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COMPARATIVE ANALYSIS OF PROFITABILITY AND TECHNICAL EFFICIENCY AMONG DIFFERENT SCALES OF POULTRY-EGG PRODUCTION IN JOS METROPOLIS OF PLATEAU STATE, NIGERIA.

[1]Folorunso, S.T., [3]Ademiluyi, I.O. and [2]Gama, E.N

[1]Department of Agricultural Economics and Extension, University of Jos, Jos, Nigeria.
[2]Department of Agricultural Economics and Extension, Federal University Dutse, Jigawa State, Nigeria.
[3]Department of Agricultural Extension and Management, Federal College of Forestry, Jos, Plateau State, Nigeria.

Corresponding author: Folorunso,S.T; 08037018157, solocom2012@gmail.com, solomon4jesus4ever@yahoo.co.uk.

ABSTRACT

This study compared the profitability and technical efficiency among different scales of poultry-egg production in Jos metropolis of Plateau State, Nigeria. A two-stage sampling technique was used to select 143 respondents. Primary data were collected on socioeconomic variables, (age, gender, marital status, educational level, farm/flock size, farming experience, source of capital, cooperative membership and extension contacts and input-output data) using well-structured, open and close-ended questionnaire and interview schedules. Data collected were analyzed using budgetary technique and stochastic production frontier model. The result of profitability analysis indicated that poultry-egg production was profitable in the study area with ₦675, 671.79, ₦4, 897,236.09 and ₦16, 327,633.66 per farmer for small, medium and large scale farms. Rate of return to investment per bird from small farm size, medium and large farm sizes were found to be 19.51%, 31.21% and 83.13% respectively. The capital turnover per bird is ₦ 1.20, ₦1.31 and ₦1.83 respectively for small, medium and large scale farmers respectively. Also, the profitability indices for the small, medium and large scales are ₦0.16, ₦0.24 and ₦0.45. The result of technical efficiency showed the following: the mean technical efficiency of the small, medium and large were 0.68, 0.74 and 0.79 respectively with the large scale having the highest, followed by the medium and the small scale having the least respectively; the minimum technical efficiency were 0.30, 0.15 and 0.10 respectively for small, medium and large scale, with the small scale having the highest, followed by medium and the large scale had the least. The maximum technical efficiency for small, medium and large scale farmers were 0.77, 0.95 and 0.96 respectively, with the large scale farmers having the highest, followed by the medium scale farmers and the small scale farmers having the least. The study recommends that; Farmers should be encouraged to increase their scale of production from small scale to large scale through policies that will promote such. Given the profit margin among the three scales, special intervention is needed from the government at all levels through farmers' cooperatives in the area of inputs subsidy, technical efficiency of the farmers could be increased especially among the small scale farmers through accessible and efficient extension service delivery and further research should be funded towards improved and cost effective feed.

Key words: Comparative, Profitability, Technical Efficiency, Different scales, Poultry-egg Production, Jos metropolis, Plateau state, Nigeria.

INTRODUCTION

Poultry is a collective name given to a group of birds reared or hunted for useful purposes. They are domesticated birds kept for egg or meat production which include chickens (domestic fowls), turkeys, ducks and geese (Busari and Okanlawon, 2015). Poultry is the quickest source of meat and its production process involves the least hazardous and arduous in relation to other livestock enterprises. Hence, increased poultry production is one of the surest and quickest ways of bridging the animal protein intake gap between developing and developed countries of the world (Haruna *et al.,* 2002). According to Ayoola (2015), the protein gap is evident in the number of eggs consumed by a Nigerian annually. He stressed that the intake of eggs by Nigerians is 70 pieces of eggs per person annually while in developed countries such as China, the intake of eggs records 370 pieces of egg per person annually. The task of bridging this protein intake gap appears formidable in view of the present economic and technological constraints besetting our livestock industry. According to Zuberu, *et al.,* (2015), poultry egg production is one of the major sub-sectors in the Nigerian agricultural industry which supply protein, lipids and vitamins of high zoological value to man. Poultry eggs, apart from supplying protein are also

good sources of high energy nutrients. Poultry egg is one of the most nutritious and most complete foods known to man and it provides the means by which rapid transformation of animal protein intake can be achieved (Ayoola, 2015).

Small scale poultry eggs are made of farms having less than 1000 birds while medium scale are farms having between 1000 and less than 5000 birds as seen in the Omotosho and Oladele's study (1998 cited in Busari, *et al*., 2015).

A farmer who maintains at least 5000 birds is classified as a large scale producer. Small scale poultry farms are mostly found in the rural areas where production input are difficult to obtain and marketing outlet are not well organized while large scale poultry farms are usually found in the urban area as well as semi urban areas where there is access to adequate production facilities and marketing outlet (Busari and Okanlawon, 2015). Food production in Nigeria has not increased at the rate that can meet the increasing population. While food production increases at the rate of 2.5%, food demand increases at the rate of 3.5% due to high rate of population growth of 2.83% (FAO, 2006). With the aforementioned growth rate, Nigeria population is estimated to about 195,392,363 by 2018 (NPC, 2006), which is far above the animal protein supply. The animal protein consumption in Nigeria is below the standard of United Nations. In Nigeria, the production of food has not increased at the rate that can meet the increasing population. While food production increases at a rate of 2.5%, food demand increases at a rate of more than 3.5% due to high rate of population growth of 2.83% (Ojo & Fagbenro, 2010). The apparent disparity between the rate of food production and demand for food in Nigeria has led to a food demand supply gap thus leading to a widening gap between domestic food production and total requirement, thus an increased demand resulted in food importation and high rates of increase in food prices and as a result, wide spread hunger and malnutrition are evident in the country (Ugwumba & Chukwuji, 2010). They further stressed that the growth of a country's population is usually accompanied by increase in the demand for the basic necessities of life including water, food and shelter. This is the case with the unrestricted increase in the demand for protein rich food items of animal origin especially. Food and Agricultural Organization recommended a minimum of 20 grammes for developing countries as against the 75grammes optimal daily requirement for normal growth and development (FAO, 2006). However, the animal protein consumption in Nigeria is less than 10 grams per person per day, which is a far cry from the FAO minimum recommendation (Onoja & Achike, 2011). This could be attributed to numerous problems that poultry farmers in Nigeria are faced with which includes; low capital base, inefficient management, low technical efficiency, economic inefficiency, disease, parasite and poor housing. Others include high cost of feed, poor quality of day old chick, inadequate extension agent and training facilities. He therefore emphasized that poultry production capacities of farm has to increase rapidly to be able to meet up with the increasing protein demand, and for this to be achieved, there is a need to improve the present level of production (Umar, 2012).

