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Relative Profit Efficiency of Feed Milling Systems Among Poultry Egg Producers in Ogun State

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Abstract
The role of poultry egg consumption in ameliorating protein intake deficiencies in developing countries such as Nigeria cannot be overemphasized. One way of encouraging increased egg production is by improving profit that accrues to the enterprise. Feed accounts for over 70 percent of poultry production cost, thus efficiency in the use of feed in production is a veritable source of increasing the profit of the producers. This study thus investigated the relative profit efficiency of feed milling systems of poultry egg producers in Ogun State. A total of ninety-nine poultry farms selected using simple random sampling technique was used for the study. Data collected were analyzed using descriptive statistics to investigate the socio-economic and institutional characteristics and stochastic frontier profit function (Cobb-Douglas) to estimate profit efficiency of poultry egg producers in the study area. An average farmer in the sample was 44 years old; 84.8% were male, 81.8% had tertiary education and 66% were full-time farmers. Self-feed millers, toll feed users and commercial feed users, were respectively 36, 21 and 42 percent of the respondents. Some 72% of respondents stocked day-old chicks and likewise 72% of the respondents used are a brown breed of birds. The average farm size was 9, 380 birds. Prices of all the variable inputs except that of labor significantly influence the profit efficiency of poultry farmers while the prices of all fixed inputs also have significant effect. Result of the analysis further showed that the profit efficiency of the farmers ranged between 17% and 99% with mean efficiency score of 82.45%. This indicated that the poultry egg farmers were not fully profit efficient and that there was 17.55% allowance to improve profit efficiency. Furthermore, the result showed household size, extension service; years of education, gender of respondent, marital status and non-farm employment were determinants of profit efficiency. The average profit per bird for self-feed millers, toll-mill users and commercial feed users were N1,879.45; N1,684.65 and N1, 257.41 respectively. The test of difference between mean profit efficiency amongst those with different feed milling systems, type of bird stocked and breed of bird used were significant at 1% level. Self-milling was the most profit efficient feed milling system for poultry egg producers in the study area, followed by toll milling while the use of commercial feed was the least. Likewise, use of day-old-chicks was the most profit efficient, followed by stocking of point-of-cage while point-of-lay was the least profit efficient. The profit efficiency for those using *is a brown* breed of birds was better than those using *nera* black breed of birds. The study concluded that there are opportunities for increasing profit efficiency in poultry egg production by focusing policy on the profit efficiency factors and by supporting on-farm feed-mill production projects.

Keywords: Relative profit efficiency; Feed milling systems; Egg production; Ogun State

Introduction
In an economy where technologies are lacking, efficiency studies show the possibility of raising productivity by improving efficiency without increasing the resource base or developing new technology (Yusuf and Malomo, 2007).

Feed as a resource in poultry production accounts for over 70% of the total cost of production (Bamiro*et al.*, 2006). Feed manufacturers in the country can be categorized into three groups namely: large-scale commercial feed millers, on-farm self-millers, and the toll feed millers. These feed milling systems provide egg producers options to manage cost, improve efficiency or maximize profits.

According to Adepoju (2008), feed cost is the most important single cost item associated with layer production due to increase in the cost of maize, groundnut cake, soya bean meal, fish meal and scarcity of wheat and corn offal. Sonaiya and Sivan (2004), noted that availability of feeds at economic prices is the most important condition for profitable layer production, because, it constitutes more than 75 percent of the total expenditure. Despite price fluctuations of feed material, feed cannot be rationed for optimum egg production because the growth rate of birds, meat yield and hatchability depend to a large extent on the quantity and quality of feed used (Decuypere and Bruggeman, 2007). An upward increase in feed cost reduces enterprise profit margin (Adeyinka and Mamman, 2002) and this is a disincentive to the poultry egg farmers. Chavas and Alibe (1998) stressed that the most profitable use of feed required *ad-libitum* feeding for maximum egg production at all levels of cost and prices, so long as egg revenue exceeds total feed costs. However, it is important to emphasize that the aim of commercial egg producers is to maximize egg revenue over and above total costs (*i.e* maximize profit).

The problem of protein and caloric malnutrition repeatedly highlighted as a major contributing factor to the serious health hazard in developing countries especially Nigeria (Nurudeen, 2012) and the imposition of ban on the importation of poultry and poultry products that can be produced locally in the country is an indication that local producers must leave up to expectation of meeting the local demand. Farmers need not be only efficient in their production activities; they also have to be responsive to market indicators, so that scarce resources are utilized efficiently to increase productivity as well as profitability.

This study therefore investigates the relative profit efficiency of the three feed milling systems available to poultry egg producers in Ogun State (viz on-farm self-milling, toll feed milling and commercial feed milling in a way that is responsive to market indicators expressed in inputs and output prices.

