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

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ABSTRACT

The study compared the allocative efficiency and profitability of poultry-egg farmers in Jos metropolis of Plateau State, Nigeria, across different scales. To select 143 respondents, a two-stage sampling technique was used. Using well-structured questionnaire and interview schedules, primary data on socioeconomic variables were collected. Collected data were analyzed using budgetary technique and stochastic production frontier model. Result of allocative efficiency showed the following: The mean allocative efficiency of the small, medium and large scales was 0.68, 0.12 and 0.11 respectively; the minimum allocative efficiency for small, medium and large scales was 0.30, 0.10 and 0.10 respectively. The maximum allocative efficiency was 0.59, 0.18 and 0.11 respectively for small, medium and large scale farmers. The profitability result indicated that egg production for small, medium and large-scale farms was profitable in the study area with ₦675, 671.79, ₦4, 897,236.09 and ₦16, 327,633.66 per farmer. The rate of return on investment per bird was found to be 19.51%, 31.21% and 83.13% respectively for small, medium and large farm sizes. For small, medium and large-scale farmers respectively, the capital turnover per bird was ₦ 1.20, ₦1.31 and ₦1.83. Also, the profitability indices for the small, medium and large scales are ₦0.16, ₦0.24 and ₦0.45. The study recommends that; Farmers should be advised to increase production from small scale to large scale through policies that will promote such, special intervention is needed from the government at all levels through farmers' cooperatives in the area of inputs subsidy, price efficiency of the farmers could be increased through accessible and efficient extension service delivery and further research should be funded towards improved and cost effective feed. Also, N0.16, N0.24 and N0.45 are the profitability indices for the small, medium and large scales. The study advises that farmers should be advised through policies to increase production from small to large scale. Specific government involvement at all levels through farmers' cooperatives in the field of input subsidies is required to encourage this, price productivity of farmers could be increased through accessible and efficient provision of extension services, and further research could be funded towards improved and cost-effective feed.

Keywords: Comparative, Allocative Efficiency, Profitability, Different scales, Poultry-egg Production, Jos metropolis, Plateau state, Nigeria.

INTRODUCTION

The efficiency measurement remains an important area of research both in developed and developing countries around the world. In assessing profitability and agricultural growth linked to income, the measurement of efficiency will go a long way in attaining this (Tijani *et al*, 2006). Determination of the efficiency status of farmers is very important for policy purposes. In economies where technologies are limiting factors, efficiency studies indicate the possibility of raising productivity by improving efficiency without increasing the resource base or developing new technology (Yusuf and Malomo, 2007). One of the methods of approaching the problem of boosting production is to examine how efficiently the farmers use their resources; if resources used are inefficient, increase in production can be achieved by making adjustment in the optimal use of factors of production. Where it is efficient, the only way of increasing production is by adopting modern inputs and improved production technology (Oladeebo and Oluwaranti, 2012).

In the findings of Ojo, (2003), in the profit relationship, profit function approach combines the concepts of technical and allocative efficiencies, and any errors arising in the production decision are assumed to translate to lower profit or income for the producer. Profit efficiency, therefore, is defined as the ability of a farm to achieve the highest possible profit given the prices and levels of fixed factors of that farm, and profit inefficiency, in this context, is defined as loss of profit for not operating on the frontier (Alli & Flin, 1989).

The Poultry subsector is the quickest source of meat and its method of production requires the least hazardous and complicated in compared to other livestock enterprises. Hence, to achieve increased poultry production is one of the assured 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 annual intake of eggs records 370 pieces of egg per person. The challenge of bridging this protein intake gap appears insurmountable in view of the present economic and technological constraints confronting our livestock industry. Zuberu, *et al.,* (2015), reported that poultry production as one of the major sub-sectors in agriculture is a major supplier of protein, lipids and vitamins of high zoological value to man. Poultry eggs, apart from being a supplier of protein is also a good source of high energy nutrients. Of all animal sources of protein, 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). Classification of poultry according to scale of production indicate that small scale poultry eggs are made of farms with less than 1000 birds while medium scale are farms which have between 1000 and less than 5000 birds while farmers with 5000 birds and above are classified as large scale farms (Busari and Okanlawon 2015).