According to Adene and Oguntade, (2006), in most parts of Nigeria and the world over, the large scale poultry industry do better in terms of technical efficiency, economic efficiency and allocative efficiency. Ume, *et al.,* (2016), stated that the large scale poultry industry makes more profit and has the least cost of production as compared to small and medium scale poultry industry. The large scale poultry firm also enjoys economies of scale, this cut down its cost of production and maximizes its profit. For instance, Yusuf and Malomo (2007) in their result show that a large farm has the lowest cost of production per bird. As the farm size increases, the total cost of production decreases which means that large farm size has the highest average gross margin. This is attributed to the fact that most large scale poultry firms hatch the chicks instead of buying from commercial hatcheries formulated feeds instead of purchasing them in bags and has good channels of marketing and an excellent source of obtaining other inputs such as water, veterinary services, electricity and fuel at the lowest cost per naira.

Raising agricultural productivity, reducing food insecurity and poverty is an important policy goal for concerned government since agriculture plays a major role in the economy of many developing countries, as it is a significant source of nourishment for citizens and a means of livelihood for the most vulnerable members of this country (Adewuyi, 2002). Increasing agricultural productivity requires one or more of the following; an increase in output and input with output increasing proportionately more than inputs; an increase in output while inputs remain the same; a decrease in both inputs and output with input decreasing more; or decreasing input while output remains the same (Adewuyi, 2006; Oni *et al.*,2011). Although, concerted efforts have been made by past and present governments of Nigeria towards improving agricultural productivity and production efficiency and in alleviating poverty among the rural farmers, millions of people in Nigeria are still poor and hungry (Simonyan *et al*., 2010). Furthermore, despite the fact that large scale egg production industry do best economically, there is however few large scale poultry farms in Nigeria to meet the protein demand by the country. There is a need therefore to compare the scales of production so that the majority of farmers who

do not have the huge startup capital to start on a large scale will learn a more advanced method of production which will improve their efficiency in resource allocation, marketing and storage and thus increase egg production from the grass root (Esibiodu *et al* 2014). From the foregoing therefore, the following objectives of the study were generated. i. compare the profitability of poultry-egg production in the study area, ii. compare the technical efficiency of poultry-egg farmers in the study area.

METHODOLOGY

Study Area.

The study was conducted in Jos metropolis of Plateau State, Nigeria. Jos metropolis is made up of Jos north and Jos south Local Government Areas of Plateau State. The study area is located between latitude 9^{o} $56'$ North and longitude 8^{0} $53'$ East and has a monthly temperature ranging from 21 – 25 ^{0}C and from mid-November to late January, night temperature drop as low as 11 ^{o} C (52^{o}F). The annual rainfall of Jos metropolis is about 1,400mm. Jos metropolis has a population figure of 876, 214 and projected to 1,282,689 people in 2018 (NPC, 2006). The ethnic composition includes the Birom, Afizeere, Naraguta, N'gas, Irigwe, Yoruba, Igbo and the Hausa. The major occupation of the inhabitant of Jos metropolis is mainly trading and farming. The major crops grown in Jos metropolis include Maize, Guinea corn, Irish potato, Cassava, Yams and Acha and vegetables such as Tomatoes, while the major livestock raised in the study area are; Cattle, Sheep, Goat, Pigs and Poultry production among others (Amos, 2006).

Sampling techniques and sample size.

A two-stage sampling technique was adopted. The first stage included a purposive selection Jos metropolis from the 17 local Government areas in Plateau state. The two local government areas were chosen based on the preponderance of poultry farmers in the area as contained in the information from the Poultry Association of Nigeria (PAN), Plateau state chapter (2011). According to PAN (2016), there are about seven hundred and fifteen registered poultry farmers in the metropolis of which in there are 216 small scale farmers, 373 medium scale farmers and 126 large scale farmers. The second stage of the sampling procedure involved the random selection of twenty percent of farmers registered under small (43), medium (75) and large scale (25) production in the metropolis. This gave a total sample size of 143 (one hundred and forty three) respondents.

Method of data collection.

Primary data used for this study were collected by the use of well-structured, open and close-ended questionnaire which were administered to poultry egg farmers. The questionnaire was designed to elicit information on the socioeconomic characteristics of respondents, access to credit, size of flock, cost of inputs and revenue generated from output.

Method of data analysis

The analytical tools used are; Net Farm Income analysis which is used to achieve objective I and stochastic production frontier model was used to achieved objective ii.

Model specification.

