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TECHINICAL AND SCALE EFFICIENCY OF POULTRY EGG PRODUCTION IN NIGERIA

Ajiboye A*. Farayola C.O**, Ogunjimi O.O***

* Department of Agricultural Economics and Extension Services Ekiti State University
PMB 5363, Ado Ekiti. Ekiti State, Nigeria
** Agricultural Development Management Department, General Management Division, PMB 1383 Kwara State, Nigeria.
***Department of Agricultural Science Education, Emmanuel Alayande University of Education PMB 1010
Corresponding Author: abiodun.ajiboye@eksu.edu.ng
Telephone: +2348030452320

Abstract: The study investigated the technical and scale efficiency of poultry egg production in Nigeria using a stochastic frontier approach. Data used for the analysis was extracted from the Nigeria - General Household Survey, Panel 2018-2019, Wave 4 of the world Bank .The result showed that the dataset is filled with backyard production system which is very close to 99%. The remaining was for both semi intensive and intensive production system. Only 8 of the states did not attain to full scale efficiencies. The result showed a very poor performance in terms of TE-CRS and TE-VRS. For the efficiency by size, the intensive production system has the highest value while the backyard and semi intensive were the second and third values respectively. In terms of the sectorial categorization, there was virtually no difference in the efficiency performance of the urban and rural settings. The paper grossly underscored the abject negligence of government and other high capacity stakeholders of the poultry subsector in the country.
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1.0 Introduction

The level of poverty in Nigeria is on the increase due to low level of income, high cost of food products particularly protein foods as well as its inadequate production of protein foods by farmers and lack of capital to establish on a large scale. The Nigerian poorest of the poor are the worst hit in terms of the current inflationary trend because they lack the financial strength to afford basic food needs especially animal protein or expand their production frontier due to severe interest rate regime of the current government. This group of people need more attention in terms of their diet most especially protein so as not to ruin agricultural production. It is very obvious that Nigeria is still struggling to meet up with the minimum food and nutrient requirements. Right Since the Nigerian independence in 1960, there have been flurries of literature (Aromolaran 1999, Mbanasor 2002, Nworgu 2002, Oteku et al., 2006; Iyangbe and Orewa, 2009; Adekunmi et al 2017, Akerele et al 2017 De Vries-Ten Have et al., 2020 Obayelu et al, 2022), indicating a dearth of animal protein in the diet of majority of Nigerian households. The country is highly populated and heterogeneous with the high dominance of nutritional deficiency varying across all her geopolitical zones due mainly to inadequacy supply of animal protein which sometimes result in high cost (Adekunmi et al., 2017; SPRING, 2018). As at 2019, Nigeria's per capita daily protein intake (45.4 g) was lower than both the Food and Agriculture Organization (FAO) recommended minimum per capita daily protein intake (53.8 g) and the global daily intake (64 g), indicating that the country is faced with protein deficiency (Metu et al., 2016; Akerele et al., 2017; Protein Challenge, 2020). in Nigeria malnutrition related to animal protein deficiency remains a very big challenge up till date as a result of the decline in protein (De Vries-ten Have et al., 2020). One easy way of increasing animal protein consumption in Nigeria is to focus more on the production of easy to access and affordable protein source such as poultry egg. To this end, the paper looks into the technical and scale efficiency of the Nigerian poultry egg sub-sector.

2.0 Material and method

2.1 Data

The data used was extracted from The General Household Survey-Panel (GHS-Panel) . This survey was implemented in collaboration with the World Bank Living Standards Measurement Study (LSMS) team as part of the Integrated Surveys on Agriculture (ISA) program. The objectives of the GHS-Panel include the development of an innovative model for collecting

agricultural data, interinstitutional collaboration, and comprehensive analysis of welfare indicators and socio-economic characteristics. The GHS-Panel is a nationally representative survey of approximately 5,000 households, which are also representative of the six geopolitical zones. The 2018/19 is the fourth round of the survey with prior rounds conducted in 2010/11, 2012/13, and 2015/16. GHS-Panel households were visited twice: first after the planting season (post-planting) between July and September 2018 and second after the harvest season (post-harvest) between January and February 2019. NBS (2021)

2.2 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 that combined 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.

$$\ln y_i = \beta_0 + \sum_{i=1}^{m} \beta_j \ln x_{ij} + v_i - u_i \quad i=1,2,....N \qquad (3)$$

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.

