

Technical and Economic Efficiencies in Poultry Production in Imo State, Nigeria

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ABSTRACT

This study was carried out to estimate the technical and economic efficiencies of poultry farmers in Imo State, Nigeria. The data was collected with semi-structured questionnaire from 140 randomly selected poultry farmers. A stochastic frontier production function was estimated by using the maximum likelihood estimation technique to obtain the technical and economic efficiencies of poultry farmers. The mean technical efficiency of poultry farmers was 75 percent, while their mean economic efficiency was 21 percent. The generalized likelihood test indicated that, the poultry farmers are not fully technically and economically efficient in resource use. There is 79% allowance to increase economic efficiency of poultry farmers by improvement in technical efficiency.

Keywords: Efficiency, Stochastic Frontier, Poultry, Imo State.

1. INTRODUCTION

Poultry farming is an important agribusiness enterprise that has a great potential for providing additional income to our farming community and educated unemployed persons of the rural areas through creating self employment opportunities (1) Poultry production is one of the important sub-sectors in the Nigerian economy (2).

37 In addition to its contribution to the Gross Domestic Product (GDP) and provision of
38 employment opportunities, poultry production is a major source of protein in the country.
39 Poultry meat is found to be one of the most nutritious and most complete food known to man
40 and it provides a means by which rapid transformation of animal protein intake can be
41 achieved (3). Poultry products compare favourably with economically produced animal
42 protein (4). Despite the nutritive value of poultry meat its production in the country is grossly
43 inadequate as reflected in the wide gap between demand and supply of the product. This
44 could be attributed to numerous problems that poultry farmers in Nigeria are facing.

45 These problems include low capital base, inefficient management, technical
46 inefficiency, economic inefficiency, diseases and parasites and poor housing (5), high cost of
47 feeds, poor quality of day old chicks (DOC), inadequate extension and training facilities (6).
48 The poultry production capacity of farms has to increase rapidly to be able to meet up with
49 the increasing demand, and for this to be achieved, the present level of technical and
50 economic efficiency must be improved upon. Presently, there are dearth of studies on
51 efficiency of poultry farms (7; 8). Particularly, there are limited information about the
52 performance of poultry farms in terms of technical and economic efficiencies (9).
53 Efficiency is defined as how effectively a production unit uses variable resources for the
54 purpose of profit maximization given the best production technology available (10). However,
55 a number of empirical studies on poultry production in Nigeria have focused more on
56 production constraints (5; 6), economic analysis (7;11), and profitability (3; 9). For other
57 studies that attempted to ascertain the resource use efficiency of poultry farmers in Nigeria,
58 the ordinary least squares (OLS) estimation techniques were used.
59
60

These include works by (8, 12, 9, 13). The use of the ordinary least squares (OLS) estimating technique makes it difficult to determine farm level efficiency as it provides only an average function (14, 15) though it provides consistent estimates of the parameters except the intercept (10). To overcome this shortcoming of the OLS, the stochastic frontier function was developed and has been used by several researchers to estimate efficiency in agricultural production. Its beauty lies in its ability to test and quantify the inefficiency of individual farmers in a sample because it allows for statistical noise rather than attributing all deviation to efficiency difference. It is also straight forward to implement and interpret (16). A situation that is not possible with other partial measures of efficiency such as the OLS (17). Most of the previous studies that used the stochastic frontier production function in agriculture of developing countries limited their work to the determinants of technical efficiency. Studies such as those of (18, 19,20, 21, 22, 23,24 ,10,17). (25, 26 and 27) estimated technical efficiency of crop farmers in developing countries, including Nigeria. There is a paucity of published empirical works carried out in Nigeria generally and Imo State specifically that have made use of the stochastic frontier production function to estimate technical and economic efficiency simultaneously in poultry production. This study is therefore, intended to use the stochastic frontier function to provide estimates of technical and economic efficiency in poultry production in Imo State, Nigeria.