Budgetary technique

The net farm income of poultry egg production in each of the three scales of production was analyzed using net farm income analysis, mathematically expressed as:

Net farm income model

Net farm income (NFI) model determines the return to invested capital and return to management Olukosi and Erhabor (2008). It is represented in equation (1)

NFI $=\sum P_y - \sum P_X - \sum P_K$ …… (2)

Where:

NFI = Net Farm Income (₦/hectare)

$\sum$ = Summation sign

$P =$ Unit price

$y =$ Output

X= Input (Variable)

K= Input (fixed)

According to Ronald *et al.* (2008), NFI should be considered more as a starting point for analyzing profitability than as a good measure of profitability itself. Because profitability is concerned with the size of the profit relative to the size of the business.

Size is measured by the value of the resources used to produce the profit. A business can show a profit but have a poor profitability rating if this profit is small relative to the size of the farm business. Two farms with the same NFI, for example, are not equally profitable if one used twice as much land, labour and capital as the other to produce that profit. Therefore, profitability is a measure of the efficiency of the business in using its resources to produce profit or net farm income. So, in order to conclude whether the enterprise is profitable or not, there is need to compute the profitability index as follows;

Profitability Index (PI) – This is the Net Farm Income (NFI) per unit of Gross Revenue

(GR). That is; PI = $\frac{NFI}{GR}$ …….. (3)

Equation (3) shows the level of return per naira gross income. For a farm to be profitable, the PI should be greater than zero. If PI is negative, it implies that the farm is losing money

The following profitability measures were calculated:

i. Rate of Returns on Investment (%)

RRI = $\frac{NFI}{TC} \times 100\%$ …… (4)

Where: TC = Total cost, hence (TVC + TFC)
Equation (4) shows the ratio of the accounting profit to the investment in the farm, expressed as a percentage. The RRI should be greater than the cost of capital for the investment to be worthwhile. The RRI should also be greater than or equal to the interest/hurdle rate on fixed deposit.

ii Capital Turnover (CTO): = $\frac{TR}{TC}$..... (5)

Where: TR= Total Revenue
CTO is defined as the total revenue divided by total cost of production. It describes roughly how much naira in revenue the farm can generate for each naira invested over a given period. That is, it is used to analyze the relationship between the money used to fund operations on the farm and the sales generated from the operations. This ratio should be greater than 1 for the investment to be profitable.

Stochastic frontier production model

The stochastic frontier production model can be used to determine the technical relationship between the inputs used and output obtained in farm production. Stochastic frontier model which was originally proposed by Aigner *et al*. (1977) is expressed in general form as;

$y = g(x)e^{v}.e^{-u}$. ..... (6)

The equation above can be simplified to give;

$y=g(x)e^{v-u}$ .....(7)

Where, y = observed output; g(x) =conditional mean function of given input x; v = a mean-zero error term that represents measurement error; u = a firm-specific random effect that represent the firm's technical inefficiency. In this study, the production technology for cocoa is characterized by a Cobb-Douglas production function and expressed as:

$Y = \beta_0 X_1^{\beta_1} X_2^{\beta_2} ... X_5^{\beta_5} e^{(v-u)}$. ..... (8)

A logarithmic transformation provides a model which is linear in the log of the inputs and easily used for econo metric estimation (Coelli, 1995). The empirical Cobb-Douglas production function model of the stochastic production frontier for this study is specified;

$LnQ_i=Ln\beta_0 +\beta_1 LnX_1+\beta_2 LnX_2+\beta_3 LnX_3+\beta_4 LnX_4+\beta_5 LnX_5+\beta_6 LnX_6+ V_i-U_i$.....(9)

Where;
Y= Total Farm Output of layer poultry (Kg)
The independent variables are:
X_1= Farm size (Number of birds stocked)
X_2= Quantity of water (litres)
X_3=Quantity of feed (Kg)
X_4= Hired labour (Mandays)
X_5= Family labour (Mandays)
X_7= Utility (Energies) (Hours)
Z_1= Age (years)
Z_2= Marital status (1;0)
Z_3= Household size (Number of persons)
Z_4= Level of education (Years)
Z_5= Farming experience (years)
Z_6= Cooperative membership (years)
Z_7= Access to credit (1; 0)
β_0 = intercept
β_{ij} =vector of production function parameters to be estimated i=1, 2, 3,…,n farms;
j=1, 2, 3… m inputs.
v_i = random variability in the production that cannot be influenced by the farmer.
μ_i = the deviation from maximum potential output attributable to technical inefficiency.
The variance of the random error $\boldsymbol{\delta}v^2$ and that of the technical inefficiency effect δu^2 and the overall variance of the model are related as follows:-

$\delta^2=\delta v^2+\delta u^2$.....(10)

$\gamma=\delta u^2/\delta^2$ ..... (11)

Equation (5) measures the total variation of production (output) from the frontier which can be attributed to technical or allocative inefficiency (Battese, 1992).The δ^2andγ, coefficients are the diagnostic statistics that indicate the relevance of the use of the stochastic frontier function and the correctness of the assumptions made on the distribution form of the error term.
Stochastic frontier Empirical estimation of efficiency is normally done with the methodology of stochastic frontier production function. The stochastic frontier production model has the advantage of allowing simultaneous estimation of individual technical and allocative efficiencies of the farmers as well as the determinants of technical efficiency (Battese and Coelli, 1995). Economic application of stochastic frontier model for efficiency analysis include Aigner *et al*. (1977) in which the model was applied to U.S agricultural data, Ogundari and Ojo (2005), Ajibefun *et al*. (2002) and Ali and Byerlee (1991) in which they offer comprehensive review of the application of the stochastic frontier model in measuring the technical and economic efficiencies of agricultural producers in developing countries. Karl (1990) states that Technical efficiency is the ability of the firm to produce the maximum output from its resources. One firm is more technically efficient if it produces a level of output higher than another firm with the same level of input usage and technology. Measures of technical efficiency give an indication of the potential gains in output if inefficiencies in production were to be eliminated.
An economically efficient firm operates on both the frontier function and the expansion path. Early studies focused primarily on technical efficiency using a deterministic production function. However, this approach has an inherent limitation on the statistical inference on the parameters and resulting efficiency estimates. In order to overcome this deficiency Aigner, Lovell and Schmidt (1992) developed the stochastic frontier production function for estimating farm level technical efficiency as shown in equation (10).