In spite of the fact that Nigeria's agricultural sector employing over 60 percent of the labour force in the agricultural sector in Nigeria (IFAD, 2014), the country was unable to meet the just concluded Millennium Development Goal (MDG), which targeted 50 percent reduction of hunger in the country. The percentage of children underweight under-five only reduced from 35.7 percent in 1990 to 25.5 percent in 2014, which is below the MDG target of 17.85 percent by 7.6 percent (Nigeria Millennium Development Goal End Point Report, 2015). Figures from the 2016 Central bank of Nigeria (CBN) Statistical Bulletin showed that the contribution of agriculture to Nigerian Gross Domestic Product (GDP) consistently decreased from 37.5 percent in 2002 to 21.2 percent in 2016. Similarly, food crop production declined from over 34 percent of the GDP in 2002 to 18.6 percent in 2016. Nigeria is yet to produce enough agricultural products for its large population. This is evidence by the fact that the overall agricultural contribution to GDP remains low while the agricultural product imports are on the high side. (Umar, 2012) in his findings attributed these to numerous problems that Nigeria's poultry farmers are confronted with, which includes; poor/low capital base, ineffective and inefficient management, low technical and allocative 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 capacities of farm have 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. The following objectives of the study were generated from the foregoing; i. compare the socioeconomic characteristics of the farmers ii. compare the allocative efficiency of poultry-egg farmers and iii. compare the profitability of poultry-egg production.

METHODOLOGY

Study Area.

This research was carried in Jos metropolis of Plateau State, Nigeria. Jos metropolis comprises of Jos north and Jos south Local Government Areas of the State. The study area is located between latitude 9° 56′ North and longitude 8° 53′ East and has a monthly temperature ranging from 21 – 25 °C and from mid-November to late January, night temperature drop as low as 11 °C (52°F). The annual rainfall of Jos metropolis is about 1,400mm. Jos metropolis has a population figure of 876, 214 and projected to 1,179,700 people in 2015 (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 livestocks raised in the study area are; Cattle, Sheep, Goat, Pigs and Poultry production (Amos, 2006).

Sampling techniques and sample size.

For the purpose of this study, 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, 373 and 126 small, medium and large scale farmers respectively. 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. Of the one hundred and forty-three questionnaires distributed, one hundred and one questionnaires were retrieved.

Method of data collection.

For this study, primary data used were collected with the use of 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 which include; access to credit, size of flock, cost of inputs and revenue generated from output.

Method of data analysis

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

Model specification.

Stochastic frontier production (SFP) model

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

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

The equation above can be simplified to give;

$$y = g(x)e^{v-u} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

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 poultry-egg 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 econometric estimation (Coelli, 1998). The empirical Cobb-Douglas production function model of the stochastic production frontier for this study is specified;

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

Where;

Y= Total Farm Output of poultry-egg (Kg)

The independent variables are:

X_1= Farm size (Total 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 δv^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 (11) measures the total variation of production (output) from the frontier which can be attributed to technical or allocative inefficiency (Battese, 1992).The δ^2 and γ, 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 & 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).

$Y_i = f(X_i;\beta) + \in i, i = 1,2, n$ …………………..…. (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, *et al.* (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)

$E(V_i/\in_i|) = \frac{\sigma.\sigma}{\sigma}.\left[\frac{f(\epsilon j\lambda\sigma)}{1-F(\epsilon i\lambda\sigma)}\right]\frac{\epsilon i\lambda}{\sigma}$ ………………… (13)

Where $\lambda = \sigma u/_{\sigma v}$, $\sigma^2 = \sigma^2 u + \sigma^2 v$, 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)

$TE = \frac{Y_i}{Y_i^*} = \frac{E(Y_i/U_i X_i}{(Y_i/U_{i=0,}X_i)} = E\left(\frac{-U_i}{\epsilon_i}\right)$ …………………… (14)

The corresponding cost frontier of Cobb-Douglas functional form which is the basis of estimating the economic efficiency of the farmers is specified as:

$C_i = g(P_i;\alpha)\exp(V_i + \mu_i)$ (4)

where,

C_i: The total input cost of the i^{th} farms g : The suitable function

p_i : Input prices employable by the i^{th} farm in poultry-egg production measured in naira

α: The parameter to be estimated

V_i and μ_i are defined below. The cost efficiency (CE_i) of individual farmers is defined in terms of the ratio of the

predicted minimum cost C_i^* to observed cost (C_i).
That is:
$CE_i = C_i^*/C_i = g(P_i; \alpha) \exp \mu_i / g(P_i; \alpha) \exp (V_i + \mu_i) = \exp(V_i)$