This study was conducted in the year 2012 in the three agricultural zones of Imo State.

The State lies within latitudes $5^{\circ} 40^1$ and $7^{\circ} 05^1$ North and longitude $5^{\circ} 35^1$ and $8^{\circ} 30^1$ East. It had a population of about 3.92 million people in 2006 (NPC, 2006). Imo State is divided into three agricultural zones of Owerri, Orlu and Okigwe, and further subdivided into 27 Local Government Areas (LGAs). Farming is the major occupation of the people.

The weather and environmental conditions of the state favour the production of poultry and other livestock such as sheep, goat, rabbit, pigs, etc. A pre-survey was initially carried out in each zone to identify poultry farmers through the assistance of Imo State Agricultural Development Programme (ADP) extension agents and officials of All Farmers Association of Nigeria (AFAN). The number of poultry farmers identified varied among the LGAs in each agricultural zone. Two LGAs from each zone that had the highest number of poultry farmers were purposively selected, making a total of six LGAs. The sampling frame was the list of poultry farmers in each selected LGA.

Proportionate sampling followed by random sampling techniques were employed in each LGA to selected the sample size of 140 poultry farmers. The study used mainly primary data which were collected with the aid of semi-structured questionnaire. Data were collected on variables such as socioeconomic characteristics of farmers, resource inputs and output in poultry production. Data were analyzed using descriptive statistics such as mean, frequency

98 distribution and percentages, as well as stochastic frontier production function.

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101 **Analytical Framework**

102 The stochastic frontier production function was specified as;

103
$$Y = f(X_i, \beta) \exp(V_i - U_i), i = 1, 2, \dots, n \dots \dots \dots (1)$$

104 Where, Y is output of poultry, X_i is actual input vector, β is vector of production function
105 parameters, V is random error term with zero mean, and U is non-negative one sided error
106 term.

107 Given that the functional form for this study is self dual, i.e. Cobb-Douglas, the
108 corresponding cost frontier can be derived and written as,

109
$$C = f(P, Y, \gamma) \dots \dots \dots (2)$$

110 Where, C is minimum cost associated with the production of poultry, P is vector of input
111 prices, Y is output of poultry, γ is vector of parameters.

112 Using Sheppard's Lemma we can obtain

113
$$\partial C / \partial P_i = X_i(P, Y, \gamma) \dots \dots \dots (3)$$

114
$$\partial^2 C / \partial P_i \partial P_j$$

115 This is the system of minimum cost input demand equations (28,16, 15). Substituting a
116 farm's input prices and quantity of output in equation (3) yields the economically efficient
117 input vector X_i . With observed levels of output given, the corresponding technically and
118 economically efficient costs of production will be equal to X_i , P and X_i , respectively, while the
119 actual operating input combination of the farm is X_i , P.

120 The three cost measures can then be used to compute the technical efficiency (TE)
121 and economic efficiency (EE) indices as follows;

122

123
$$TE = E(Y_i / U_i, X_i) \dots \dots \dots (4)$$

124
$$EE = E(C_i / U_i = 0, Y_i P_i) \dots \dots \dots (5)$$

125

$$(Y_i / U_i, X_i) \dots (4)$$

$$(C_i / U_i = 0, Y_i, P_i) \dots (5)$$

128

129 Note however that, efficient production is represented by an index of 1.0 while the lower
 130 values indicate a greater degree of inefficiency. Using the method by (15 and 14) which was
 131 based on the work of (30), efficiency can then be measured using the adjusted output as
 132 shown in equation (6).

$$Y^* = f(X_i, \delta) - U_i \dots (6)$$

134 Where, U can be estimated as;

$$E(U_i / \varepsilon_i) = \delta \delta (\varepsilon_i / \delta) = \varepsilon \delta \frac{1}{2f} - \dots (7)$$

138 Where, f(.) and F*(.) are standard normal density and cumulative distribution functions

139 respectively, $\delta = \partial / \partial v$, $\varepsilon_i = V - U$ and $\delta^2 = \delta_u + \delta_v^2$

140

141 Y^* is the observed output adjusted for statistical noise. When $\varepsilon_i \delta$ and δ estimates, are
 142 replaced in equations (6) and (7), it will provide estimates for U and V.