Y_i= f (X_i;β) + $\in i, i = 1,2,n$ …… (12)
Where Y_i = output, X_i = actual input vector, β,= vector of production function and $\in$= error term that is composed of two elements, i.e. $\in = V_i - U_i$ where V_i= symmetric disturbances which is iid and N (0, σ^2V) while U_i= one-sided error term that is independent of $V_{i\ and\ N(0,\sigma^2)}$.
Following Jondrow, Lovell, Miterov and Scmidt (1982), the estimation of technical efficiency was further defined by the mean of conditional distribution of inefficiency term U_i given as shown in equation (12)
$E(V_i/\in_i|) = \frac{\sigma.\sigma}{\sigma}.\left[\frac{f(\epsilon j\lambda\sigma)}{1-F(\in i\lambda\sigma}\right]\frac{\in i\lambda}{\sigma}$ ……..…… (13)
Where $\lambda = {\sigma u}/{\sigma v}$, $\sigma^2 = \sigma^2$u +σ^2v, while f and F represents the standard normal density and cumulative distribution function respectively evaluated as ${\in j\lambda}/{\sigma}$.
The farm -specific technical efficiency is defined in terms of observed output (Y_i) to the corresponding frontier output (Y^*) using the available technology derived from the result of the equation (13)
$TE = \frac{Y_i}{Y_i^*} = \frac{E(Y_i/U_iX_i}{(Y_i/U_{i=0,X_i})} = E\left(\frac{-U_i}{\in_i}\right)$ ……..……(14)

Hypothesis Testing
H_0: There is no difference the in farm income of the three scales of poultry-egg farmers in the study area.

RESULTS AND DISCUSSION

Profitability in layer Poultry Production
The result in Table 1 shows the net farm income for the three categories of farm. The result indicate that the average total cost incurred per farmer was about ₦1,855,945.02, ₦9,532,778.97 and ₦18,212,817.25 in small, medium and large scale farms, respectively. The cost include variable costs per bird such as cost of stock, the cost of feed, the cost of medication, cost of water, cost of electricity, cost of kerosene, cost of litter materials, cost of crates and cost of transportation. The result revealed that the major cost in the production in all three scales of production was cost of feed which accounted for 89%, 91% and 93% of the total variable cost in small, medium and large scale farms respectively. Table 6 also indicated that the average total revenue generated per farmer in small scale farms is ₦2, 351,616.81 while ₦14, 430,015.06 and ₦34, 540,450.91 in medium and large scale farm respectively.
Finally, the budgetary analysis per farmer indicated that small scale poultry farm has a profit of ₦675, 671.79 while medium and large scale farm have a profit of ₦4, 877,236.09 and ₦16, 327,633.66 respectively. This is supported by Yusuf and Malomo, (2007) and Busari and Okanlawon, (2015) who pointed out that the profits depend on the scale of production. This reduction in cost of drug, feed and utilities(such as water, electricity etc.) reflect the fact that large scale farms have better management towards diseases and benefit more from economies of scale. The huge average profit made per farmer in the large scale farm category is probably due to the benefit of economies of scale. From the Table 1, the large scale farms made a profit of ₦675, 671.79 more than medium and small scale farmers which made about ₦4, 877,236.09 and ₦16,327,633.66 respectively.
The Rate of Return to Investment (RRI) per bird from small farm size, medium farm size and large farm size were found to be 36%, 51% and 90% respectively. The Capital Turnover (CTO) per bird was ₦1.36 for the small farm size, ₦1.51 for the medium and ₦1.90 large farm size respectively. The capital turnover values imply that for every one naira invested in small scale poultry-egg production, ₦1.36 was returned to the farm size. For every one naira spent on medium scale poultry-egg production, ₦1.51 was generated as revenue. Also, ₦1.90 was obtained as revenue for every one naira invested in large scale poultry-egg production in the study area.
Also, the profitability indices for the small farm size, medium size and large farm size were ₦0.27, ₦0.34 and ₦0.47 respectively. This implies that for every one naira earned as revenue from each of the different categories of farms, 27 kobo, 34 kobo and 47kobo returned to the three categories of farmers as net income respectively. The profit made by the different farms may be as a result of many factors, such as cost of bird, and volume of sales among others. All these depend on farm size. The higher PI, RRI and CTO of ₦0.47, ₦0.90 and ₦1.90 respectively obtained by the large scale poultry-egg farms in the study area are indications of efficiency. Also, bulk purchases of inputs and large operation may lead to a reduction in their cost and allow them to enjoy economies of scale. The profit of the small scale poultry-egg farmers was lower compared to the medium and large scale in the study area.
With these values of capital turnover and profitability index, improvement in poultry egg production is likely to increase the returns of poultry egg farmers in the study area.
The higher RRI, CTO and PI in the study area revealed that poultry-egg production in general, was profitable and the large farm size had the highest profit, followed by medium farm size and then small farm size. This finding is at variance with the findings of Umar (2012) who recorded different results in RRI (34.94, 38.88 and 42.37 respectively for small, medium and large scale respectively), CTO (1.35, 1.39 and 1.42 respectively for small, medium and large scale) and PI (0.26, 0.28 and 3.0 respectively for small, medium and large scale respectively) in his work titled economic analysis of poultry-egg production in Bauchi LGA., Bauchi state,

Nigeria.