Concept of Profit Efficiency

A profit function is an extension and formalization of the production decisions taken by a farmer. The advantage of using this approach is that input and output prices are treated as exogenous to farm household decision making, and they can be used to explain input use. The profit function approach combines the concepts of technical, allocative and scale inefficiency in the profit relationships and any error in the production decision translates into lower profits or revenue for the producer (Ali *et al.*, 1994) and hence, lower profit efficiency (Rahman, 2003). Profit efficiency is the ability of a firm to achieve potential maximum profit, given the level of fixed factors and prices faced by the firm (Adesina and Djato, 1996) and profit inefficiency in this context is defined as the loss of profit from not operating on the frontier (Ali and Flinn, 1989; Oguniyi, 2008).

Stochastic Profit Frontier and Normalized Profit Function

Battese and Coelli (1995) extended the stochastic production frontier model by suggesting that the inefficiency effects can be expressed as a linear function of explanatory variables, reflecting farm-specific characteristics. This extension allows estimation of the farm-specific efficiency scores and the factors explaining efficiency differentials among farmers in a single stage estimation procedure.

The stochastic frontier profit function is defined as:

$$\pi j = f(Pij, Zij, Dij)\ \exp ei \quad (1)$$

where π_j is normalized profit of the *jth* farm and it is computed as gross revenue less variable cost divided by farm-specific output price; P_{ij} is the price of the *ith* variable input faced by the *jth* farm divided by output price; Z_{ij} is level of the *ith* fixed factor on the *jth* farm; D_{ij} is the *ith* dummy variable for the *jth* farm ; e_i is an error term which is assumed to behave in a manner consistent with the frontier concept (Ali and Flinn, 1989)

$$ei = vi - ui \quad (2)$$

I = 1……… n; n is the number of farms in the sample. v_i is two sided random error assumed to be independently and identically distributed with zero mean and constant variance, i.e ~N (0, σv^2) and u_i is non-negative random variable, associated with inefficiency in production, which is assumed to be independently distributed and truncated at zero of the normal distribution with variance σ_υ^2 . The two components are assumed to be independent of each other, v_i represents the random error due to factors outside the control of farmers as well as the effects of measurement errors in the output variable and stochastic noise while u_i represents variations in efficiency due to production inefficiency resulting from farmer-specific socio-economic and institutional characteristics, i.e $eui = \delta + \Sigma\delta\, d\, Wd$...... ....(3)

where, wd is the *dth* explanatory variable associated with inefficiencies on the *jth* farm and δ0 and δd are unknown parameters to be estimated (Rahman, 2003

Thus, the profit efficiency (PEj) of the *jth*farm in the context of the stochastic frontier profit function is given as:

$$PEj = [exp(-ui)|ei] = E[exp(-\delta 0 - \Sigma\delta d wd)|ei]$$

.............(4) (Rahman 2003) .

Pe_i lies between 0 and 1, and it is inversely related to the level of profit inefficiency. E is the expectation operator. The likelihood function in term of the variance parameter, $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / \sigma^2$ (Battese and Coelli, 1995).

Methodology

This study was carried out in Ogun State, Nigeria which is endowed with a favourable climate and good vegetation for all the year round cultivation of various cash and food crops as well as livestock rearing. Ogun State is known for its heavy concentration of poultry production, particularly layers production (Yussuf and Malomo, 2007). Poultry production is practiced at both commercial level and small-scale level. Ogun State is the highest producer of poultry especially poultry eggs (Omodele and Okere, 2014). It therefore has the potential to supply a large portion of the nation's demand for poultry and poultry products if available resources are efficiently used for optimal production.

Primary data collected from 120 poultry egg farmers comprising 30 farmers randomly selected from each of the four Agricultural Development Programme zones of the state using producers sample frame obtained from the Poultry Association of Nigeria (PAN), Ogun State chapter was used. Data collected were for a production cycle. Amongst the 120 distributed copies of questionnaire, 99 which comprised 36, 42 and 21 for respective self-millers, commercial feed users and toll feed millers were completely filled and found useful for our analysis.

Data collected were on socio-economic characteristics of poultry (egg) farmers, feed technology system, housing type, types of input birds (day-old-chicks, point of cage or point of lay), poultry production data (such as resources used, costs, returns, prices, constraints to poultry production, quantity of eggs collected, cost of labor, feeding cost, vaccination costs, access to and use of credit among others).

Data Analysis

Descriptive statistics, gross margin analysis and the stochastic frontier profit function were employed for data analyses.

