Nigeria. A multistage sampling technique was employed in the selection of 156 respondents. Data were analysed using descriptive statistics, budget technique and Cobb-Douglas stochastic frontier production model. The result of the study reveals that the average age of a broiler farmer in the study area was 43 years with a minimum of secondary school education, 10 years of experience in broiler production and an average family size was 7 members. With an average stock of 396 birds, the gross revenue was ₦ 1,766,578, the total cost was ₦1,660,254, and gross margin recorded was ₦106,324. The estimate of the production model revealed that initial stock, feeds, and medication were the significant inputs that influenced the production of broilers. The technical efficiency estimates of the broiler farmers ranged from 78% and 100% with a mean technical efficiency of 92.5%. The high cost of feeds, which constituted 76% of the total variable cost, was identified as the major constraint to broiler production. It is therefore recommended that initiatives that could drastically reduce market price of feeds should be implemented by relevant agencies of governments and NGOs.

Keywords: Broiler Production, Profitability, Technical Efficiency, Stochastic Production, Frontier Function

INTRODUCTION

Poultry is a key sub-sector in the Nigerian livestock industry. According to Central Bank of Nigeria (2019), the poultry sub-sector has been the most capitalised component of all the agricultural livestock sectors with a current net worth value of ₦1.6 trillion which represents 25% of the agricultural Gross Domestic Product (GDP) contribution to the Nigerian economy (CBN, 2019). Poultry production has two major components: broilers and layers. Broilers are basically chicken raised for meat purposes. Specifically, the broiler component of the poultry sub-sector has a resource of 104,247,960 birds which account for 48.72% of the Nigerian livestock production National Bureau of Statistics, NBS, (2020). This underscores the position of broiler farming in the livestock industry. The broiler sub-sector has been very relevant in providing employment opportunities particularly among the subsistence and medium class sector of the Nigerian populace (Aniekan *et al*., 2020). It has been reported that about 14% of the Nigerian population are involved in boiler farming, mainly on subsistence level (Ameh *et al*., 2016). Broiler production has also been considered as an important potential source of protein for the teeming Nigerian population, not just because of the prolific and speed growth of broilers, but also its adaptability to wide range of weather variations and its ease of integration with other farm activities particularly on smallholder scale (Mgbakor and Nzeadachie, 2013). Other importance attached to broiler production is the ability of broiler to transform nutrients into high quality protein within a short period of time (Ezeano and Ohaemesi, 2020).

Despite these attractions, the Nigerian poultry industry has been dimed as highly volatile due to myriads of challenges confronting the sector. These challenges include poor growth rate, high price of inputs such as feeds, high incidence of pest and diseases, poor management skills, infrastructural deficits, lack of credit facilities, lack of functional regulatory bodies to ensure compliance with best industry practice among others (Mayokun and Ogheneruemu, 2018; Orimogunje *et al*., 2021). The cumulative impact of these constraints has limited the development of the sector, in which broiler products are almost always inadequate in supply relative to its demand. Omolayo (2018) emphasised that the low supply of broiler products relative to its high demand can also be attributed to low returns on investment and poor resource management. Hence, the need to raise productivity level through efficient use of resources. A typical broiler farmer in Nigeria is profit oriented where relative income generated are compared to cost of production within the period.

Based on the aforementioned problems, this study was designed to examine profitability and efficiency of broiler farm business in the North-central Nigeria. The specific objectives therefore are to: (i) estimate the gross margin of broiler farms; (ii) examine the input/output relationship in broiler production; (iii) estimate technical efficiency of broiler farms; (iv) identify the determinants of TE; and (v) identify the constraints associated with poultry production in the study area.

METHODOLOGY

The study was carried out in North-central Nigeria. The North-central comprises six states of Plateau, Nasarawa, Benue, Niger, Kogi and Kwara. It lies in latitude 8^0 N and 10^0N, and longitude 30E and 10^0E, with mean annual temperature range from 24^0C to 37^0C, while the mean annual rainfall is between $100cm^3$ and $200cm^3$ (Terngu et al., 2014). The rainy season last from April to October while dry season spells from December to March. The common crops grown in the area are rice, yam, maize, sorghum, cassava, Irish potato, sesame etc. Livestock production like cattle, poultry, goats and sheep as well as fishery are also common in the area. Farming is the major occupation of the people in the area.