Table 1: Average annual profitability analysis of poultry-egg production.

	Small scale		Medium scale		Large scale	
Item	**Average**	**%of total variable cost**	**Average**	**%of total variable cost**	**Average**	**%of total variable cost**
A. Variable cost						
Cost of stock	52,833.72	3.62	289,938.00	3.29	6,146,648.96	3.63
Cost of feed	1,310480.58	89.79	8,068,912.71	91.56	15,522,405.24	91.67
Cost of medication	68640.08	0.85	63,451.48	0.72	103,290.81	0.61
Labor cost	12,405.71	0.48	266,570.35	0.15	28,785.96	0.17
Cost of water	3,940.64	0.27	13,219.06	0.20	194,728.55	1.15
Electricity	4816.33	0.33	17,625.41	0.27	42332.29	0.25
Kerosene	1459.50	0.10	7,050.16	0.08	338.66	0.002
Litter materials	437.89	0.03	881.27	0.01	1693.29	0.01
Disinfectant	727.75	0.05	1762.54	0.02	6773	0.04
Petrol/Diesel	1313.55	0.09	6168.89	0.07	3386.58	0.02
Crates	1021.65	0.07	2643.81	0.03	338.66	0.002
Transportation	1459.50	0.10	881.27	0.01	3386.58	0.02
Mortality	58,379.80	4.00	313,732.30	3.56	298,019.34	1.76
B. Total variable cost(TVC)	**1,459,495.02**	100	**8,812,704.97**	100	**16,932,917.25**	100
Gross Margin (TR-TVC)	**1,072,121.79**		**5,617,310.09**		**17,607,533.66**	
C. Fixed Cost/(₦)						
i. Feeder and drinkers						
ii. Nest cost	148,148.82	36.36	211,053.69	29.31	379,106.38	29.62
iii. Housing cost	111,152.36	27.28	297,894.61	41.37	521,431.26	40.74
D.TFC	148,148.82	36.36	211,125.70	29.32	379,362.36	29.64
Total cost (₦)	**407,450.00**	100	**720,074.00**	100	**1,279,900**	100
D. Revenue(₦)						
i. Spent layer	1,067,329.65	42.16	5,171,717.40	35.84	13,125,371.35	38.00
ii. Eggs	1,097,455.89	43.35	6,281,385.56	43.53	14,127,044.42	40.90
iii. Poultry droppings	346,831.50	13.70	2,864,357.99	19.85	428,301.91	12.40
iv. Empty bags	19,493.00	0.77	109,668.11	0.76	176,156.30	0.51
TOTAL REVENUE	**2,531,616.81**		**14,430,015.06**		**34,540,450.91**	
NFI	**675,671.79**		**4,897,236.09**		**16,327,633.66**	
PI	**0.27**		**0.34**		**0.47**	
RRI	**0.36**		**0.51**		**0.90**	
CTO	**1.36**		**1.51**		**1.90**	

Source: Author's field survey, 2016.

Test of Differences in Income between the Different Farm Sizes.

Analysis of variance (ANOVA) and Double Difference Estimator tests were carried out to establish whether significant difference exists among the three categories of farms in terms of income as proxy for profit. The result presented in Tables 2, 3 and 4 showed the average income/Bird of the small, medium and large scale poultry farm in the study area. The F-value (93.07) revealed that there were significant differences among the income obtained by the three categories of the poultry farms under consideration. The result of coefficient of variation as presented in Table 2 indicated that there is more variability in the incomes of the small and medium scale farmers than with the large scale farmers. The result of Double difference Estimator (DDE) on Table 4 shows that there is significant difference in the small, medium and large scale layer-egg production (6.00, 13.61 and 10.93).

Presentations of Tables for DDE and ANOVA analysis

Table 2: Level of income among the scale of farmers

Level of income	Mean	Standard deviation	CV	Frequency
Small scale	1745343	1611709.4	92	22
Medium scale	12556206	8629149.5	69	68
Large scale	38641251	4880970.4	13	11

Note: CV=Coefficient of variation

Table 3: Analysis of variance among level of income

Source	SS	Df	MS	F-value	Prob>F
Between groups	1.00E+16	2	5.02E+15	93.07	0.000
Within groups	5.28E+15	98	5.39E+13		
Total	1.53E+16	100	1.53E+14		

Note: SS=Sum of square, df= degrees of freedom and MS= Means square

Table 4: Post hoc test

Total annual by scale	Contrast	Standard error	t-value
Medium scale vs Small scale	1.08E+07	1800660	6.00
Large scale vs Small scale	3.69E+07	2710975	13.61
Large scale vs Medium scale	2.61E+07	2385827	10.93

Technical efficiency of poultry-egg production

The result revealed that the Maximinm Likelihood estimates and inefficiency determinants of the specified frontier are presented in Table 5. The study revealed that the generalized Log likelihood function were -0.69, -0.85 and -0.13 for small, medium and large scale farms respectively. The log likelihood function implies that inefficiency does exist in the data set. The log likelihood ratio value represents the value that maximizes the joint densities in the estimated model. Thus, the Cobb-Douglas approach used in this estimation is an adequate representation of the data. The values of gamma (γ) estimates are0.95, 0.93 and 0.50 for small, medium and large scale farms and it is also statistically significant at 1% level of probability. This is consistent with the theory that true γ-value should be greater than zero. This implies that 95%, 93% and 50% of random variation in the yield of the poultry-egg farmers for small, medium and large scale respectively were due to the farmers' inefficiency in their respective sites and not as a result of random variability. Since these factors are under the control of the farmer, reducing the influence of the effect of γ will greatly enhance the technical efficiency of the farmers and improve their yield. The gamma γ indicates the systematic influences that are unexplained by the production function and the dominant sources of random error. This means that the inefficiency effects make significant contribution to the technical inefficiencies of layer-egg farmers in the study area. The value of sigma squared (σ^2) was significantly different from zero level of probability with estimated values of 0.95, 0.27 and 0.50 for small, medium and large scale poultry-egg farmers respectively. This indicates a good fit and correctness of the specified distributional assumptions of the composite error terms. The LR value was 94.008, 48.6800 and 38.1430 for small, medium and large scale farms respectively.