143 In this study, a Cobb-Douglas function was fitted to the stochastic production frontier of the
 144 poultry farmers using the Maximum Likelihood method. This functional form has been used
 145 in many empirical studies particularly those relating to developing countries' agriculture (16,
 146 14). It has been useful in estimating economic efficiency because it's self-dual. However,
 147 (14) had opined that functional form has limited effect on empirical efficiency measurement.

148 The production function model is specified as follows;

$$\ln Y = \ln \delta_0 + \delta_1 \ln X_1 + \delta_2 \ln X_2 + \delta_3 \ln X_3 + \delta_4 \ln X_4 + \delta_5 \ln X_5 + \delta_6 \ln X_6 + \delta_7 \ln X_7 + \varepsilon_i \dots (8)$$

151 Where, Y is output of poultry (kg), X1 is quantity of feed (kg), X2 is flock size (number of
 152 birds), X3 is labour input (mandays), X4 is cost of drugs and medication (N), X5 is capital
 153 (N), X6 is cost of management (N), and X7 is other inputs (N), Ln is natural logarithm, $\delta_0 -$

154 δ_7 are coefficients to be estimated, ϵ_i is composed error term which is also defined as $V - U$.
 155 the use of single equation model is justified by the assumption that farmers maximize
 156 expected profits as it is often assumed in similar studies (15,14). It is expected a priori that
 157 the coefficients of $X_1, X_2, X_3, X_4, X_5, X_6, X_7$, will be positive. The cost frontier function is
 158 also specified thus;

$$\ln C = \ln a_0 + a_1 \ln P_1 + a_2 \ln P_2 + a_3 \ln P_3 + a_4 \ln P_4 + a_5 \ln P_5 + a_6 \ln P_6 + a_7 \ln P_7 + a_8 Y^* + \epsilon_i \dots (9)$$

161 Where, C is cost of production per poultry farmer, P_1 is cost of feed, P_2 is cost of birds
 162 (N/bird), p_3 is cost of labour (N/manday), p_4 is cost of drugs and medication (N/bird), p_5 is
 163 cost capital (N), p_6 is cost of management (N/manday), p_7 is other costs (N/bird), Y^* is
 164 output of matured bird in kg adjusted for statistical noise, $a_1 - a_7$ are parameters to be
 165 estimated, a_0 is the y – intercept, and ϵ_i is the composed error term. It is expected a priori
 166 that the coefficients of $P_1, P_2, P_3, P_4, P_5, P_6$ and P_7 will be positive.

167

168 2. RESULTS AND DISCUSSION

169 Socio-economic characteristics of farmers.

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171 In Table 1, the socioeconomic characteristics of the poultry farmers are presented. The table
 172 indicates that an average poultry farmer spent about 9 years in formal education, had 8
 173 persons in their household, acquired 13.6 years experience in poultry farming, had 727
 174 birds, received 0.81 extension visit, and was aged about 45 years old. Also, 86.4% of them
 175 are married, only 30.7% of them had access to credit, and 65.7% of them belong to farmers
 176 associations. This result imply that most of the poultry farmer are literate enough to
 177 understand improved poultry production technologies that can improve their farm income.
 178 The larger household sizes could be an advantage to the poultry farmers in the area of
 179 provision of household labour. The mean farming experience indicates that the poultry
 180 farmers are experienced enough in poultry production to understand the rudiments of poultry
 181 farming. The mean farm size implies that most of the poultry farmer are operating at small
 182 scale. The poultry farmers received poor extension contact which could lead to low adoption
 183 of poultry production technologies. The mean age of the farmers indicates that they are at
 184 their active stage of life to under take the level of operations involving in poultry production.