A multistage sampling technique was used to select the respondents for the study. The first stage of sampling involved purposive selection of three states namely, Plateau, Nasarawa and Niger. These states being contiguous to national headquarters, Abuja, which provides ready market for poultry products, have concentration of poultry businesses in the region. Secondly, the list of poultry farmers in the metropolitan towns of Lafia and Keffi in Nasarawa State, Jos and Bukuru in Plateau State, and Suleja and Minna in Niger States were obtained from Agricultural Development Programme (ADP) in each of the states which formed the sampling frame for the study. Next stage of sampling involved random selection of 50% of the registered farmers from each of the metropolitan towns in each state as follows: Nasarawa State (Lafia=30 and Keffi=22); Niger State (Minna= 35 and Suleja=25) and Plateau state (Jos= 20 and Bukuru=24). Hence, one hundred and fifty-six (156) broiler farmers were selected for the study.

Data were collected using questionnaire instruments administered by trained extension agents in each of the states in the Months of August and September, 2021. Data were collected on such variables like socio-economic characteristics of the farmers, input quantities and prices, output quantities and prices, as well as constraints to broiler enterprise. Descriptive statistics such as mean, frequency and percentages were used in achieving objective v. while Budget technique tools such as gross margin, operating ratio, farm income were used for achieving objective i. Objectives ii, iii and iv were achieved using Cobb-Douglas stochastic frontier production model.

Generally, the measurement of efficiency can be done either through classical or frontier approach. In poultry production classical approach simply compares total output (meat or egg) to total cost, while the frontier method identifies efficient farms as any farm operating on the production frontiers that generates more profits (Mayokun and Ogheneruemu, 2018).

Stochastic Frontier production Function and Technical Inefficiency Estimation: Technical efficiency can be defined as the ability to achieve maximum potential output from a specified quantity of input, considering the physical relationship of the production process (Bamiro *et al*., 2006). Therefore, excessive use of bundles of inputs with a resultant low output is a symptom of technical inefficiencies among other things. Hence, how much of farm output that lies below the production frontier of a farm, is its measure of loss or inefficiency (Adesiyan, 2014).

Technical efficiency of broiler production was estimated using Cobb-Douglas Stochastic Production function. The stochastic frontier production functions have been considered very helpful as it is used to measure not only technical efficiency sources in production but also the impact of measurements of errors not considered as inherently related to production (Battese *et al*., 2004). Hence, in adopting stochastic frontier model, the error term (e_i) is used in the estimation of technical efficiency. This model was first introduced by (Aigner and Cain, 1977; Meeusen and van den Broeck, 1977), and further developed and used by several others, among which are (Schmidt and Knox Lovell, 1979; Bravo-Ureta *et al*., 2020; Kumbhakar and Tsionas, 2021)**.** Technical efficiency of a production is the achievement of maximum possible output for a given quantity of inputs in view of the physical production relationship (Bamiro and Shittu, 2009). Therefore, a farm is said to be inefficient if more output could still be produced from the current level of input (Osinowo and Tolorunju, 2019)

Let's consider a farmer who uses farm inputs X_1, X_2………… X_n, to produce output Y., to obtain a maximum possible output from the combination of different inputs. The efficient transformation of these inputs to output is expressed by the production function $f(x)$.

The stochastic frontier production function model can be mathematically expressed as

$$Y_i = f(X_i;\ \beta)\ exp\ (e_i),\quad i= 1,2,3\ldots\ldots\ldots n \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The frontier production function $Y_i = f\ (X_i;\ \beta)$ is the measure of the maximum level of potential output for a given set of inputs X_i .The error term e_i reflects the random deviations in output from the frontier. This error has a duality component of V_i which represents the shocks and variations in production output as a result of inherent and uncontrollable factors beyond the control of the producer (e.g., natural disasters, weather fluctuations). The error, V_i is symmetrical and assumed to be independent and identically distributed with a zero mean and constant variance *(0, σv^2)*. The second error component is (U_i), which is a non-negative random variable that reflects technical inefficiency on the side of the farmers, and responsible for deviation in production below frontier production level. This error seems is slightly different and independent of the V_i as it is non-negative with a non-zero mean, constant variance and is half normal *N (0, $\sigma^2 u$)* (Osinowo and Tolorunju, 2019). Thus, $e_i = V_i - U_i$ represents composite error term:

Therefore,

$Y_i = f(X_i; \beta)\ f(X_i; \beta)\ exp\ Vi\quad i= 1,2,3\ldots\ldots\ldots n$ .... (2)

Y_i= production output for i[th] farm

X_i= quantities of input vector for i[th] farm

β= vectors of parameters that are unknown on the i[th] farm

V_i= cumulative error of random shocks

U_i= effects of inefficiency (non-negative)

The model above estimates simultaneously the technical efficiency of the individual respondent as well as the determinants of the technical efficiency of such respondent or farmer as in this case. Empirically, Technical efficiency is measured by the decomposition of error deviations into a random component V_i and the inefficiency component U_i

The frontier output is given as

$Y^*_i = f(X_i; \beta)\ exp\ Vi,$

$i= 1,2,3\ldots\ldots\ldots n$ .... (3)

Therefore, the technical efficiency of a specific farm is the ratio of observed farm output to the corresponding frontier potential output of that farm given the available Technology (Ojo, 2003)

$$TE= Y^*_i / Y_i = \frac{f\ (X_i;\ \beta)\ exp\ (Vi-Ui)}{F\ (X_i;\ \beta)\ exp\ Vi} \quad (4)$$

TE= f exp (U_i)

Model Specification:

The SFP function of broiler production was assumed to have the following specification according to Osinowo and Tolorunju (2019):

$lnY_i = ln\beta_0 + \beta_1 lnX_{1i} + \beta_2 lnX_{2i} + \beta_3 lnX_{3i} + \beta_4 lnX_{4i} + \beta_5 lnX_{5i}\ Vi - Ui$--(5)

Where;

ln = natural logarithm to base e,

Y_i= body weight of broiler in kg of the i[th] farm,

$\beta_{0=}$ constant term,

β_1-β_5= vectors of the unknown parameters to be estimated,

While Xs represents the independent variable input bundles used by i[th] broiler farmer during the production and is defined as follows:

X_1 = initial stock (number of day-old chicks)

X_2 = feeds in kg

X_3 =medication in litre

X_4= labour in man-day

X_5=water in litre

V_i = independent random errors which are assumed to identically distributed with a zero mean and constant variance (0, σv^2).

U_i= variation arising from technical inefficiencies of the farmer.

The diverse level of farm output recorded by farmers could be attributed to the individual farmers' production efficiencies. To explain these output variations across the sample broilers farmers, the controllable factors (U_i) were hypothesised as determinants of technical inefficiencies illustrated thus.

$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i}$ ....(6)

Ui = is the technical inefficiencies of the i[th] broiler farmer

δ_0 = is the constant term

$Z_{1=}$ age of the i[th] farmer in years

Z_2 = poultry farming experience of the i[th] farmer in years

Z_3 = educational level of the i[th] farmer in years

Z_4= household size of the i[th] farmer in number

$\delta_1 - \delta_4$ = coefficients of the maximum likelihood estimates

Gross Margin Analysis: It is usually recommended when a broiler farmer incurs mainly variable costs. Farm budget containing details of activities and financial plan that runs on the farm over production cycle. Gross margin is the difference between gross income and total variable cost.

Thus.

GM=GR-TVC………………………………………………………… …… *(7)*

GM= Gross margin/396 birds

GR= Gross revenue/396 birds

TVC= Total variable cost/396 birds

The Operating ratio (OR) of the farm was also examined as another indicator of profitability. It can be defined as:

OR = TVC ÷ GR

RESULTS AND DISCUSSION

The result in table 1 shows the descriptive statistics of some of the key variables employed in the analyses. The minimum initial stock of the birds in the study area was 40 birds, while the maximum was 4,000 birds. The mean of initial stock was 396 birds with a standard deviation of about 525 birds. This confirmed that broiler enterprise in study area was largely operated as a small-scale farm (Omotosho and Oladele, 1988). According to Omotosho and Oladele (1988), poultry farms with less than 1,000 stock are classified as small-scale enterprise. For the final stock, the minimum of 102 kg of the total stock weight was identified, while the maximum was 29,000 kg. The mean of total weight of the final stock was 1,298 Kg which determines its market value. The minimum kilogram of feeds within the production cycle was 263 kg, the maximum was 68,000 kg, while the mean was 5,010.6 kg.

