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

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Authors' contributions

This work was carried out in collaboration between all authors. Authors DOO and JUM designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors PNO, COE and AHU, NGBC managed the analyses of the study. Author CCGI managed the literature searches. All authors read and approved the final manuscript.

Research Article

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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.

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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].

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

These problems include low capital base, inefficient management, technical inefficiency, economic inefficiency, diseases and parasites and poor housing [5], high cost of feeds, poor quality of day old chicks (DOC), inadequate extension and training facilities [6]. The poultry production capacity of farms has to increase rapidly to be able to meet up with the increasing demand, and for this to be achieved, the present level of technical and economic efficiency must be improved upon. Presently, there are dearth of studies on efficiency of poultry farms [7,8]. Particularly, there are limited information about the performance of poultry farms in terms of technical and economic efficiencies [9].

Efficiency is defined as how effectively a production unit uses variable resources for the purpose of profit maximization given the best production technology available [10]. However, a number of empirical studies on poultry production in Nigeria have focused more on production constraints [5,6], economic analysis [7,11], and profitability [3,9]. For other studies that attempted to ascertain the resource use efficiency of poultry farmers in Nigeria, the ordinary least squares (OLS) estimation techniques were used.

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]. [25,26,27] 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 5^0 40^1 and 7^0 05^1 North and longitude 5^0 35^1 and 8^0 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 distribution and percentages, as well as stochastic frontier production function.

2. ANALYTICAL FRAMEWORK

The stochastic frontier production function was specified as;

$$Y = f(Xi, \beta) \exp(Vi - Ui), \; i = 1,2,\ldots..n \tag{1}$$

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

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

$$C = f(P, Y, \gamma) \tag{2}$$

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

Using Sheppard's Lemma we can obtain

$$\frac{\delta C}{\delta Pi} = Xi(P, Y, \gamma) \tag{3}$$

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

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

$$TE = E(Yi/ U_i, Xi,) \tag{4}$$

$$EE = E(Ci/ U_i =0, Yi\ Pi) \tag{5}$$

$$(Yi/ U_i, Xi,) \tag{6}$$

$$(Ci/ U_i =0, Yi\ Pi) \tag{7}$$

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

$$Y^* = f\ (Xi, \delta) – U_i \tag{8}$$

Where, U can be estimated as;

$$E(Ui/\varepsilon_i) = \delta\ \delta\ \ (\varepsilon_i\ \lambda/\delta) \quad = \quad \frac{\varepsilon\delta}{2f} \tag{9}$$

Where, f(.) and F*(.) are standard normal density and cumulative distribution functions respectively, $\delta = \delta/ \delta v$, $\varepsilon i = V – U$ and $\delta^2 = \delta u + \delta v^2$

Y* is the observed output adjusted for statistical noise. When εiδ and δ estimates, are replaced in equations (6) and (7), it will provide estimates for U and V.

In this study, a Cobb-Douglas function was fitted to the stochastic production frontier of the poultry farmers using the Maximum Likelihood method. This functional form has been used in many empirical studies particularly those relating to developing countries' agriculture [16,14]. It has been useful in estimating economic efficiency because it's self-dual. However, [14] had opined that functional form has limited effect on empirical efficiency measurement. The production function model is specified as follows;

$$Ln\ Y = Ln\ \delta0 + \delta1 ln\ X1 + \delta2\ ln\ X2 + \delta3\ ln\ X3 + \delta4\ ln\ X4 + \delta5\ ln\ X5 + \delta6\ ln\ X6 + \delta7\ ln\ X7 + \varepsilon i \ldots (10)$$