Hence, CE_i ranges between zero and one. The farmer's Economic Efficiency (EE_i) was estimated as the inverse of cost efficiency i.e., $EE_i = 1/CE_i$

The production technology of the food crop farmers was specified by the Cobb-Douglas frontier production function defined as follows:

$$\ln Y_i = \beta_o + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + V_i - \mu_i \ldots\ldots (6)$$

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.

where,
Y_i : Farm Output from farm i
X_1 : Farm Size (hectare)
X_2 : Hired labor (man days)
X_3 : Family labor (man days)
X_4 : Cost of planting materials (naira)
X_5 : Fertilizer (kg)
X_6 : Herbicides (liter)
V_i : `Random variability in the production that cannot be influenced by the farmer. Vis are assumed to be independent and identically distributed random errors having normal N~(0, δv^2) distribution and independent of μ_i
μi: Deviation from maximum potential output attributed to technical inefficiency. The μi is assumed to be non-negative truncation of the half-normal distribution N~ (μ, $\delta\mu^2$)
β_0: Intercept
β_1-β_6: Production function parameters to be estimated
i : 1, 2, 3, … n farms

The Cobb-Douglas cost frontier function for the food crop farmers is specified as:

$$\ln C_i = \beta_0 + \beta_1 \ln P_{1i} + \beta_2 \ln P_{2i} + \beta_3 \ln P_{3i} + \beta_4 \ln P_{4i} + \beta_5 \ln P_{5i} + V_i + \mu_i \qquad (7)$$

where:
C_i = Total input cost of the ith farms (naira) P_{1i} = Rent on land per hectare (naira)
P_2 = Wage rate of labor per month (naira)
P_3 = Average price of chick (naira)
P_4 = Price of feed per bag (naira)
P_5 = Average price of utility per hour (naira)
The technical and cost inefficiency effects, μ_i is defined

as:

$$\mu i = \delta 0 + \delta 1Z1 + \delta 2Z2 + \delta 3Z3 + \delta 4Z4 + \delta 5Z5 + \delta 6Z6 + \delta_7 Z_7 \quad \ldots\ldots(8)$$ where,

μI: Inefficiency effect
Z_1: Age of the farmer (years)
Z_2: Marital status (1,0)
Z_3 : Household size (Number of persons)
Z_4 : Educational level of farmer (years)
Z_5: Farming experience (years)
Z_6: Cooperative membership (member = 1, non-member = 0)
Z_7: Access to credit (Access =1, Non-access=0)

The δ_0 and δ_i coefficients are un-known parameters to be estimated along with the variance parameters δ^2 and γ. The variances of the random errors, δv^2 and that of the technical and cost inefficiency effects $\delta\mu^2$ and overall variance of the model δ^2 are related. Thus $\delta^2 = \delta v^2 + \delta\mu^2$. The δ^2 indicates the goodness of fit and the correctness of the distributional form assumed for the composite error term. The ratio $\gamma = \delta\mu^2/\delta^2$, measures the total variation of output from the frontier which can be attributed to technical or cost inefficiency. The sigma square (δ^2) and the gamma (γ) coefficients are the diagnostic statistics that indicate the relevance of the use of the stochastic production frontier function and the correctness of the assumption made on the distribution form of the error term. The estimates of all the parameters of the stochastic frontier production function and the inefficiency model were simultaneously obtained using the program FRONTIER version 4.1 (Coelli, 1996).

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 & Erhabor (2008). It is represented in equation (1)

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

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 (%)

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

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.