The minimum quantity of medication applied throughout the production cycle was 9 litres, while the maximum was 3,600 litres. The minimum labour utilization in poultry production was 45 man-days while the maximum was 270 man-days. The mean labour was 77 man-days with a standard deviation of 42 man-days. The minimum water utilization by the birds within the production cycle was 70 litres, while the maximum water usage was 45,000 Litres. However, the mean water use by the birds as identified in the study area was 3,688 Litres.

In the case of farmers' characteristics, the average age of broiler farmers was 43 years, which implies that the farmers that were engaged in broiler farming were within their productive age bracket. On the average, this suggests that the farmers had sufficient energy to cope with the demands of poultry farming. This relates closely with a previous study that stated that the majority of broiler farmers had a mean age of 45 years (Omolayo, 2018). The average broiler farmers in the study area attended tertiary education with about 14 years of education. This high literacy level can afford them the opportunity to independently acquire better skills in the management of broiler farming. The 10 years of farming experience, on average, suggests that the farmers in the study area were well experienced in broiler farming. The mean household size of seven could be of help in the provision of family labour.

Table 1: Descriptive statistics of the variables.

Variables	Minimum	Maximum	Mean	Standard deviation
Final stock (Kg)	101.80	29000	1297.95	2891.70
initial stocks (No)	40	4000	396.09	524.90
Feed (Kg)	262.50	68000	5010.62	9170.39
Medication (litre)	9	3600	361.85	394.42
Labour (man-day)	45	270	77	42
Water (litre)	70	45000	3687.70	5874.37
Age (year)	25	60	43	6
Education (year)	2	16	14	4
Experience (year)	1	30	10	7
Household size (No)	1	19	7	5

Profitability Analysis

Table 2 below shows average revenue and the associated cost of the production for broiler in the study area. The average revenue earned from the production of 396 broilers was ₦ 1,766,578 while the associated average cost incurred in the production was ₦1,660,254, which implies that the gross margin was ₦106,324. This implied broiler farming is profitable enterprise in the study area. In the cost analysis, cost of feeds has been identified as the highest cost of production in the study area as it constituted 76% of the total variable cost of production. Dalhatu *et al.* (2018), observed that the single most important factor that constitutes the highest cost to broiler production was cost of feed. Other studies that highlighted feed cost as the largest cost to poultry farming in general includes Mgbakor and Nzeadachie (2013), Adesiyan (2014) and Ezeano and Ohaemesi (2020)

Table 2: Cost and returns per 396 birds per production cycle

Variable	Av. Quantity	Average Unit Price (₦)	Av. Cost/Ave Revenue (₦)	% of Total Variable Cost
A) Output				
Body weight at maturity (Kg)	1,298	1361	1,766,578	
GR= ₦ 1,766,578				
B) Variable Inputs				
Initial Stock (No)	396	427	169,092	10.2
Feed (Kg)	5011	253	1,267,783	76.3
Medication (litre)	362	491	177,742	10.7
Labour (man-day)	77	449	34,573	2.1
Water (L)	3,688	3	11,064	0.7
TVC= ₦1,660,254				
C) Profit				
GM=₦106,324				
IRT=1.06				

Input/output Relationship

Table 3 presents the results of the maximum likelihood estimates of the frontier production function for broiler farming in the study area. Three variables namely initial stock, feeds, and medication were positively and highly significant at 1%, which indicates that increasing the use of these inputs will increase the production of broilers. For instance, with 1% increase in feeds, broiler output or body weight of a bird is expected to increase by 0.21%. Similarly, 1% increase in medication would increase broiler output by 0.11% while 1% increase in the number of stocks would increase output by 0.63%. Disease control, feed intake and flock size are key determinants of output level in broiler production (Adesiyan, 2014; Omolayo 2018). Return to scale analysis shows that broiler production in the study area was characterised by increasing return to scale. In other word, if the quantum of inputs employed using the existing production technology is doubled, the broiler output would increase by more than twice.