2.3 The model

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

$$\ln(Y_i) = \beta_0 + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \beta_4 \ln x_4 + v_1 - u_i \qquad (5)$$

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 fish produced in kilograms per period; X_1 stocking capacity per period; X_2 represent represents the total quantity of feed (in kilograms) per period, X_3 represents the pond size; X_4 represent the total number of labour in mandays . 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 parameters of the stochastic frontier production function was estimated using the programme R studio.

3.0 Results and Discussion

Table 1 shows the distribution of the respondents by state and by zone. There were six Geopolitical zones in the country. The first zone is the north central which comprise seven states, FCT inclusive. The sum total of these respondents in the zone was 348 which was second in terms of numbers of respondents. The following zone is the north east consisting of six states. A total of 312 respondents were drawn from the poultry producers in the zones. This number was the third in rank in terms of

the size of respondents the next is the North West zone with a total of seven states. This zone has the highest number of respondents,350 (22.89%) the south east had 256 respondents drawn from the five states in the zone and this represent 16.74% of the total population making the zone to rank 4th in terms of number of respondents. The Southsouth had six states and 116 respondents were drawn from the zone and the it ranked last in terms of number of respondents. The state with the highest data set was Bauchi from north east while Rivers and Bayelsa both ranked lowest with just two respondent respectively.

Table 1: Distribution of Respondents by State and Zone

State	Zone	Frequency	Percentage
Benue	Northcentral	102	6.67
FCT	Northcentral	11	0.72
Kogi	Northcentral	34	2.22
Nasarawa	Northcentral	20	1.31
Niger	Northcentral	19	1.24
Plateau	Northcentral	67	4.38
Kwara	Northcentral	95	6.21
		348	22.76
Adamawa	Northeast	57	3.73
Bauchi	Northeast	136	8.89
Borno	Northeast	14	0.92
Gombe	Northeast	35	2.29
Taraba	Northeast	44	2.88
Yobe	Northeast	26	1.70
		312	20.41
Jigawa	Northwest	80	5.23
Kano	Northwest	86	5.62
Katsina	Northwest	62	4.05
Kebbi	Northwest	22	1.44
Sokoto	Northwest	45	2.94
Zamfara	Northwest	10	0.65
kaduna	Northwest	45	2.94
		350	22.89
Abia	Southeast	47	3.07
Anambra	Southeast	47	3.07
Ebonyi	Southeast	55	3.60
Enugu	Southeast	45	2.94
Imo	Southeast	62	4.05
		256	16.74
Akwa Ibom	Southsouth	48	3.14
Bayelsa	Southsouth	2	0.13
Cross River	Southsouth	29	1.90
Delta	Southsouth	7	0.46
Edo	Southsouth	28	1.83
Rivers	Southsouth	2	0.13
		116	7.59
Ekiti	Southwest	26	1.70
Lagos	Southwest	7	0.46
Ogun	Southwest	28	1.83
Ondo	Southwest	6	0.39
Osun	Southwest	41	2.68
Oyo	Southwest	39	2.55
		147	9.61
TOTAL		1529	100.00

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From table 2 above, our classification is based on the Food and Agriculture Organization of the United Nations (FAO) standard of poultry production classification .1-1000 is classified as backyard system, between 1001 and 2000 is classified as semi intensive while above 2000 is classified as intensive production system. The result showed that the dataset is filled with backyard production system which is very close to 99%. The remaining was for both semi intensive and intensive production system. The result is a reflection of the kind of setting Nigeria is, in terms of development. it is expected that by this time of the century, mega poultry farms will should be widespread almost everywhere in the country. But small scale producers dominates .The basic reason for this is because investors prefer investing in other sectors of the economy where risks and uncertainties is less minimal than the agricultural sector where mostly the production system is plagued with lots of vagaries and potential resource failures. Furthermore, backyard system is very accessible and easy for low income individuals to embark upon unlike the semi-intensive and intensive system where input that cost millions of naira is needed to set them up. Also it easy to man and control the backyard poultry system than the two counterparts because many poultry business have folded up due to the pilfering and sharp practices of the workers.

Table 2: Distribution of Poultry Production Systems in Nigeria

Size	Frequency	Percentage
Backyard	1509	98.69
Intensive	5	0.33
Semi-intensive	15	0.98
Total	1529	100.00

The next table is the summary statistics or the annual output and input variables of the three systems. The variables are value of egg sold, cost of vaccine, cost of veterinary services, cost of water, cost of feed and cost of labour. From the p-value and the ANOVA test of differences in the units, it can be seen that the result is highly significant for all the variables. The mean value of egg sold was least for backyard system which is #11,300 while the mean value for intensive and semi intensive were respectively #1,132,619 and #113302.For the input variables, the intensive production system also had higher mean cost of vaccines, veterinary services, feed. The semi intensive system had higher cost of water while the backyard system had highest mean cost of labour. The result is a little bit digressive from reality because in most situations, small scale farmers tend to employ more of self and family labour than larger farmers.