Budgetary analysis specifically gross margin was used to estimate the costs and returns in poultry egg production in the study area. The difference between gross revenue and total variable costs of production gives the gross margin. This was used to assess the profitability of poultry farmers who are engaged in egg production. This is given as:

$$GM = TR - TVC \quad \text{---------------------(5)}$$

Where GM = Gross Margin, TR = Total Revenue and TVC = Total Variable Cost (cost incurred in the use of variable inputs).The gross margin was computed on the basis of one bird ,i.e GM/bird.

$$GM/\text{bird} = 1/Q_c(\Sigma P_e Q_e + \Sigma P_c Q_c + \Sigma P_w Q_w - \Sigma C_j X_j)$$

Where: GM/ bird = Farm Gross Margin (Naira)/bird; P_e = farm-gate price of egg (Naira/crate); Q_e = total number of crates of eggs produced ; P_c = farm-gate price of culled birds sold (naira/bird); Q_c = number of culled birds sold (numbers); P_w = farm-gate price of waste from the farm sold (naira /kg); Q_w = quantity of waste from farm sold (kg); C_j = Unit price of the variable input j (naira); X_j = Quantity of the variable input j.

The Stochastic Frontier Profit Model Specification

The empirical model for the stochastic frontier profit function of the poultry egg farmers in the study area given in Cobb-Douglas functional form is specified as:

$$\ln \pi_j = \ln \alpha 0 + \beta 1 \ln P1 + \beta 2 \ln P2 + \beta 3 \ln P3 + \beta 4 \ln P4 + \beta 5 \ln Z1 + \beta 6 \ln Z2 + \beta 7 \ln Z3 + \alpha 1 D11 FM + \alpha 2 D12 FM + \alpha 3 D21\ BS + \alpha 4\ D22 BS + \alpha 5 D31 B + vi - ui \quad \text{--- (7)}$$

Where, ln = natural logarithm,

π_j = restricted normalized profit computed for the *jth*farm, defined as gross revenue less fixed costs divided by farm specific output price P (average price of a crate of egg).

P_{ij}= price of variable inputs *I*, normalized by average price of output for *jth* farm (a crate of egg) (i=1…….4) so that:

P_1= normalized price of feed (in naira/kg)

P_2= normalized price of labor (in naira/day)

P_3= normalized price of medication or drugs or vaccines (in naira/production season).

P_4= normalized price of other operating costs (naira/production season).

Z_{ij}= the quantity of fixed inputs *i* for *jth*farm (i = 1….3)
Z_1 = cost of stocked bird for the *jth* farm (day old chick or point of cage or point of lay) in naira.
Z_2= capital used for the *jth* farm (cost of cage, machines etc) in naira
Z_3= farm size of the *jth* farm (number of birds owned by farmers)
Dij = dummy variables for farm specific characteristics *i* for the *jth*farm
*D*11*FM*= dummy for feed milling system (1=self milling, 0=otherwise)
*D*12*FM*= dummy for feed milling system (1=toll milling, 0=otherwise)

It is to be noted that commercial feed is chosen as the base dummy for this study because it is expected that farmers using this feed milling system are the least profit efficient.

*D*21*BS* = dummy for type of bird stocked (1= day-old-chicks, 0=otherwise).
*D*22*BS* = dummy for type of bird stocked (1= point-of-cage, 0=otherwise) .

It is to be noted that point-of-lay is chosen as the base dummy for this study because it is expected that farmers using this mode of stocking are the least profit efficient.

*D*31*B* = dummy for breed of bird (1= *isabrown,* 0 = *nera black*).

Nera black breed is chosen as the base dummy for this study because although it produces actively in the short run,*isa* brown layers are feed efficient and convert feeds given to produce more eggs in the long run, (Olawunmi and Dudusola, 2012).

It should be noted that in order to avoid dummy variable trap, qualitative variables with *m* categories were represented with *(m-1)* dummy variables to avoid the problem of Multicollinearity (dummy variable trap).

v_i= random error
ui = inefficiency variable (which represents farmer specific characteristics related to profit inefficiency)
u_i= inefficiency variable (which represents farmer specific characteristics related to profit inefficiency)

The inefficiency model is specified as:

$$ui = \delta 0 + \Sigma \delta d \, wd \quad \text{..............................(8)}$$

Where δ0, δ*d* are parameters to be estimated, wd = variables explaining inefficiency effects and are defined as follows: w_1 = age of farmer in years; w_2 = marital status (dummy: 1=married, 0= otherwise); w_3 = household size in number; w_4 = non-farm employment (dummy: 1=none, 0 = otherwise); w_5 = farming experience in years; w_6 = extension service in number; w_7 = years of education in years; w_8 = access to credit (dummy: 1=yes, 0 = no); w_9= sex of farmer (dummy: 1=male, 0=female); w_{10} = poultry training (dummy: 1=yes, 0 = no); w_{11}= membership in any farmers organization (dummy: 1=yes, 0 = no); w_{12} = rearing period (weeks); w_{13} = live ratio of bird stocked (ratio of saleable birds to initial total number of birds stocked)

αo, αi,βi,δ0, δd are the parameters to b e estimated.