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

Socioeconomic Characteristics of Poultry-egg farmers

Table 1 revealed that the mean age of small, and medium scale respondents in the study area were 28 years each. Majority of the farmers in these categories are younger compared to the mean age (41 years) of the farmers in large scale farms. Under small scale poultry producers, nine percent (9%) were within the age range of 10 – 20years, seventy-seven percent (77%) were within the age range of 21- 30 years and fourteen percent (14%) were within the age range of 31- 40 years. As compared to the medium scale farmers who had twenty-eight percent (28%) of the farmers in the range of 21- 30years, forty-six percent (46%) in the range of 31 – 40years, twenty-one percent (21%) in the range of 41 – 50 years and four percent (4%) in the range of 51 – 60 years. However, only nine percent (9%) of large-scale farmers was in the range 21- 30 years, thirty-six percent (36%) in the range of 31 – 40years, forty-five percent are of the range 41- 50 years and nine percent (9%) were in the range of 51 – 60 years. The majority (77%) of small-scale farmers are within the range 21 – 30, while the majority of medium scale farmers (45%) and large-scale farmers (45%) are within the range of 31 – 40 and 41 – 50 respectively. This shows that adults in the range of 30 – 50 years are more involved in poultry-egg production business in the study area. Twenty-three percent (23%) of the small-scale respondents were married while the remaining seventy-seven (77%) were singles. This is in agreement with the findings of Fernandez-Cornejo, *et al.*, (2007) states that younger farmers in their active age, are likely to adopt new technology faster than the older ones.

However, majority (63%) of medium scale respondents and majority of large-scale respondents (90%) were married while thirty-seven percent (37%) and ten percent (10%) were singles respectively.

The result in table 1 also shows that the mean household size of small-scale respondents was 4 persons while the mean household size of medium scale farm respondents was 6 persons. The table shows that large farm respondents had the highest mean household size when compared to small and medium scale farm respondents. The table also shows that the respondents had different household sizes. This shows that the larger the scale of production, the more the number of people dependent on it. This result is in agreement with the findings of Haruna *et al*. (2007), which recorded that 40% of the poultry egg farmers had household size of less than 5 persons while 60% had household size of more than 5 persons. Similarly, Oluwatayo *et al*., (2008) in their research titled “Resource use Efficiency of Maize Farmers in Rural Nigeria. Evidence from Ekiti State”, more educated farmers tend to have smaller families. The implication is that the farmers with small family size will spend less on feeding, education, health care and other living expenses on their dependents. Table 1 revealed that majority (94%) of small and 96% of medium scale farmers had received formal education. This is also true about the large-scale poultry egg farmers in which one hundred percent (100%) had received formal education. This is in agreement Binjin, (2007), which mentioned that most of the poultry egg farmers in Jos metropolis had formal education to tertiary level. This enhance their ability to adopt new technology which could translate to increased poultry egg production (Haruna *et al*., 2002).

Table 1 shows that the mean years of farming experience of respondents in medium and large-scale farms was 6 years while the mean years of farming experience of respondents in small scale farms was 4 years. This implies that an average farmer who has either medium or large-scale farm was two years more experience in the business than average farmers who has small scale farms in the study area. This shows that large and medium scale poultry farmers are more experienced as compared to small scale poultry egg farmers in the study area. This shows that those who engage in large scale poultry egg production had more experience which is necessary for efficiency make more profit than those who are engaged in medium and small-scale farms. The result also shows that medium scale poultry farmers are more experienced as compared to small scale farmers in the study area. This is in line with the work of Ashagidigbi *et al*. (2011), which states that farming experience reduces losses is farm business and also enhances efficient allocation and utilization of resources which increases productivity.

The result in table 1 further indicates that forty-five percent (45%) of the respondents in small scale poultry farming were male while the majority (55%) was female. Also, the majority (69%) of medium scale farmers were female while the remaining 35% were male. The case is the same in large scale poultry respondents as the majority (63%) were female while thirty-six percent (36%) were male. The result shows that 65% of the respondents were female while the remaining 35% were male. This is in agreement with the findings of Haruna *et al.* (2007), which estimated that majority of poultry farmers in Jos metropolis are female. The result shows that small scale farm respondents had 15% more male as compared to the 30% male in medium scale farm respondents. However, medium scale category had more female respondents. This is followed by large scale farms and then small-scale farm category which had the least percentage of females when compared to the percentage of females in the other two scales of production in the study area.