Table 3 shows the distribution of the egg producers by return to scale. on a state by state level.29 of the states, the FCT inclusive had a Drs of zero while the Drs of 11.1%.Delta had the highest Drs of 22.2% and this represent just 2 of the data set. For the IRS, all the states recorded zero. Only Benue state had an IRS of 100%.The state with the highest CRS is Bauchi 9%.

Table 3: Summary Statistics of Annual Output and Input Variables by Production System

	Backyard (N=1509)	Intensive (N=5)	Semi-intensive (N=15)	Total (N=1529)	p value
Value of eggs sold					< 0.001
Mean (SD)	11200.244 (549.448)	1132619.800 (71219.287)	113302.133 (6267.227)	11237.695 (4180.671)	
Cost of Vaccine					< 0.001
Mean (SD)	1295.507 (2125.860)	47000.000 (48425.200)	9533.333 (7905.754)	1525.782 (4315.096)	
Cost of Vet Services					< 0.001
Mean (SD)	1069.185 (1309.359)	18100.000 (19119.362)	14033.333 (11717.610)	1252.060 (2544.104)	
Cost of Water					< 0.001
Mean (SD)	3104.460 (192.843)	3120.000 (0.000)	4688.000 (6455.442)	3120.046 (665.503)	

Cost of Feed					< 0.001
Mean (SD)	11995.689 (1485.545)	22784.000 (30148.918)	17082.000 (3156.226)	20965.202 (251941.239)	
Cost of Labor					< 0.001
Mean (SD)	1999 (36)	1600 (548)	1667 (488)	1994 (77)	

Table 4: Distribution of Egg Producers by Returns to Scale

	DRS (N=9)	IRS (N=1)	ORS (N=1519)	Overall (N=1529)
state				
Anambra	1 (11.1%)	0 (0%)	46 (3.0%)	47 (3.1%)
Delta	2 (22.2%)	0 (0%)	5 (0.3%)	7 (0.5%)
Imo	1 (11.1%)	0 (0%)	61 (4.0%)	62 (4.1%)
Kano	1 (11.1%)	0 (0%)	85 (5.6%)	86 (5.6%)
Katsina	1 (11.1%)	0 (0%)	61 (4.0%)	62 (4.1%)
Lagos	1 (11.1%)	0 (0%)	6 (0.4%)	7 (0.5%)
Ogun	1 (11.1%)	0 (0%)	27 (1.8%)	28 (1.8%)
Oyo	1 (11.1%)	0 (0%)	38 (2.5%)	39 (2.6%)
Benue	0 (0%)	1 (100%)	101 (6.6%)	102 (6.7%)
Abia	0 (0%)	0 (0%)	47 (3.1%)	47 (3.1%)
Adamawa	0 (0%)	0 (0%)	57 (3.8%)	57 (3.7%)
Akwa Ibom	0 (0%)	0 (0%)	48 (3.2%)	48 (3.1%)
Bauchi	0 (0%)	0 (0%)	136 (9.0%)	136 (8.9%)
Bayelsa	0 (0%)	0 (0%)	2 (0.1%)	2 (0.1%)
Borno	0 (0%)	0 (0%)	14 (0.9%)	14 (0.9%)
Cross River	0 (0%)	0 (0%)	29 (1.9%)	29 (1.9%)
Ebonyi	0 (0%)	0 (0%)	55 (3.6%)	55 (3.6%)
Edo	0 (0%)	0 (0%)	28 (1.8%)	28 (1.8%)
Ekiti	0 (0%)	0 (0%)	26 (1.7%)	26 (1.7%)
Enugu	0 (0%)	0 (0%)	45 (3.0%)	45 (2.9%)
FCT	0 (0%)	0 (0%)	11 (0.7%)	11 (0.7%)
Gombe	0 (0%)	0 (0%)	35 (2.3%)	35 (2.3%)
Jigawa	0 (0%)	0 (0%)	80 (5.3%)	80 (5.2%)
kaduna	0 (0%)	0 (0%)	45 (3.0%)	45 (2.9%)
Kebbi	0 (0%)	0 (0%)	22 (1.4%)	22 (1.4%)
Kogi	0 (0%)	0 (0%)	34 (2.2%)	34 (2.2%)
kwara	0 (0%)	0 (0%)	95 (6.3%)	95 (6.2%)
Nasarawa	0 (0%)	0 (0%)	20 (1.3%)	20 (1.3%)