The maximum likelihood estimates of the parameters of the stochastic frontier profit function and the inefficiency model defined by equations 7 and 8 were simultaneously estimated using FRONTIER 4.1 [Coelli, 1996)

Test of Hypotheses

Different hypotheses were tested to confirm the dependence of profit efficiency of farmers on feed milling systems, type of bird stocked and breed of birds.

The full model is given as:

$$\ln\pi_j=\ln\alpha 0+\beta 1\ln P1+\beta 2\ln P2+\beta 3\ln P3+\beta 4\ln P4+\beta 5\ln Z5+\beta 6\ln Z6+\alpha 1D11FM+\alpha 2D12FM+\alpha 3D21BS+\alpha 4D22BS+\alpha 5D31B+vi-\mu i \quad ....(9)$$

Where: α1 and α2 are coefficients of dummy variables for feed milling systems (FM)

α3 and α4 are coefficients of dummy variables for type of bird stocked (BS)

α5 is the coefficient of dummy variable for breed of bird (B) .

$$\beta 4\ln P4+\beta 5\ln Z5+\beta 6\ln Z6+\alpha_3D_{21BS}+\alpha 4D22BS+\alpha 5D31B+vi-\mu i \quad ------(10)$$

$$\ln\pi=\ln\alpha 0+\beta 1\ln P1+\beta 2\ln P2+\beta 3\ln P3+\beta 4\ln P4+\beta 5\ln Z5+\beta 6\ln Z6+\alpha 1D11FM+\alpha_2D_{12FM}+\alpha 5D31B+vi-\mu i \quad ----------------------(11)$$

$$\ln\pi=\ln\alpha 0+\beta 1\ln P1+\beta 2\ln P2+\beta 3\ln P3+\beta 4\ln P4+\beta 5\ln Z5+\beta 6\ln Z6+\alpha 1D1FM+\alpha_2D_{12FM}$$

$$\ln\pi=\ln\alpha 0+\beta 1\ln P1+\beta 2\ln P2+\beta 3\ln P3+\alpha 3D21BS+\alpha 4D22BS+vi-\mu i \quad -------------(12)$$

The corresponding statements of hypotheses of equations 10,11 and 12 are:

H_1: profit efficiency of the farmers is independent of their feed milling systems

H_2: profit efficiency of the farmers is independent of the type of bird stocked

H_3: profit efficiency of the farmers is independent of breed of birds

Results and Discussions

Socio-economic and Institutional Characteristics of Poultry Egg Farmers

Socio-economic variables of importance considered in this study were gender, age of farmers, years of education, marital status and experience in poultry farming, household size; poultry farm size, feed milling systems, type of bird stocked, breed of birds and non-farm employment. Also, institutional characteristics considered were access to extension services, membership of cooperative societies, access to credit and training in poultry farming.

The results as presented in Table 1 show that an average farmer was 44 years old. The mean years of education and experience in poultry farming were 15 and 10 years respectively. The average household size of the respondents was 4 persons. About 78% of the farmers were married and 84.8% were male. An average farmer had 9, 380 birds, majority of the farmers (72%) stocked day-old-chicks, about 15% stocked point of cage while 12% stocked point of lay. Some 72% of the farmers stocked *is a brown* breed of birds while 27% stocked *nera-black* breed. Some 66 % of the farmers were full time farmers while 33% were part - time farmers. About 42% of the farmers used commercial feeds, 37% used self-milled feeds while 21% used toll milled feeds. Also only 33% of farmers were members of cooperative societies and 74% had training in poultry business mostly through colleagues and seminars. Access to credit was limited because only 6% of the respondents had access to credit facilities.

Table 1: Distribution of respondents by socio-economic and institutional characteristics of the farmers.