185 Table 1. Distribution of Poultry Farmers According to Socioeconomic Characteristics
186

187	Variable	Frequency	Percentage	Mean
188	Marital status	121	86.4	
189	Married	19	13.6	
190	Single	140	100	
191	Total			
192	Level of education (years)			
193	0 (No formal education)	6	4.3	
194	1–6	34	24.3	
195	7 – 12	75	53.6	
196	13 – 18	23	16.4	
197	19 and above	2	1.4	
198	Total	140	100	8.8 years
199	Household size (No. of persons)			
200	2–4	11	7.9	
201	5–7	39	27.9	
202	8 – 10	52	37.1	
203	11 and above	38	27.1	
204	Total	140	100	8 persons
205	Farming experience (years)			
206	≤ 10	26	18.6	
207	11 – 15	64	45.7	
208	16 – 20	37	26.4	

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217	21 and above	13	9.3	
218	Total	140	100	13.6 years
219	Flock size (No. of birds)			
220	≤ 500	31	22.1	
221	501 – 700	41	29.3	
222	701 – 900	15	10.7	
223	901 – 1100	34	24.2	
224	1101 – 1300	13	9.3	
225	1301 and above	6	4.3	
226	Total	140	100	727 birds
227	Extension contact (No. of visits)			
228	0 (No. of visits)	79	56.5	
229	1 – 2	52	37.1	
230	3 – 4	7	5.0	
231	5 – 6	2	1.4	
232	Total	140	100	0.81 visits
233	Access to credit			
234	Access	43	30.7	
235	No access	97	69.3	
236	Total	140	100	
237	Farmers associations membership			
238	Member	92	65.7	
239	Non – member	48	34.3	
240	Total	140	100	
241	Age (years)			
242	≤ 30	8	5.7	
243	31 – 40	37	26.5	
244	41 – 50	54	38.6	
245	51 – 60	24	17.1	
246	61 – 70	14	10.0	
247	71 and above	3	2.1	
248	Total	140	100	45.4 years
249	Sources: survey data 2012			
250				
251				
252				
253				
254				
255	Statistics of Output and Input Variables			

Table 2 presents the summary statistics of output and input variables in poultry production in Imo State, Nigeria. The table shows that mean output per poultry farmer was 2181 kg, quantity of feed was 4813 kg, flock size was 772 birds, labour input was 604 mandays, expenditure on drugs and medication was N3105, capital was N103465, cost of management was N81500, other inputs was N3655. The total cost of production per farmer was N136495.64, feed cost per 50kg bag was N6016, cost of one bird was N143.30, labour cost per manday was N1540, cost of drugs and medication per bird was N13.54, cost of capital was N125413, cost of management was N2013, while cost of other inputs was N14.34 per bird.

TABLE 2. SUMMARY STATISTIC OF OUTPUT AND INPUT VARIABLES IN POULTRY PRODUCTION

Variable	Unit	Mean
Output (Y)	kg	2181
Feed (X_1)	kg	4813
Flock size (X_2)	Number of Birds	772
Labour (X_3)	Mandays	604
Drugs and medication (X_4)	₦	3105
Capital (X_5)	₦	103465
Management (X_6)	₦	81500
Other inputs (X_7)	₦	3655
Total cost (C)	₦/farmer	136495.64
Feed cost (P_1)	₦/50kg	6016
Cost of birds (P_2)	₦/bird	143.30
Labour cost (P_3)	₦/manday	1540
Cost of drugs and Medication (P_4)	₦/bird	1354
Cost of capital (P_5)	₦/farmer	125413
Cost of management (P_6)	₦/manday	2015
Cost of other inputs (P_7)	₦/bird	14.34