	DRS (N=9)	IRS (N=1)	ORS (N=1519)	Overall (N=1529)
Niger	0 (0%)	0 (0%)	19 (1.3%)	19 (1.2%)
Ondo	0 (0%)	0 (0%)	6 (0.4%)	6 (0.4%)
Osun	0 (0%)	0 (0%)	41 (2.7%)	41 (2.7%)
Plateau	0 (0%)	0 (0%)	67 (4.4%)	67 (4.4%)
Rivers	0 (0%)	0 (0%)	2 (0.1%)	2 (0.1%)
Sokoto	0 (0%)	0 (0%)	45 (3.0%)	45 (2.9%)
Taraba	0 (0%)	0 (0%)	44 (2.9%)	44 (2.9%)
Yobe	0 (0%)	0 (0%)	26 (1.7%)	26 (1.7%)
Zamfara	0 (0%)	0 (0%)	10 (0.7%)	10 (0.7%)

Table 5 shows the state-level efficiencies of egg farms. Only eight of the states did not attain to full scale efficiencies. the result showed a very poor performance in terms of TE-CRS and TE-VRS. FCT has the lowest CRS efficiency of 0.07, followed by Delta state 0.09%. The highest CRS is Bayelsa state had a very low sample representative yet had the best CRS efficiency performance.

Table 5: State Level Efficiencies of Egg Farms

State	TE-CRS	TE-VRS	SE
Abia	0.15	0.15	1.00
Adamawa	0.14	0.14	1.00
Akwa Ibom	0.23	0.23	1.00
Anambra	0.21	0.23	0.98
Bauchi	0.16	0.16	1.00
Bayelsa	0.26	0.26	1.00
Benue	0.18	0.18	1.00
Borno	0.14	0.14	1.00
Cross River	0.16	0.16	1.00
Delta	0.09	0.24	0.72
Ebonyi	0.18	0.18	1.00
Edo	0.16	0.16	1.00
Ekiti	0.10	0.10	1.00
Enugu	0.10	0.10	1.00
FCT	0.07	0.07	1.00
Gombe	0.15	0.15	1.00
Imo	0.15	0.16	0.98
Jigawa	0.15	0.15	1.00
Kano	0.14	0.14	0.99
Katsina	0.15	0.16	0.99
Kebbi	0.19	0.19	1.00
Kogi	0.23	0.23	1.00
Lagos	0.19	0.31	0.88
Nasarawa	0.12	0.12	1.00
Niger	0.15	0.15	1.00
Ogun	0.19	0.22	0.97
Ondo	0.14	0.14	1.00
Osun	0.16	0.16	1.00
Oyo	0.15	0.18	0.97
Plateau	0.13	0.13	1.00

Rivers	0.03	0.03	1.00
Sokoto	0.16	0.16	1.00
Taraba	0.21	0.21	1.00
Yobe	0.18	0.18	1.00
Zamfara	0.11	0.11	1.00
kaduna	0.19	0.19	1.00
kwara	0.15	0.15	1.00

Tables 6 and 7 For the efficiency by size, the intensive production system has the highest of 0.25 while the backyard and semi intensive had efficiency values of 0.16 and 0.05 respectively. In terms of sector i.e. whether the farm is located in the urban or rural setting, both had the same performance of 0.16 each for CRS and IRS respectively. The rural setting had higher VRS efficiency of 0.18.

Table 6: Efficiency by Size

size	CRS	VRS	SE
Backyard	0.16	0.16	1.00
Intensive	0.25	0.45	0.60
Semi-intensive	0.05	0.24	0.80

Table 7: Efficiency by Sector

sector	CRS	VRS	SE
Rural	0.16	0.16	1.00
Urban	0.16	0.18	0.98

4.0 CONCLUSION AND RECOMMENDATION

The study investigated the technical and scale efficiency of poultry egg production in Nigeria using a stochastic frontier approach. The result showed that the dataset is filled with backyard production system which is very close to 99%. The remaining was for both semi intensive and intensive production system. Only 8 of the states did not attain to full scale efficiencies. The result showed a very poor performance in terms of TE-CRS and TE-VRS. For the efficiency by size, the intensive production system has the highest value while the backyard and semi intensive were the second and third values respectively. In terms of the sectorial categorization, there was virtually no difference in the efficiency performance of the urban and rural settings. Improved performance needs to be encouraged among the sectors. Enabling policy environment should be created by government to encourage large scale investors in the poultry subsector.

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