Characteristics	Operationalization	Frequency	Percentage (%)
Average age of farmer	44 years		
Average years of education	15 years		
Average years of experience	10 years		
Average household size	4 persons		
Marital status			
	Married	78	78.80
	Single	21	21.20
Sex of Farmer			
	Male	84	84.80
	Female	15	15.20
Average flock size	9,380 birds		
Mode of stocking			
	Day-old-chicks	72	72.70
	Point-of-cage	15	15.10
	Point-of-lay	12	12.20
Breed of birds			
	Brown	72	72.70
	Black	27	27.30
Non-farm employment			
	Yes (part-time farmers)	33	33.30
	No (full-time farmers)	66	66.70
Feed Milling Systems			
	Commercial feed users	42	41.40
	On-farm self-millers	36	36.40
	Toll mill users	21	21.20
Membership of cooperative societies			
	Yes	33	33.30
	No	66	66.70
Poultry training	Yes	74	74.20
	No	25	25.80
Access to credit	Yes	6	6.10
	No	93	93.90
Access to extension services	Yes	42	42.40
	No	57	57.60
Average rearing period	71weeks		

Field survey data, 2015

Costs and returns in poultry egg production

The results in Table 2 show that feed cost accounts for the highest proportion of the cost of production across all the three (3) feed milling systems. This result agrees with the findings of several researchers: Yusuf and Malamo (2007); Iyayi, (2008); Adepoju (2008); Afolami *et al*., (2013) and Tanko *et al*., (2014) who also found that feed cost comprised the highest share of total cost of poultry production, implying that feed is an essential cost item in layer production. The result also shows that the total revenue per bird for commercial feed users, toll mill feed users and self-feed millers were ₦6742.04, ₦6155.49 and ₦6397.52 respectively; The gross margin per bird were ₦1964.25, ₦2357.93 and ₦2370.60 for commercial feed users, toll mill users and self-millers respectively. The profit per bird computed as total revenue less total cost were ₦1257.41, ₦1684.65 and ₦1879.45 for commercial feed users, toll mill users and self-feed millers respectively.

The profit distribution indicated that poultry egg production in the study area was profitable for the three (3) feed milling systems.Self-milling was the most profitable, followed by toll milling, while the least profitable was commercial feeds. This may be because on-farm production of feed reduced cost of transportation, processing and packaging as well as eliminated mark-ups of commercial feed producers who produce to maximize profits. Also, farms that have storage facilities purchased feed inputs during on-season at cheaper prices, stored and used them over the production cycle to reduce feed cost. The average total number of birds kept by commercial feed users, toll mill users and self-millers were 3,146; 646 and 9,295 birds respectively. This shows that most of the self-feed millers are large –scale farmers while the toll millers are mostly small-scale farmers.

The revenue from sales of egg constitutes the highest portion of total revenue per bird as presented in Table 3, followed by revenue from sales of spent layers and revenue from waste (i.e droppings) was abysmal throughout the production cycle for all the feed milling systems. The finding is similar to that of Narahari, (2002); Emam and Hassan (2010) and Tanko *et al*., (2014) who found that sale of eggs contributed the highest share of the total revenue realized by egg producers. The total revenue generated per bird for commercial feed users, toll mill feed users and self-millers were ₦6742.04; ₦6155.49 and ₦6397.52 respectively.

Table 2: Comparative analysis of profit per bird for a production cycle by feed milling systems

Variable	Commercial feed users	Toll millers	Self-millers
Feed (naira)	4475.49	3832.13	3444.58
Labor	324.20	73.69	160.53
Drugs/vaccine	39.53	41.58	35.48
Operating cost (cost of transportation, communication, fuel, shaving)	38.53	20.13	44.31
Total variable cost	4777.75	3767.56	3385.01
Average Stocking cost (day-old chicks, point of cage or point of lay)	368.22	457.96	313.79
Capital (cost of cage and other equipments)	338.63	215.32	177.37
Total fixed cost	706.84	673.29	491.17
Total cost	5484.59	4440.84	4518.07
Total revenue	6742.04	6155.49	6397.52
Gross margin	1964.25	2357.93	2370.62
Profit	1257.41	1684.65	1879.45

Source: Field survey data, 2015

Table 3: Comparative analysis of revenue per bird for a production cycle by feed milling systems

Output	**Commercial feed users**	**Toll milling**	**Self-milling**
Egg	5933.50 (88.89%)	5328.64 (86.57%)	5434.96 (87.96%)
Spent layers	808.54 (12.01%)	826.85 (13.43%)	794.70 (12.04%)
Waste	0 (0%)	0.20 (0%)	0.35 (0%)
Total	6742.04	6155.49	6397. 52

Source: Field survey data, 2015

Figures in parentheses are percentages of total cost

Maximum likelihood estimates of stochastic profit frontier function

The variance parameter for sigma square (σ^2) was 0.088 significant at 1 percent level (Table 4). This value of sigma square showed that the data had a good fit to the stochastic model. The estimated gamma coefficient of 0.93 was also highly significant at 1 percent level indicating that one sided random inefficiency component strongly dominates the measurement error and other random disturbances indicating that about 93 percent of the variation in actual profit from maximum profit (profit frontier) between farms, mainly arose from differences in farmers practices rather than random variability.