SOURCE: SURVEY DATA 2012

292 Estimation of stochastic production and cost Frontier Functions

293 The estimates of the stochastic production frontier function (Table 3) indicate that, all the
 294 coefficients carried the expected positive signs. The coefficients of feed (X₁), flock size (X₂),
 295 labour (X₃), and capital (X₅) were significant at 1% level, while the coefficients of drugs and
 296 medication (X₄), management (X₆), and other inputs (X₇) were significant at 5% level. The
 297 sum of the elasticities was 1.958, indicating that, the poultry farmers were operating in the
 298 region of increasing returns to scale. The gamma (γ) was 0.783 which was high enough and
 299 significant at 1% level. It gives an indication that the unexplained variations in output are the
 300 major sources of random errors. It also shows that about 78 percent of the variations in
 301 output of poultry farmers are caused by technical inefficiency.

302
 303 Table 3. MLE of the Stochastic Production Frontier Function in Poultry Production
 304 in Imo State.

305	Variable	Coefficient	t-ratio
306	Constant	5.297	4.392**
307	Feed (X ₁)	0.493	3.011**
308	Flock size (X ₂)	0.378	2.813**
309	Labour (X ₃)	0.512	3.016**
310	Drugs and medication (X ₄)	0.067	2.512**
311	Capital (X ₅)	0.281	3.157**
312	Management (X ₆)	0.146	2.341*
313	Other inputs (X ₇)	0.081	2.339*
314	Diagnostic statistics		
315	Gamma (γ)	0.783	2.544**
316	Sigma square (σ^2)	0.531	2.493**
317	Log likelihood function	-106.39	
318	LR test	22.73	

319 *significant at 5%

320 ** significant at 1%

321 Source: output of Frontier 4.1 by (30)

322 It also confirms the presence of the one-sided error component in the model and hence, the
 323 use of the OLS in estimating the function, becomes inadequate in representing the data. The

sigma square (δ^2) estimate was 0.531 and significant at 1%, and therefore, assures us of the goodness of fit and correctness of the distributional assumptions of the composite error. The generalized likelihood test gave a value of 22.73 which indicates that the farmers are not fully technically efficient. (16, 10, 17, and 14), obtained similar results in their different studies.

Table 4. MLE of the stochastic cost Frontier in Poultry Production in Imo State, Nigeria.

Variable	Coefficient	t-ratio
Constant	6.094	4.106**
Feed cost (Px1)	0.409	3.115**
Cost of birds (P x2)	0.312	3.044**
Labour cost (P x3)	0.503	3.152**
Cost of drugs and Medication (P x4)	0.092	1.643
Cost of capital (P x 5)	0.056	1.814
Cost of management (Px6)	0.115	2.522*
Cost of other inputs (Px7)	0.058	1.549
Output (Y*)	1.731	4.037**
Diagnostic statistics		
Gamma (γ)	0.98	3.918**
Sigma square (δ^2)	0.65	3.433**
Log likelihood function	-96.03	
LR test	67.25	

*Significant at 5%

**Significant at 1%

Source: Output of Frontier 4.1 by (30)

In the cost frontier function (Table 4), all the variables carried the expected positive signs. The coefficients of feed cost (Px1), cost of birds (Px2), labour cost (Px3), and output (Y*) adjusted for statistical noise were significant at 1%, while the coefficients of cost of management (Px6), was significant at 5%. The coefficients of cost of drugs and medication (Px4), cost of capital (Px5), and cost of other inputs (Px7) were not significant even at 5% level.

The gamma (γ) estimate was 0.98 and was significant at 1% level indicating that 98% of the

variation in output were caused by economic inefficiency. The sigma square (δ^2) was 0.65 and was significant at 1% level, and indicated the goodness of fit and correctness of the specified assumptions of the distribution of the compound error term (15). The generalized likelihood test gave a value of 67.25 which indicates that the farmers are not fully such economically efficient.