Table 3: Maximum likelihood estimation (MLE) of the broiler production function

Variable	Parameter	Coefficients	Std. error	*t*-ratio
Constant	β_0	0.953	0.394	2.418**
Initial stock (number)	β_1	0.633	0.115	5.495***
Medication (litre)	β_2	0.105	0.036	2.951***
Feeds (Kg)	β_3	0.209	0.081	2.591***
Labour (man-day)	β_4	-0.056	0.123	-0.451
Water (Litre)	β_5	0.017	0.039	0.435
Return to Scale=1.90				

*** Significant at 1%; ** significant at 5 %

Technical Efficiency scores

The distribution of the technical efficiencies of the farmers are presented in Table 4. The results reveals that the technical efficiency scores range between 78% and 100%. The mean technical efficiency score was 93%. Also, 93% of the respondents were within the efficiency range of 81%-99%. The findings therefore suggest that an average broiler farmer in the study area could potentially increase broiler production by about 7% given the existing production technology. Only about 4% of the broiler farmers in the study area were producing at frontier capacity with efficiency of 100%. The general distribution of the efficiency scores of the broiler farmers in the study has a standard deviation of 0.06 signifying how cluster were the farmers in terms of production efficiency.

Table 4: Technical efficiency distribution among broiler farmers

TE class	Frequency	Percentage (%)
≤80	5	3.2
81-90	50	32.8
91-99	95	60.2
100	6	3.8
Total	156	100
Mean		0.93
Standard deviation		0.06
Minimum		0.78
Maximum		1.00

Determinants of technical inefficiency

The results in Table 5 show that the hypothesized socio-economic variables included in inefficiency effect model could not explain satisfactorily the behaviour of broiler farmers in relation to the efficiency of resource management in the study area as none of these variables was statistically significant. However, the sigma squared parameter for the broilers was 0.152 significantly different from zero at 1% (0.01) level of probability. This is an indication of goodness of fit and correctness relative to specified distribution of the assumed composite error terms in the broiler farmers estimated model. However, the value of Gamma parameter was very small and insignificant and could be interpreted to mean the differences between frontier output and real (observed) output was not due to technical inefficiency.

Table 5: Determinants of technical inefficiency

Variable	Coefficients	Standard error	t-ratio
Constant	0.202	0.849	0.238
Age of farmers	-0.080	0.253	-0.314
Years of experience	-0.102	0.077	-1.333
Education level	0.115	0.081	1.410
Household size	0.0481	0.0749	0.6427
Sigma squared	0.152	0.017	9.167***
Gamma	0.001	0.001	0.753

*** significant at 1%; ** significant at 5%; *** significant at 10%

Constraints faced by broiler farmers

Table 6 highlights the constraints faced by broiler farmers in the study area. High cost of feeds was considered as the most severe of all the constraints in the study area. This confirms with the findings of this research in which the cost of feeds alone was identified to account for over 76% of the total variable cost. This also agrees with a study conducted on the profitability of broiler farmers in cross river state Nigeria, in which high cost of feeds was also revealed as the most constraining factor faced by broiler farmers (Otu *et al*., 2021). Similarly, Osinowo and Tolorunju (2019) in their study also identified high cost of feeds as the most unbearable constraint identified by the poultry farmers.

High mortality rate was ranked the second most severe constraint and incidence of diseases the was ranked third. This is followed by high cost of medication. Mortality in broiler farming has a close correlation with inadequate control of diseases due to lack of proper medication and poor skills in handling birds. In a separate study, it was also revealed that lack of adequate skills and training was responsible for high mortality in broiler farming (Ezeano and Ohaemesi, 2020).

Table 6: Constraints faced by broiler farmers in the study area

Constraints	**Frequency**	**Ranking**
High cost of feed	104	1st
High Mortality rate	46	2nd
Incidence of diseases	23	3rd
High cost of drugs	09	4th

CONCLUSION AND RECOMMENDATIONS

Broiler farming in the North-central, Nigeria was profitable enterprise as average gross margin was ₦106,324 per 396 birds, but at the same time consistent with the assertion that the return is low. Three variables (initial stock, feeds, and medication) were positively and highly significant influencing the output of broiler farmers. On farm efficiency, an average broiler farmer in the study area could still increase efficiency-gap of broiler enterprise by 7% given the existing production technology. The high cost of feeds, which constituted 76% of the total variable cost, was identified as the major constraint to broiler production as well as profit limiting factor. It is therefore recommended that initiatives that could drastically reduce market price of feeds or subsidize the cost of feeds to poultry farmers in the study area should be implemented by relevant agencies of governments and NGOs. This would not only boost profitability but also encourage enterprise expansion for greater output, employment generation and ultimately bridging the gap between demand and supply of poultry products in the country.

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