The result of technical efficiency in poultry-egg producing farms in the study area reveals the relationship between production variables and output is as follows;

Farm size had positive coefficients of 0.2406, 2.7486 and 2.2764 for small, medium and large scale poultry-egg farmers respectively and was significant at 1% level of probability across the three scales. The positive and significant coefficient of firm size stresses its importance and positive relationship between the variable and production. This implies that a unit increase in the farm size will result in an increase in

poultry-egg production by 0.2406%, 2.7486% and 2.2764% respectively in the three scales of egg production. The medium scale layer-egg farmers had the highest response, followed by large scale while the small size has the least contribution to egg production.

Quantity of water has positive coefficients of 1.0524, 0.8562 and 3.0866 in small, medium and large scale farms respectively. The result shows that quantity of water is statistically significant at 1% level of probability in each of the three scales of production. The positive coefficient of quantity of water in the three scales of production implies that a unit increase in quantity of water will lead to an increase in poultry-egg production by 1.0524%, 0.8562% and 3.0866% respectively, with the large scale having the highest, followed by small scale while the medium scale has the least contribution to poultry- egg production.

Quantity of Feed is another variable which affects the poultry egg production in the study area. The result revealed that the variable had a positive coefficient of 0.4358, 0.2692 and 2.3448 in small, medium and large scale farms respectively. The variable is statistically significant at 1% level of probability in each of the three scales of production. The positive coefficient of the feed in the scales of production implies that a unit increase in feed will lead to an increase in small, medium and large scale egg production by the values of the coefficients (0.4358%, 0.2692% and 2.3448% respectively) in the study area, with the large scale having the highest, followed by small scale while the medium scale has the least. This is in line with the findings of Haruna *et al.* (2007).

The result of hired labour use in poultry-egg production revealed that hired labour hadnegative coefficients of -11.0976 and -0.3784 in small and medium scale farms respectively while the large scale farms has a positive coefficient of 3.2206. The variable is statistically significant at 1% across the three scale of production. The negative coefficient of hired labour implies that to increase egg production by a unit, labour will have to be reduced by 11.0976% and 0.3784% in small and medium scale farms respectively. It also infer over utilization of hired labour resource on the farms among these two scales. However, more hired labour need to be reduced in small scale farms than the medium scale farms. In the large scale farms however, a unit increase in labour use will increase egg production by 3.2206%. This result compares favorably with the findings of Nmadu *et al.* (2014).

Family labour was another variable determining technical efficiency of poultry egg farmers in the study area. The result showed that family labour has significant positive coefficients of 2.5711and 1.3183 for medium and large scale farms only at 5% and 10% levels of probabilities. This means that a unit increase in the family labour, the medium and large scale farms will increase egg production by 2.5711% while in large scale farms, a unit increase in utility will increase egg production by 1.3183%. This is in line with several studies by Umoh (2006) and Okike (2000) which show the importance of labour in farming, particularly in developing countries where mechanization is rare on small scale farms. In the study area, human power plays a crucial role in virtually all farming activities. This situation has variously been attributed to the practice of split-plot cropping on small scattered land holdings and lack of affordable equipment (Umoh, 2006).

The Table 5also revealed that utility (energies) has positive coefficients of 14.1340 and 2.0560 respectively for medium and large scale farms and significant at 5% and 1% level of probabilities across the two scales in the study area. This means that increasing utilities (energy) by 1 unit will increase egg production by 14.1340% and 2.0560 % for medium and large scale farms in the study area. Increasing use of energy in medium scale farms gave the highest increase in egg production whilethe large scale gave the least.

The result of the inefficiency model is contained in Table 5. The estimated coefficients with negative signs attached indicate that they reduce technical inefficiency among the poultry-egg farmers, while positive signs indicate that the coefficients increase technical inefficiency or reduce technical efficiency. The results showed that Age, marital status, household size, level of education, farming experience, membership of cooperative and access to credit were the determinants of technical inefficiency among the poultry-egg farmers. Age, farming experience farming experience and cooperative association were negatively related with technical inefficiency, while household size and amount of credit were positively related with technical inefficiency.

The coefficient of gender were -1.0864, -1.2192 and -0.5540 respectively for small, medium and large scale respectively. They were all negative across the three scales of production and significant at 5% 10% level of probability for small scale while the medium and large scale were significant at 5% levels of probabilities. This implies that holding other factors constant, a change in

the gender of poultry-egg farmers will reduce their technical inefficiency by magnitude of 1.0864%, 1.2192% and 0.5540% respectively.