362

363 **Estimates of Technical and Economic Efficiency in Poultry Production**

364 The estimates of Technical Efficiency of poultry farmers are presented in Table 5. Results
365 show that technical efficiency ranged from 0.36 to 0.97 with mean technical efficiency as
366 0.75. This suggests that there are about 25% chance of increasing output without additional
367 resources in poultry production. This result also indicates that, for the average poultry farmer
368 to achieve the technical efficiency level of his/her most efficient partner, he would realize
369 about 23 percent (i.e. $1 - (95/97)$) cost savings. On the other hand, the least technically
370 efficient poultry farmers, will have about 64 percent (i.e. $1 - (36/99)$) cost savings.

371 The efficiency distribution, show that, about 4.3 percent of poultry farmers attained between
372 0.91 – 1.00 technical efficiency levels. About 38 percent of the poultry farmers attained
373 technical efficiency of between 0.71 – 0.80, while only 2.86% of the poultry farmers attained
374 technical efficiency below 0.51.

375

376 The high mean technical efficiency is suggestive of the fact that only a small fraction of the
377 output of the output is attributed to resource wastage. The technical efficiency distribution
378 agrees with that obtained by (10, 17 and 14).
379

380 **Table 5. Frequency Distribution of Technical Efficiency of Poultry Farmers in**
381 **Imo State, Nigeria**

382	Technical Efficiency	Frequency	Percentage
383	≤ 0.50	4	2.86
384	0.51 – 0.60	13	9.29
385	0.61 – 0.70	20	14.29
386	0.71 – 0.80	53	37.86
387	0.81 – 0.90	44	31.42

388	0.91 – 1.00	6	4.28
389	Total	140	100
390	Mean Technical Efficiency	0.75	
391	Minimum Technical Efficiency	0.36	
392	Maximum Technical Efficiency	0.97	

393 Source: Derived from output of computer programme, frontier 4.1 by (30)

394 The Economic Efficiency estimates are presented in Table 6. It shows a range from
 395 0.14 to 0.56. The mean economic efficiency in poultry production in the study area was
 396 21%. The estimates also show that for the average poultry farmer to attain the level of
 397 the most economically efficiency farmer in the sample, he/she would experience a cost
 398 saving of 62.5 percent (i.e, 1 – 21/56) in poultry production.

400 However, the least economically efficient poultry farmer will experience efficiency
 401 gain of about 25 percent (i.e., 1 – 14/56) in poultry production to attain the level of the
 402 most economically efficient farmer in the sample. The results are also lower than that
 403 obtained (16 and 14).

404 Table 6. Frequency Distribution of Economic Efficiency of Poultry Farmers in Imo
 405 State Nigeria.

407	Economic Efficiency	Frequency	Percentage
408	≤ 0.20	65	46.41
409	0.21 – 0.30	42	30.00
410	0.31 – 0.40	20	14.29
411	0.41 and above	13	9.3-
412	Total	140	100
413	Mean Economic Efficiency 0.21		
414	Minimum Economic Efficiency 0.14		
415	Maximum Economic Efficiency 0.56		

416 Source: Derived from output of computer programme, Frontier 4.1 (30)

418 3. CONCLUSION

419 This study estimated technical and economic efficiencies of poultry farmers in Imo State,
 420 Nigeria. The study found that poultry farmers in the state are not fully technically and
 421 economically efficient in their use of resources and therefore, there is enough allowance to

422 increase their efficiencies if some important policy variables are addressed. It has also
423 shown that the major efficiency problem of the poultry farmers is not so much of technical.
424 Therefore, the farmers with their current resource base and technology, if technical efficiency
425 is improved can substantially improve economic efficiency, which is the product of technical
426 and allocative efficiencies.

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619 **DEFINITIONS, ACRONYMS, ABBREVIATIONS**

620 Here is the Definitions section. This is an optional section.

621 **Term:** Definition for the term

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623 **APPENDIX**