Maximum likelihood estimates of all the efficiency parameters except that of the price of labour were significant. The coefficients of the dummy variables for feed technology were significant at 1% and 5% while those of price of feed, price of drugs and price of vaccine, operating price, stocking cost, capital, farm size, dummy variables for type of bird stocked and dummy variable for breed of bird stocked were significant at 1%.

The coefficients of cost of stocking and capital were negative and significant while coefficients of cost of feed, cost of drugs and vaccine, operating cost (transportation, communication, fuel and shavings cost), farm size, dummy variables for feed technology, dummy variables for type of bird stocked and dummy variable for breed of bird stocked were positive and significant. This implies that a unit increase in the prices of inputs with positive coefficients will lead to increase in the profit of egg production and vice versa. The estimated coefficient for feed cost (0.758) is positive as postulated and significant at 0.01 probability level. The result corroborates that of Effiong and Udom, (2010) in egg laying enterprise in AkwaIbom State, thus confirming that feed is an essential resource in poultry egg production.

The result of the estimated coefficient of bird stocked was negative and significant implying that cost of stocking had efficiency decreasing effect. Similar result was observed by Raymond *et al*., (2013) and Ike &Ugwumba (2011), who considered the relatively high responsiveness of profit to day-old chick prices, thus suggesting that measures that are aimed at reducing the prices of this input would be most appropriate. Also, drug and vaccination coefficient was positive and significant, signifying an appropriate use of medication in the study area. An over-use of medications exerts a negative effect on farmers profit as postulated.

The positive and significant estimated coefficient of farm size implies that increasing the number of birds stocked leads to increase in profit. The results agree with the findings of Effiong and Onyenweaku (2006) and Tanko *et al*., (2014) who stressed that large-scale farmers seem to be more efficient in resource use than the small-scale farmers. Also, increase in size is bound to bring further cost reduction since capacity is bound to increase fast (Awuja, 2000; Effiong and Umoh, 2010).

Furthermore, the estimated coefficients of feed milling system variables (the shifting intercepts, dummy: D_{11} = self-milling; D_{12}, toll milling=1) were positive and significant at 1% and 5% respectively. This implies that both variables had efficiency increasing effect as expected.

Given that $\alpha_1 > \alpha_2$, it implies that relatively self-milling was the most profitable, while toll milling was more profitable than use of commercial feeds. This may be as a result of reduced cost of processing as well as economies of scale for self-millers who were mainly large scale farmers. Also, the aim of commercial feed producers is to make profit which is reflected in mark-up in feed cost. In order to reduce the cost of feed, some farmers employed the services of toll millers by procuring feed materials and milling them at a cost.

Also, the estimated coefficients of type of bird stocked α_3 and α_4 for (dummy D_{21}, day-old-chick and D_{22}, point-of-cage =1, 0 otherwise) were positive and statistically significant at 1%. The efficiency increasing effect of the type of bird stocked conforms to *a priori* expectation. This implies that stocking of day old chicks leads to increase in profit. The results agree with the findings of Gueye (1999) and Tanko *et al*., (2014) that day old chicks require less feeds, drugs, medication and labour. Given that $\alpha_3 > \alpha_4$, implies that relatively, use of day-old-chicks was most profitable, while point-of-cage was more profitable than point-of-lay.

Lastly, in the profit model, the estimated coefficient of breed (dummy for*isa brown* birds),α_5 was positive and significant as postulated. This is an indication that *isa brown* breed of layer was more profit efficient than the *nera black* breed. This may be because *isa brown* breed birds may be highly resistant to pests and diseases, have high laying rate, lay quality and healthy brown eggs as well as being production efficient all the year round (Olawunmi and Dudusola, 2012).

Estimates of profit efficiency of farmers

The frequency distribution of efficiencies of poultry egg farmers in the sampled area as presented in Table 5, revealed an average profit efficiency of 82.45%. This implies that about 82.45% maximum profit is gained due to production efficiency while the remaining profit loss expressed as the difference between observed profit and the frontier profit can be attributed to both technical and allocative inefficiencies. The farmers had a wide variation in their levels of efficiency. The least efficient farmer had 17 % profit efficiency while the most efficient had 99%. Generally, farmers were fairly efficient. About 85% of the respondents had profit efficiency scores of more than 60%, only 6% had less that 40% while 9% had between 41 and 60% profit efficiency score. In spite of these, the results implied that a considerable amount of profit (17.55%) can be obtained by improving technical and allocative efficiency in poultry egg production in the study area.