Where, Y is output of poultry (kg), X1 is quantity of feed (kg), X2 is flock size (number of birds), X3 is labour input (mandays), X4 is cost of drugs and medication (N), X5 is capital (N), X6 is cost of management (N), and X7 is other inputs (N), Ln is natural logarithm, δ0 – δ7 are coefficients to be estimated, εi is composed error term which is also defined as V– U. the use of single equation model is justified by the assumption that farmers maximize expected profits as it is often assumed in similar studies [15,14]. It is expected a priori that the coefficients of X1, X2,X3, X4, X5, X6, X7, will be positive. The cost frontier function is also specified thus;

$$LnC = lna0 + a1lnPx1 + a2lnPx2 + a3lnPx3 + a4lnPx4 + a5lnPx5 + a6ln Px6 + a7lnPx7 + a8Y^* + \varepsilon i \ldots\ldots (11)$$

Where, C is cost of production per poultry farmer, P 1 is cost of feed, P2 is cost of birds (N/bird), p3 is cost of labour (N/manday), p4 is cost of drugs and medication (N/bird), p5 is cost capital (N), p6 is cost of management (N/manday), p7 is other costs (N/bird), Y* is output of matured bird in kg adjusted for statistical noise, a 1 – a7 are parameters to be estimated, a0 is the y – intercept, and εi is the composed error term. It is expected a priori that the coefficients of Px1, Px2, Px3, Px4, Px5, Px6 and Px7 will be positive.

3. RESULTS AND DISCUSSION

3.1 Socio-Economic Characteristics of Farmers

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

Table 1. Distribution of poultry farmers according to socioeconomic characteristics

Variable	Frequency	Percentage	Mean
Marital status	121	86.4	
Married	19	13.6	
Single	140	100	
Total			
Level of education (years)			
0 (No formal education)	6	4.3	
1–6	34	24.3	
7 – 12	75	53.6	
13 – 18	23	16.4	
19 and above	2	1.4	
Total	140	100	8.8 years
Household size (No. of persons)			
2–4	11	7.9	
5–7	39	27.9	
8 – 10	52	37.1	
11 and above	38	27.1	
Total	140	100	8 persons
Farming experience (years)			

≤ 10	26	18.6	
11 – 15	64	45.7	
16 – 20	37	26.4	
21 and above	13	9.3	
Total	140	100	.6 years
Flock size (No. of birds)			
≤ 500	31	22.1	
501 – 700	41	29.3	
701 – 900	15	10.7	
901 – 1100	34	24.2	
1101 – 1300	13	9.3	
1301 and above	6	4.3	
Total	140	100	7 birds
Extension contact (No. of visits)			
0 (No. of visits)	79	56.5	
1 – 2	52	37.1	
3 – 4	7	5.0	
5 – 6	2	1.4	
Total	140	100	31 visits
Access to credit			
Access	43	30.7	
No access	97	69.3	
Total	140	100	
Farmers associations membership			
Member	92	65.7	
Non – member	48	34.3	
Total	140	100	
Age (years)			
≤ 30	8	5.7	
31 – 40	37	26.5	
41 – 50	54	38.6	
51 – 60	24	17.1	
61 – 70	14	10.0	
71 and above	3	2.1	
Total	140	100	.4 years

Sources: survey data 2012

3.2 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 N 2013, 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	54
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

3.3 Estimation of Stochastic Production and Cost Frontier Functions

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

Table 3. MLE of the stochastic production frontier function in poultry production in Imo state

Variable	Coefficient	t-ratio
Constant	5.297	4.392**
Feed (X_1)	0.493	3.011**
Flock size (X_2)	0.378	2.813**
Labour (X_3)	0.512	3.016**
Drugs and medication (X_4)	0.067	2.512**
Capital (X_5)	0.281	3.157**
Management (X_6)	0.146	2.341*
Other inputs (X_7)	0.081	2.339*
Diagnostic statistics		
Gamma (γ)	0.783	2.544**
Sigma square (δ^2)	0.531	2.493**
Log likelihood function	-106.39	
LR test	22.73	

**significant at 5%, ** significant at 1%, Source: output of Frontier 4.1 by (30)*

It also confirms the presence of the one-sided error component in the model and hence, the use of the OLS in estimating the function, becomes inadequate in representing the data. The sigma square (δ2) 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. [16,10,17,14], 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 (δ2)	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 (δ2) 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.