Table 1: Socioeconomic characteristics of poultry-egg respondents

Variable	Small- scale		Medium –scale		Large-scale	
Age	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
10 – 20	2	9	0	0	0	0
21 – 30	17	77	19	28	1	9
31 – 40	3	14	31	46	4	36
41 – 50	0	0	14	22	5	45
Above 50	0	0	4	6	1	9
Mean	**28**		**28**		**41**	
Marital status						
Married	5	23	43	63	10	91
Single	17	77	25	37	1	9
Household size						
1 – 5	21	95	33	49	4	36
6 – 10	0	0	34	50	6	55
11 – 15	1	5	2	3	0	0
Above 15	0	0	0	0	1	9
Mean	**4**		**6**		**7**	
Edu						
Non-formal	1	5	3	4	0	0
Primary	1	5	9	13	0	0
Secondary	3	14	1	2	0	0
Tertiary	17	76	55	81	25	100
Mean	**15**		**15**		**17**	
Farming Exp.						
1 – 5	18	81	29	43	2	18
6 – 10	4	18	39	57	9	81
Mean	**4**		**6**		**6**	
Gender						
Male	10	45	21	31	4	37
Female	12	55	47	69	7	64
Total	**22**	**100**	**68**	**100**	**11**	**100**

Source: Field survey, 2016.

Allocative Efficiency of Poultry-egg Production

The results of translog stochastic frontier cost and production function for poultry-egg farmers revealed that the Maximinm Likelihood estimates and inefficiency determinants of the specified frontier are presented in Table 6. The study revealed that the generalized Log likelihood function were -0.27, -48.99 and -62.45 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 are 0.99, 0.99 and 0.77 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 99%, 99% and 77% 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 (Idiong, 2005). Since these factors are under the control of the farmer, reducing the influence of the effect of γ will greatly enhance the allocative efficiency of the farmers and improve their income and profit. 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 allocative inefficiencies of poultry-egg farmers in the study area. The value of sigma squared ($\boldsymbol{\sigma^2}$) was significantly different from zero level of probability with estimated values of 2.73, 2.91 and 1.29 for small, medium and large-scale layer-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, 48.680 and 38.143 for small, medium and large-scale farms respectively.

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

Cost of stocking has negative coefficients of -0.0159 and -30.478 for small and large-scale poultry-egg farmers respectively and is significant at 10% level of probability across the two scales. The negative and significant coefficient of cost of stocking stresses the importance of the variable in poultry-egg production. The negative coefficient of cost of stocking implies that to increase egg production by 1 unit, the cost of stocking will have to be reduced by 0.02% and 30.48%

for small and large scale farms respectively. The large scale poultry-egg farmers had the highest response, followed by small scale farmers with the least contribution to poultry-egg production. This finding concurs with the one of Ogundari *et al.,* (2007).

Cost of medical and veterinary services has positive coefficients of 0.4223 and 0.4809 in medium and large-scale farms respectively and are both significant at 1% level of probability. The positive coefficient of medical and veterinary services implies that to increase poultry-egg production by 1 unit, cost of veterinary services will have to be increased by 0.42% and 0.48% respectively for the two scales. This is in agreement with Nmadu, *et al*., (2014), which explained that poultry egg farmers should implement better management practices to minimize the incidence of disease outbreaks and reduce hired labour in other to reduce the cost of production.

Cost of feed is another variable which affects the poultry-egg production in the study area. The result revealed that the variable has a positive coefficient of 0.8545 in large-scale farms and is significant at 1% level of probability in this scale of production. The positive coefficient of the feed in the large scale of production implies that to increase production by 1 unit, it will lead to an increase in the cost of feed by 0.85% in the large scale poultry-egg production. This is in line with the findings of Haruna *et al.* (2007).

The result of cost labour use in poultry-egg production revealed that labour has positive coefficients of 0.1618 in small scale only. The variable is statistically significant at 10% level of probability for this scales of production. The positive coefficient of labour implies that to increase egg production by 1 unit, labour cost will have to be increased by 0.16% in this scale. It may not be a serious issue in the medium and large scale respectively probably because of the transition from manual management operation to high technologies. This result compares favorably with the findings of Nmadu *et al.* (2014).

Cost of utilities (which include cost of electricity, water, kerosene etc.) were other variables determining allocative efficiency of poultry-egg production in the study area. The result showed that utility has positive coefficients of 0.31007 and 0.1261 for medium and large scale farmers respectively and significant at 5% and 1% level of probability. This means that for poultry-egg production to increase by 1 unit, the cost of utility will have to rise by 0.31% and 0.13% for medium and large scale production respectively. This is supported by the findings of Daniel (2009), which pointed out that availability of electricity and water contributes to production in poultry and livestock farming.

The table also revealed that rent cost of structures has negative coefficient of -0.5071 and significant at 1% level of probability for only medium scale in the study area. This means that to increase production by 1 unit, rent cost will have to be reduced by 0.51%. This result also indicate that medium scale farmers probably are mostly operating from rented structures in the study area.