Table 4: Maximum likelihood estimates of stochastic profit frontier function

Normalized variables	Parameter	Coefficients	t-ratio
Constant term	β_0	1.5118*	15.0947
Feed (P_1)in kg/naira	B_1	0.7579*	24.9845
Labor (P_2)in naira/man-day	β_2	-0.0157	-1.5894
Drug/vaccine (P_3)in naira	β_3	0.1226*	5.3187
Operating cost (P_4) in naira	β_4	0.1111*	5.1985
Fixed inputs			
Stocked bird (Z_1) in naira	β_5	-0.4618*	-12.8146
Capital (Z_2) in naira	β_6	-0.1763*	-10.6714
Farm size (Z_3) in numbers	β_7	0.6121*	10.4779
Dummy variables			
Feed milling (1=self milling, 0=otherwise)((D_{11})	α_1	0.2358*	5.4768
Feed milling (1= toll milling, 0=otherwise) (D_{12})	α_2	0.0718*	2.3773
Type of bird stocked (1=day-old-chicks, 0 otherwise)(D_{21})	α_3	0.4446*	22.09829
Type of bird stocked (1= point of cage, 0=otherwise) (D_{22})	α_4	0.4171*	10.0978
Breed of bird (1=*isa brown*, 0=otherwise) (D_{31})	α_5	0.2397*	13.9629
Inefficiency variables (farmers specific)			
Age (W_1)	δ_1	0.0540*	8.5151
Marital status (W_2)	δ_2	-1.1860*	-3.1083
Household size (W_3)	δ_3	-0.2878*	-5.9360
Mode of farming (W_4)	δ_4	-0.7762*	-3.0363
Farming experience (W_5)	δ_5	0.0361**	1.9634
Extension service (W_6)	δ_6	-0.7025*	-3.0126
Years of education (W_7)	δ_7	-0.1495*	-4.8438
Access to credit (W_8)	δ_8	0.4457	1.2835
Sex of farmer (W_9)	δ_9	-0.5632*	-2.7856
Poultry training (W_{10})	δ_{10}	1.4178*	7.3811
Cooperative membership (W_{11})	δ_{11}	0.2064	1.0381
Rearing period (W_{12})	δ_{12}	0.0329*	4.8937
Live ratio of birds (W_{13})	δ_{13}	0.3366**	2.0327
Sigma square		0.0887*	10.4038
Gamma(γ)		0.9299	52.9988
Log likelihood ratio	LR	218.49	

Source: Field survey data, 2015

* Statistically significant at 1% ** statistically significant at 5%

Table 5: Distribution of respondents by profit efficiency

Profit efficiency	Number of respondents	Percentage (%)
<0.20	3	3.0
0.20 – 0.40	3	3.0
0.41 – 0.60	9	9.10
0.61 – 0.80	18	18.20
>0.80	66	66.70
Total	99	100

Minimum score = 0.17, Maximum score = 0.99 , Mean score = 0.82

This result conformed to the findings of Tijani *et al*., 2006; Olasunkanmi *et al*., 2012; Tanko *et al.*, 2014 and Rahman, 2003 who reported mean profit efficiency levels of 0.84, 0.79, 0.74 and 0.77 for South Western Nigerian cassava farmers, layers producers in Sokoto State, egg producers in Aiyedetto Farm Settlement, Nigeria and rice farmers in Bangladesh respectively.

Determinants of Profit Efficiency

In analyzing the sources of inefficiency, thirteen (13) factors were considered. These were age of farmers, educational level, household size, farming experience, marital status, gender, live ratio of initial number of stocked birds, rearing period, extension contacts; membership in cooperative societies, mode of farming (full-time or part-time), training in poultry farming and farmers access to credit facility.

Household size, extension service, and years of education, gender of farmers, marital status and non-farm employment had negative coefficients as postulated implying that each of these socio-economic characteristics (farm specific variables) had efficiency increasing effect. The coefficients of access to credit and cooperative membership were not significant. Also the estimated coefficients of age of farmers, years of farming experience, training in poultry farming, rearing period and live ratio of birds stocked were positive implying that each of these socio- economic characteristics (farm specific variables) had efficiency decreasing effect.

The negative co-efficient of gender (dummy: female=0, male= 1) indicates that male poultry farmers were more efficient than their female counterpart. This may be due to the fact that they were favored in terms of access to extension services, access to credit and training schemes, farm input supplies and services and new production technologies. This is in agreement with the observation of Oluwatayo *et al*; 2008 and Tanko *et al*., 2014 who observed that male farmers were economically more efficient than female farmers in their study area and the enterprise is therefore sex stereotyped.

Also, the negative and significant household size coefficient suggests that large household-size comprising of persons of active age bracket could constitute a work force with the propensity to increase efficiency. This is also corroborated by the study of Oluwatayo *et* *al* (2008) and Tanko *et al*.,(2014).