3.4 Estimates of Technical and Economic Efficiency in Poultry Production

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

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

The high mean technical efficiency is suggestive of the fact that only a small fraction of the output of the output is attributed to resource wastage. The technical efficiency distribution agrees with that obtained by [10,17,14].

Table 5. Frequency distribution of technical efficiency of poultry farmers inImo State, Nigeria

Technical efficiency	Frequency	Percentage
≤ 0.50	4	2.86
0.51 – 0.60	13	9.29
0.61 – 0.70	20	14.29
0.71 – 0.80	53	37.86
0.81 – 0.90	44	31.42
0.91 – 1.00	6	4.28
Total	140	100
Mean Technical Efficiency	0.75	
Minimum Technical Efficiency	0.36	
Maximum Technical Efficiency	0.97	

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

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

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

Table 6. Frequency distribution of economic efficiency of poultry farmers in Imo State Nigeria

Economic Efficiency	Frequency	Percentage
≤ 0.20	65	46.41
0.21 – 0.30	42	30.00
0.31 – 0.40	20	14.29
0.41 and above	13	9.3-
Total	140	100
Mean Economic Efficiency	0.21	
Minimum Economic Efficiency	0.14	
Maximum Economic Efficiency	0.56	

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

4. CONCLUSION

This study estimated technical and economic efficiencies of poultry farmers in Imo State, Nigeria. The study found that poultry farmers in the state are not fully technically and economically efficient in their use of resources and therefore, there is enough allowance to increase their efficiencies if some important policy variables are addressed. It has also shown that the major efficiency problem of the poultry farmers is not so much of technical. Therefore, the farmers with their current resource base and technology, if technical efficiency is improved can substantially improve economic efficiency, which is the product of technical and allocative efficiencies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ahmed S, Hamid M. A Status of poultry production and Development Strategies in Bangladesh. Proceedings of the workshop on livestock Development in Bangladesh, 1992. held on July 16 – 18 1991 at Bangladesh livestock Research institute, Savar, Ohaka.
2. Rahman, SA, Yakubu A. The status of commercial poultry egg production in Nasarawa State in Nigeria. Production Agriculture and Technology. An International journal of Agricultural Research. 2005;1(1):122–129.
3. Murtala N, Hamna U, Abdurahaman S, Qwaram MY, Suleiman O. Cost and Return Analysis of Poultry Eggs Marketing: A case study of Bauchi State. A paper presented at the Annual Conference of the Nigerian Association of Agricultural Economics 2004 held at Ahmadu Bello University, Zaria, Nigeria. November 3 – 5.
4. Obioha FC. A Guide to poultry Production in the Tropics. 1992 Acena Publishers Enugu, Nigeria.
5. Alabi RA, Isah AO. Poultry Production constraints. The case of Esan West Local Government Area of Edo State, Nigeria. African Journal of Livestock Extension. 2002;1(1):58 – 61
6. Bamgbose, A. M. Sani, R.M; Sanusi, M and Rufum, U.S .Major constraints of Poultry production in Bauchi Metropolis. Proceedings of 3 rd Annual ASAN Conference, Ikeja, Lagos. 1998;259–261
7. Daokinal, R.M .Analysis of Returns and Constraints in Poultry Production. Pakistan Journal of Agricultural Economics 2005;3(2):14 – 23.
8. Ohajianya DO, Obasi PC. Resource use Efficiency in small holder poultry production in Imo State, Nigeria. International Journal of Social Sciences 2005;4(1):194 –203.
9. Sarker SC, Abedin J, Islam SMF. Performance of Commercial Poultry Farms: A Profitability and Efficiency Analysis. Bangladesh Journal of Agricultural Economics 1999;xxii(l):63 – 75.
10. Kebede TA. Farm Household Technical Efficiency: A stochastic Frontier Analysis: A study of Rice producers in Mardi-Watershed in the Western Development Region of Nepal. Masters Thesis, Department of Economics and Social Science, Agricultural University of Norway. 2001;56-58.
11. 11.Olabimbo MA. Analysis of Table Egg Production as a livelihood activity in Ekiti State. Journal of Agriculture and Social Research. 2006;6(2):17-22.