The result of inefficiency model reveals that gender has a positive coefficient of 0.2586 and 0.3003 and are significant at 1% and 5% for small and medium scale farmers respectively while large scale farmers has a negative coefficient of -1.6740 and significant at 1% level of probability at the three scales of production. This implies that gender can raise allocative inefficiency of small and medium scale poultry egg farmers by 0.26% and 0.30% respectively while it will increase the efficiency of the large scale by 1.67%. This result compares favorably with the findings of Ibrahim (2004).

The result further revealed that marital status has positive coefficients of 0.5581, 0.3186 and significant at 1% levels of probability for small and large scale respectively while the medium scale farmers has a negative coefficient of -0.3952 and significant at 5% level of probability. This implies that a change in marital status of poultry-egg farmers will increase inefficiency by 0.56% and 0.32% respectively for small and large scale farmers while it will increase allocative efficiency of the medium scale farmers by 0.39%. This result compares favorably with the findings of Ibrahim (2004).

The result further shows the importance of farming experience in attaining efficiency in poultry-egg production. The coefficients of farm experience were -0.1154, -0.2358 and -3.3168 and were all significant at 1% level of probability across the three scales of poultry-egg production. The implication of this result is that if farming experience increase by 1 unit, allocative efficiency will increase by 0.12%, 0.24% and 3.32% respectively for small, medium and large scale farmers.

It also shows that level of education has a negative coefficient of -1.2831, -0.1508 and -0.2770 in small medium and large scale respectively. This implies that a 1% increase in level of education will increase allocative efficiency by 1.28%, 0.15% and 0.28% respectively for small medium and large scale production respectively. This finding is consistent with the findings of Abdulai and Huffman (2000)

It also reveals that membership of cooperative has a negative coefficient of -1.9279 and significant at 1% level of probability for the small scale farmers while the medium and large scale have positive coefficients of 28.2727 and 3.3168 in small medium and large scale respectively. This implies that a change in membership status of cooperative will increase allocative efficiency by 1.93% in the small scale while it will increase the inefficiencies of medium and large scale poultry egg farmers by 28.27% and 3.32% respectively. This may be due to large amount of capital required either to start or expand these scales of farm which are not obtainable in the cooperative societies.

Table 6: Estimates of the translog cost function and stochastic frontier for poultry-egg farmers

Variable/Parameters	Small Scale			Medium Scale			Large Scale		
	Coeffi	**Standard Error**	**T-ratio**	**Coeff**	**Standard Error**	**t-ratio**	**Coeff**	**Standard Error**	**t-ratio**
A. General Model									
Constant b_0	2.6763	0.8693	3.0786***	2.3841	0.6359	3.7487***	1.2040	2.9370	0.4099^{NS}
Cost of stocking b_1 (₦)	-0.0159	0.1550	-1.6552*	0.1762	0.1832	0.9619^{NS}	-30.4777	0.1524	-1.999*
Cost of medical/Vet b_2	0.4223	0.1185	3.5635***	0.4809	0.1009	4.7627***	0.2770	0.3919	0.8102^{NS}
(₦)	0.1815	0.1570	1.1560^{NS}	-0.5071	0.1516	-0.3353NS	0.8545	0.3206	2.6650**
Cost of Feed b_3 (₦)	0.1618	0.1254	1.79055*	-0.2064	-9.985	-0.02367^{NS}	0.1261	0.1969	0.0006^{NS}
Cost of Labour b_4 (₦)	-2.4185	-8.5208	0.2838^{NS}	0.31007	0.1270	2.4413**	0.2770	0.3419	3.8107***
Cost of Utility b_5 (₦)	-	-	-	-0.5071	0.1516	-3.3437***	-	-	-
Rent of Structure b_6 (₦)									
B. **Inefficient**									
Constant	2.7272	-7.5608	36.0710***	2.9144	0.3315	8.7892***	1.2931	1.0576	7.222***
Gender	0.2586	-1.0085	-25.6438***	0.3003	0.1110	2.7056**	1.674	0.1745	9.5943***
Marital Status	0.5581	-64.049	86.6779***	0.3952	-5.566	1.7177*	0.3168	0.4905	6.458***
Household size	-2.7433	-2.1896	1.2528^{NS}	-6.2452	0.1028	-0.6074^{NS}	0.8154	0.5303	1.5375NS
Farming Experience	-0.1154	-1.1963	9.6497***	-0.2358	-5.9299	-3.977***	-9.6368	-0.2792	34.5157***
Education status	-1.9279	-78.8876	2.4482**	28.2727	-7.8752	3.5900***	3.3168	0.4905	6.76208***
Access to credit	-	-	-	15.2358	-5.9299	2.5693**	-		
C. V**ariance**									
Sigma^2	2.7287	0.7648	3.5677***	45.7164	3.0315	2.8856**	0.3266	0.2135	1.5293NS
Gamma	0.9999	-	67200.889***	-0.9931	-41.95	286.728***	-0.7771	-3055.32	0.2525NS
Likelihood	-.277303	1488.069		-48.9963			-62.454		62.454
Mean A.E	0.11			0.12			0.11	0.11	
Number of Observations	23			68			11		
LR	82.8916			48.680			38.143		