The coefficient of Household size were negative (-0.6772, -0.4380 and-3.4180) respectively for small, medium and large scale. These were inconsistent with the apriori expectation and significant at 1% probability levels across the three scale of production. This implies that as household size increases, the technical inefficiency reduces by the values of the coefficients. It also implies that technical efficiency of farmers can be improved without taken into consideration the household size poultry-egg farmers. These findings were inconsistent with Mohammed-Lawal *et al*., (2009) who reported that as household size increases the technical efficiency reduces. They observed that this may be as a result of the fact that most of the household members who are still at a very young age may not be able to contribute to labour supply since they are likely to be in school during the period of agricultural production activities. Large household size is expected to enhance labour availability (Nwaru, *et al*., 2006). It has been reported the use of large family labour on small farms result in over-utilization and hence inefficiency (Okike, 2000). Older farmers are often not amenable to changes and are neither likely to adopt improved technologies nor have the physical strength to do manual work as the younger ones Ajibefun and Aderinola, (2006); (Nwaru, *et. al.*2006). This gives credence to why there exists a positive relationship between age and technical inefficiency. The finding of this study on age is in agreement with Ogundari and Ojo (2007) who in their study of small scale farmers in Nigeria found age to be positively related to inefficiency.

The result of the study shows that level of level of education has negative coefficients of-2.5662, -0.3016 and-0.5540for small medium and large scale respectively. This implies that a unit increase in level of education will reduce technical inefficiency by the values of the coefficients in small, medium and large scale poultry-egg production respectively. This result compares favorably with finding of Busari and Okanlawon (2015) who pointed out that level of education, large household size and years of farming experience contributes to production of poultry farmers.

It reveals that year of farming experience has negative coefficients of -0.4886, -3.646 and -4.8700 in small medium and large scale respectively. This implies that a unit increase in years of farming experience will reduce technical inefficiency by the values of the coefficients in small, medium and large scale poultry egg production respectively.

The result in Table 5 also reveals that membership of cooperative has negative coefficients of -1.6841, -2.6930 and -1.1963 in small medium and large scale respectively. This implies that a change in membership status of cooperative will result in 1.6841%, 2.6930% and 1.1963% increase in technical efficiency in small medium and large scale poultry-egg production respectively.

It further reveals that access to credit has negative coefficients of -1.2831, -4.6361 and -1.0224 in small medium and large scale respectively. This implies that a change in access to credit will result in 1.2831%, 4.6361% and 1.0224% increase in the technical efficiency in small, medium and large scale poultry-egg production respectively.

Table 5: Estimates of stochastic production frontier for egg-layer respondents

Variable/Parameters	Small Scale			Medium Scale			Large Scale		
General Model	**Coeffi**	**Standard Error**	**t-ratio**	**Coeff**	**Standard Error**	**t-ratio**	**Coeff**	**Standard Error**	**t-ratio**
A. General Model									
Constant (β_0)	3.0842	0.2378	12.9624***	6.1246	0.6766	9.0520***	2.7798	0.4460	6.2061***
Farm size (β_1)	0.2406	0.0252	9.5173***	2.7486	0.4472	6.1424***	2.2764	0.2768	4..1117***
Quantity of Water (β_2)	1.0524	0.2138	4.9210***	0.8562	0.0073	11.7847***	3.0866	0.7586	4.0681***
Feed (β_3)	0.4358	0.0430	10.092***	0.2692--	0.0522	5.1552***	2.3448	0.4578	5.1217***
Hired Labour (β_4)	-11.0976	1.7980	-6.1680***	0.3784	0.0680	-5.445***	3.2206	0.5172	6.226***
Family Labour (β_5)	10.0702	3.7849	1.3303^{NS}	2.5711	0.8996	2.8582**	1.3183	0.3536	3.7281***
Utility(energies)(β_6)	3.3378	2.0542	1.6248^{NS}	14.1340	5.2860	2.6732**	2.0560	0.6046	3.4004***
B. Inefficiency									
Constant(Z_0)	-2.9316	1.4804	1.9802*	-3.4448	0.3424	10.060***	-2.4080	0.3756	6.4099^{***}
Age (Z_1)	-0.2734	0.2024	1.3506^{NS}	-1.4480	4.6306	0.3127^{NS}	-0.9540	0.9548	0.9990^{NS}
Gender (Z_2)	-1.0864	0.5518	1.9688*	-1.2192	0.5298	2.3010**	-0.5540	1.9700	2.8102^{**}
Household size(Z_3)	-0.6772	0.1596	4.2396***	-0.4380	0.0632	6.9270***	-3.4180	0.4662	3.6650^{***}
Level of Education(Z_4)	-2.5662	0.7034	3.6477***	-0.3016	0.0480	6.2660***	-0.5540	0.0812	6.8102^{***}
FarmingExperience(Z_5)	-0.4886	0.1308	3.7328***	-3.6460	2.2702	0.1059^{NS}	-4.8700	0.5162	9.4320^{***}
Member of Coops(Z_6)	-3.3682	1.2364	2.7238**	-2.6930	1.2234	2.2012**	-1.1963	0.7330	1.6320^{*}
Access to credit(Z_7)	-2.5662	0.9694	2.6472***	-9.2722	2.3882	3.8825***	-2.0448	0.7736	2.6430^{***}
C. Variance									
Stigma Square	8.2394	1.7695	4.6562***	1.2049	0.1093	11.0192***	8.5852	1.6470	5.2123^{***}
Gamma	0.9999	0.0824	12.1234***	0.9994	0.0948	10.5327***	0.9999	0.2476	4.0381^{***}
Log Likelihood	11.4229				12.6540		13.8763		
Mean T.E		0.6799			0.6947		0.7433		
Number of Observations	22			68			11		
LR	94.0008			48.6800				38.1430	

Source: Author's Field Survey, 2016. **Note:** * Significant at 10%, ** = Significant at 5%, *** = significant at 1% and NS = Not significant

Farm level technical efficiency of respondents

The frequency distribution of the technical efficiency (T.E) estimates of layer-egg farmers in the study area as obtained from the stochastic frontier analysis is presented in Table 6. The study revealed that small scale has the highest T.E (36.36%), followed by large scale (9.09%) while the medium had the least (3.88%) in the <0.20 – 0.40 range. Small scale layer-egg farmers have the highest T.E (54.54%), followed by large scale (27.87%) while the medium had the least (17.64%) in the 0.41 – 0.60 range. In the T.E 0.61 – 0.80 range, large scale has the highest (45.75%), followed by the medium scale (36.76%) and small scale has the least with (9.09). Furthermore, medium scale has the highest T.E of 39.71%, followed by small scale with 27% while large scale has 18.18% in the 0.81 – 1.0 range.