12. Mijindadi NB. Production Efficiency of Farmers in Northern Nigeria, Ph.D. Thesis, Ithaca, Cornel University. 1980;29-34.
13. Nkasiobi SO. Egg production and food security in Rivers State, Nigeria. Food production in a developing economy. Afro- Euro Centre for Development Studies, Spain. 2009;1(1):8-16.
14. Idiong IC, Onyenweaku GE, Agom DI. Technical and Economic Efficiencies in rice production systems in the Niger Delta Region of Nigeria. Food production in a developing economy, Afro-Euro Centre for Development studies, Spain, 2009;1(1):346-360.
15. Bravo-Ureta, B.E and A.E Pinheiro Technical, Economic and Allocative Efficiency in Peasant Farming: Evidence from the Dominican Republic. The Developing Economies. 1997;xxxv(1):48–67.
16. Xu X, S Jeffrey. Rural Efficiency and Technical progress and Modern Economic Evidence from Rice production in China. Staff paper 95 -02. Department of Rural Economy, Faculty of Agriculture, Forestry and Home Economics University of Edmonton Canada. 1995:32-37.
17. Ajibefun IA, Aderinola E. Determinants of Technical Efficiency and Policy Implications in Traditional Agricultural Production: Empirical study of Nigerian Food crop Farmers. Report presented at the Bi-Annual Research Workshop of AERC, Nairobi-Kenya, May 24^{th}–29^{th} 2003.
18. Bagi FS, Haung FF. Estimating production Technical Efficiency for individual farms in Tennesse. Canadian Journal of Agricultural Economics. 1983;31(1):249–256.
19. Kalirajan, K.P An Econometric Analysis of yield variability in paddy production. Canadian Journal of Agricultural Economics. 1981;29(1):283–294.
20. Kalirajan K, Shad RT. Estimating Location – Specific and fin Specific Efficiency. An Analysis of Malaysian Agriculture." Journal of Economic Development. 1986;11(2):147–160.
21. Adesina AA, Djato KK. Relative Efficiency of Women as Farm Managers. Profit Function Analysis in Coted'Ivoire; 1997.
22. Muchebelele MT, Nelson W. Migrant Labour and farm Technical Efficiency in Lesotho. World Development. Government Area in Cross River State. B.Agric. Dissertation Department of Agricultural Economics and Extension, University of Calabar, Nigeria 45. 2000;28(1):143-153.
23. Amaze PS, Olayemi JK. The Influence of Education and Extension Contact on Food Crop production in Gombe State, Nigeria. Journal of Agribusiness and Rural Development 2000;1(1):80-90.
24. Udoh EJ, Akinola A. Measurement of the Technical Efficiency of the Technical Efficiency of crop farms in the South Eastern Region of Nigeria Journal of Economic and Social Studies. 2001;43(1):93-104.
25. Nwaru JC. Rural credit Markets and Arable crop production in Imo State, Nigeria Ph.D Dissertation, Michael Okpara University of Agriculture, Umudike, Nigeria. 2004;132.
26. Onyenweaku CE, Igwe KC, Mbanasor JA. Application of a stochastic frontier Production Function to the measurement of Technical Efficiency in Yam production in Nasarawa State, Nigeria. Journal of Sustainable Tropical Agricultural Research. 2005;13(1):20-25.
27. Udoh EJ. Technical inefficiency in vegetable farms of Humid Region. An Analysis of Dry season Farming by urban Women in South zone, Nigeria Journal of Economics and social studies. 2005;1(2):80–85.
28. National Population Commission. Nigerian Census figure; 2006.
29. Bravo-ureta BE. RE Evenson production: The case of Peasant Farmers in Eastern Paraguay. Agricultural Economics. 2003;10(1):2737.

30. Coelli TJ. A Guide to Frontier 4.1: A computer programme for stochastic frontier Production and cost function estimates Department of Econometrics, University of New England, Armidale; 1996.

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