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

Farm level allocative efficiency of respondents

The frequency distribution of the Allocative Efficiency (A.E) estimates of poultry-egg farmers in the study area as obtained from the stochastic frontier analysis is presented in Table 7. The study revealed that 100% of small, medium and large-scale poultry-egg farmers respectively fall within the range of < 0.2 – 0.4 allocative efficiency.

Furthermore, in the minimum A.E of the poultry-egg farmers; small scale farmers have the highest (0.30) while the medium and the large-scale poultry-layer farmers had the same A.E (0.10). This means that for the minimum A.E.; small, medium and large-scale farmers were 30%, 10% and 10% allocatively efficient respectively. For the maximum A.E; small-scale poultry-egg farmers had the highest (0.77), followed by medium scale farmers (0.25) while large-scale farmers had the least (0.11), which means that the small, medium and large-scale farmers were 77%, 25% and 11% allocatively efficient respectively. The mean A.E was 0.39, 0.12 and 0.11 respectively for small, medium and large-scale poultry-egg farmers respectively, which means that the small, medium and large-scale layer-egg were 11%, 12% and 11% allocatively efficient respectively in the study area. The table further revealed that the medium scale poultry-egg farmers are the most allocatively efficient in the study area while both the small and large-scale farmers had the least percentage of allocative efficiency of 11% each. This implies that for the farmers with the best practices, poultry-egg farmers' cost will rise by 61%, 88% and 89% respectively from the maximum possible level of 100% due to allocative inefficiencies while for the poultry-egg farmers with the least practices, the small, medium and large scale poultry-egg farmers' cost will rise by70%, 90% and 90% respectively from the maximum 100% due to allocative inefficiencies. Also, the result shows that 100 % of the poultry-egg farmers operated with the <20 – 40 A.E which means that majority of the poultry-egg farmers operated far from their production frontier. In the short-run, there is scope for reducing poultry-egg production costs by 70%, 90% and 90% respectively by the small, medium and large-scale farmers by adopting the techniques and technologies employed by the best poultry-egg farmers.

Furthermore, the study also revealed that for the average small, medium and large scale poultry-egg farmers in the study area to become the most efficient, he will need to realize about 34%[1-(0.39/0.59)*100], 33%[1-(0.12/0.18)*100], and 27%[1-(0.11/0.15)*100] cost savings, while on the other hand, the least allocatively efficient small, medium and large scale poultry-egg farmers will need about 49% [1-(0.0.30/0.0.59)*100], 44% [1-(0.10/0.18)*100] and 33% [1-(0.10/0.15)*100] cost savings to become the most allocatively efficient poultry-egg farmer.

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

	Small scale		Medium scale		Large scale	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
< 0.20 – 0.40	22	100	68	100	11	100
0.41 – 0.60	-	-	-	-	-	-
0.61 – 0.80	-	-	-	-	-	-
0.81 – 1.0	-	-	-	-	-	-
Total	**22**	**100**	**68**	**100**	**11**	**100**
Mean		**0.39**		**0.12**		**0.11**
Maximum		**0.59**		**0.18**		**0.15**
Minimum		**0.30**		**0.10**		**0.10**
Sigma squared		**2.73**		**0.27**		**0.50**
Gamma	**0.99**		**0.93**		**0.50**	
Log likelihood		**-0.69**		**-0.85**		**-0.13**
L-R Test	**94.01**		**48.68**		**38.14**	

Source: Field survey, 2016.