Furthermore, in the minimum T.E of the layer-egg farmers; small scale farmers have the highest (0.30), followed by medium scale farmers (0.15), while the large scale farmers have the least (0.10). This means that for the minimum T.E class, small scale, medium scale and large scale farmers were 30%, 15% and 10% technically efficient respectively. For the maximum T.E; large scale layer-egg farmers has the highest (0.96), followed by medium scale farmers (0.95) while small scale farmers has the least(0.77), which means that the large scale, medium and small scale farmers were 96%, 95% and 77% technically efficient. The mean T.E is 0.68, 0.74 and 0.77 respectively for small, medium and large scale respectively, which means that the small, medium and large scale layer-egg was 68%, 74% and 77% technically efficient respectively in the study area. The table also revealed that the large scale layer-egg farmers are the most technically efficient in the study area followed by medium scale farmers and lastly, the small scale farmers who have the least percentage of technical efficiency of 68%. The table further revealed the maximum technical efficiency in small and medium scale as 77%, 93% for medium and 96% for large scale and the minimum technical efficiency was 3%, 15% and 10% respectively. The layer-egg farmers with the best practices has T.E of 0.77, 0.95 and 0.96 respectively for small, medium and large scale layer-egg famers while the layer-egg farmers with the least practices had technical efficiencies of 0.30, 0.15 and 0.10 for small, medium and large scale respectively. The result also showed a mean technical efficiency of 0.68, 0.74 and 0.77 respectively for small, medium and large scale layer-egg farmers. This implies that for the farmers with the best practices, layer-egg farmers' output fall by 23%, 5% and 4% respectively from the maximum possible level of 1.00 due to technical inefficiencies while for the farmers with the least practices, the small, medium and large scale layer-egg farmers' output fall by70%, 85% and 90% respectively from the maximum 1.00 due to technical inefficiency. On the average however, the layer-egg farmers had their output fell by 32%, 26% and 23% respective for small, medium and large scale farmers from the maximum of 1.00 due to technical inefficiency. Also, the result shows that 91% of the layer-egg farmers operated with the <20 – 60 T.E which means that majority of the layer-egg farmers operated far from their production frontier. In the short-run, there is scope for increasing layer-egg output by 47%, 80% and 86% respectively by the small, medium and large scale farmers by adopting the techniques and technologies employed by the best layer-egg farmers.

Furthermore, the study also revealed that for the average small, medium and large scale layer-egg farmer in the study area to become the most efficient, he will need to realize about 12%[1-(0.68/0.77)*100], 22%[1-(0.74/0.95)*100], and 20%[1-(0.77/0.96)*100] cost savings, while on the other hand, the least technically efficient small, medium and large scale layer-egg farmers will need about 70% [1-(0.23/0.77)*100], 84% [1-(0.15/0.95)*100] and 90% [1-(0.10/0.96)*100] cost savings to become the most technically efficient layer-egg farmers. This result is in agreement with the result obtained by Haruna *et al.* (2007) which explained that large scale poultry egg farmers are more efficient as compared to small scale poultry egg farmers.

Table 6: Distribution of respondents according to farm level technical efficiency

Small scale		medium scale		large scale		
Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**	
>0.20 – 0.40	8	36.36	4	3.88	1	9.09
0.41 – 0.60	12	54.54	12	17.64	3	27.87
0.61 – 0.80	2	9.01	25	36.76	5	45.75
0.81 – 1.0	0	-	27	39.71	2	18.18
Total	22	100	63	100	11	100
Mean		0.68	0.74		0.77	
Maximum		0.77	0.95		0.96	
Minimum		0.30	0.15		0.10	
Sigma squared		0.95	0.27		0.50	
Gamma		0.95	0.93		0.50	
Log likelihood		-0.69	-0.85		-0.13	
L-R Test		94.008	48.68		38.14	

Source: Field survey, 2016.

Summary, Conclusion and Recommendations

The study analyzed profitability and technical efficiency among different scales of poultry-eggfarmers in Jos metropolis, Plateau state. The result of data analysis shows that poultry egg production is profitable in the study area, but the level of profit depends on the scale of production. Large scale poultry egg producers were found to have higher profit than the small and medium scale poultry-egg farmers. The study further revealed that the small scale farmers have the highest percentage of those far from the production frontier. However, there is room for higher technical efficiency across the three scales of production. The study also revealed that the cost of feed was a significant factor in determining the net farm income accruable to layer-egg farmers in the study area. The study recommends that farmers should be encouraged to increase their scale of production from small scale to large scale given the profit margin among the three scale, special intervention is needed from the government at all levels through the cooperatives in the area of inputs subsidy and market stabilization mechanisms to stabilize eggs and other poultry products prices. Technical efficiency of the farmers could be increased especially among the small scale farmers through accessible and efficient extension service delivery. Further research should be funded towards nutritionally improved and cost effective feed.

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