Profitability of poultry-egg poultry production

The result in Table 2 shows the net farm income analysis for the three categories of poultry-egg farm. The result indicate that the average total cost incurred per farmer was ₦1,855,945.02, ₦9,532,778.97 and ₦18,212,817.25 in small, medium and large scale farms, respectively. The cost includes 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 2 also indicated that the average total revenue generated per farmer in small scale farms was ₦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 ₦675,623.79 while medium and large scale farm have a profit of ₦4, 897,236.09 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. From the Table 2, the large scale farms made a profit of ₦675, 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 farmer 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 farmer 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 everyone 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 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. 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 and PI in his work titled economic analysis of poultry-egg production in Bauchi LGA., Bauchi state.

Table 2: Average annual profitability analysis of poultry-egg production

	Small Scale		**Medium Scale**		**Large scale**	
Item	**Average**	**% TVC (₦)**	**Average**	**% TVC (₦)**	**Average**	**% TVC (₦)**
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	1,310,480.58	89.79	8,068,912.71	91.56	15,522,405.24	91.67
Cost of Medication	68,640.08	0.85	63,451.48	0.72	103,290.81	0.61
Labour cost	12,405.71	0.48	63,451.48	0.72	103,290.81	0.61
Cost of water	3,940.64	0.27	13,219.06	0.20	194,728.55	1.15
Cost of electricity	4,816.33	0.33	17,625.41	0.27	42,332.29	0.25
Kerosene	1,459.50	0.10	7,050.16	0.008	338.66	0.002
Litter material	437.89	0.03	881.27	0.01	1,693.29	0.01
Disinfectant	727.75	0.05	1,762.54	0.02	6,773.00	0.04
Petrol/Diesel	1,313.55	0.09	6,168.89	0.07	3386.58	0.002
Crates	1021.65	0.07	2,643.81	0.03	338.66	0.02
Transportation	1459.80qe	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. TVC	1,442,731.61	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 (₦)**						
Feeder & Drinker	148,148.82	36.36	211,053.69	29.31	379,106.38	29.62
Nest Cost	111,152.36	27.28	297,894.61	41.37	521,431.36	40.74
Housing cost	148,148.82	36.36	211,128.70	29.32	379,362.36	29.64
D.**TFC**	**407,450.00**	**100**	**720,074.00**	**100**	**1,279,900.00**	**100**
Total Cost (₦)	**1,855,945.02**		**9,532,778.97**		**18,212,817.25**	
D. Revenue (₦)						
Spent layers	355,954.44	42.16	3,728,715.90	35.84	13,125,371.35	38.00
Crates of eggs	1,097,455.89	43.36	6,281,385.56	43.53	14,127,044.42	40.90
Poultry dropping/bag	346,831.50	13.70	2,864,357.99	19.85	176,156.30	12.40
Empty bags	19,493.45	0.77	109,668.11	0.76	176,156.30	0.51
TOTAL REVENUE	**2,531,616.81**	**100**	**14,430,015.06**	**100**	**34,540,450.91**	100
NFI	**675,673.79**		**4,897,236.09**		**16,327,653.66**	
PI	**0.27**		**0.34**		**0.47**	
RRI	**0.36**		**0.51**		**0.90**	
CTO	**1.36**		**1.51**		**1.90**	

Source: 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 3,4and 5 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 sizes of the poultry farms under consideration. The result of coefficient of variation as presented in table 3 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 5 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 3: 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 4: 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 5: 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

SUMMARY, CONCLUSION AND RECOMMENDATIONS

The study analyzed profitability and Allocative efficiency among different scale of poultry-egg farmers in Jos metropolis, Plateau state, Nigeria. The result of data analysis and hypothesis shows that poultry egg production was profitable in the study area, but the level of profit depends on the scale of production. Large scale poultry egg farmers were found to have higher profit margin than the small and medium scale poultry-egg farmers. The study further revealed that all the small, medium scale and large-scale poultry-egg farmers were all far from the cost saving frontier. However, there is room for higher allocative 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 poultry-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 scales, 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. Allocative efficiency of the farmers could be increased especially among all the three scales through accessible and efficient extension services delivery and increased access to training. Further research should be funded by the government at all levels towards nutritionally improved and cost-effective feed.

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