The coefficients of education and access to extension services were negative and significant which indicated consistent enhancement of efficiency in poultry egg production through increased years of education and extension contact with farmers. The result is in consonance with those of several other researchers (Rahman, 2002; Obwona, 2006; Hyuha, 2007). Thus, programmes to encourage those of school-age are expected to raise productivity in poultry egg production. Similarly, improving access to extension services for poultry egg farmers, in particular, would be beneficial in reducing inefficiency in production.

The negative and statistically significant non-farm employment coefficient was as expected implying that having access to non-farm employment enhances efficiency in poultry egg production in the study area.This is corroborated by the result of Hyuha *et al*., 2007 and Nganga *et al*., 2010 among rice farmers in Northern Uganda and Kenyan smallholder milk producers respectively. They noted that non-farm employment presumably generates earnings that allow farmers to hire labor and purchase inputs. However, Rahman, (2003) and Ogunniyi, (2008) reported contrary result with positive and significant coefficient of non-farm employment variable among cocoyam farmers in Oyo State and rice farmers in Bangladesh respectively which indicated that farmers who engaged in non-farm activities operate at significantly lower levels of efficiency. These conflicting results suggest that although increased off-farm income can reduce financial constraint, particularly for the resource-poor farmers and thus enable them to purchase productivity enhancing inputs it can also be a source of distraction to farmers.

However, the positive and significant coefficient of years of experience and training in poultry production were against *a priori* expectation. Although it was postulated that these variables have efficiency increasing effect, the result for years of experience in poultry production provides a contrary and strong evidence that experience increases efficiency, while many previous studies find strong evidence of this relationship (Abdulai and Huffman, 2000; Rahman, 2002; Kolawole, 2006; Hyuja, 2007; Ogunniyi, 2011).

Live ratio of birds stocked which is the ratio of saleable birds to total number of birds stocked was postulated to reduce inefficiency because higher ratio implies lower mortality rate to achieve higher technical performance. The result provides strong evidence to confirm this expectation.

This is in conformity to the findings of Micheal and Boahen, (2013) who observed that ratio of saleable birds to total day old chicks stocked, reduced the level of inefficiency of broiler production in Ghana.

The efficiency decreasing effect of age is in consonance with the finding of Olasunkanmi *et al*., (2012) and Aihonsu (2002), but contradicted the finding of Ogundari (2006) and Bamiro *et al*. (2006).This implies diminishing productivity as age of farmers increases. The efficiency decreasing effect of rearing period is an indication that productivity of layers increases at a decreasing rate as the rearing period increases.

As presented in Table 6, the estimated test statistic values of 4.9, 4.9 and 4.89 vis-

Table 6: Hypotheses testing for effect of feed milling systems, type of bird stocked and breed of bird on production efficiency.

Statement of hypothesis	Test statistics (F_α)	Critical value (F_α; V_1, V_2)	Decision
H_0: $\alpha_1 = \alpha_2 = 0$	4.90*	2.12 (F_α; 2, 74)	Reject H_0
H_0: $\alpha_3 = \alpha_4 = 0$	4.90*	2.12 (F_α; 2, 74)	Reject H_0
H_0: $\alpha_5 = 0$	4.89*	2.12 (F_α; 1, 75)	Reject H_0

* Statistically significant at 1%.

a-viz their corresponding critical values of 2.12, 2.12 and 2.12 were greater at 1% level of significance. Therefore, the null hypotheses of independence of profit efficiency on the one hand and feed milling systems, type of bird stocked and breed of birds on the other were rejected and we concluded that they all affect profit efficiency in the study area.

Conclusion

This study estimated the profit efficiency of poultry egg farmers in Ogun State, Nigeria. Data obtained from 99 respondents randomly selected were analyzed by the use of descriptive statistics and stochastic Cobb-Douglas profit frontier model. Majority (about 81.8%) of the poultry egg farmers were educated in formal institutions of learning while 50 percent had more than ten years of farming experience. The average farm size was 9,380 birds for the farmers suggesting the medium-scale nature of poultry egg production in the study area. Results of profit efficiency analysis showed that profit efficiency ranged between 17% and 99%, and the mean profit efficiency level of poultry egg farmers was 82.45% which suggested that an estimated 17.55% loss in profit was due to a combination of both technical and allocative inefficiencies in poultry egg production. Thus, an average poultry egg farmer could increase profit by 17.55% by improving technical and allocative efficiencies. Major significant factors that affect poultry egg farmers' profit inefficiency were household size, years of education and experience, access to extension service, mode of farming as well as farm size. The distribution of the profit efficiency indices showed that poultry egg farmers were fairly efficient in their resource allocation based on the fact that more than half of the farmers (about 62%) had profit efficiency indices of 0.82 and above. The study concluded by inferring from the results obtained that, there is scope for increasing profitability of poultry egg production in the study area and Nigeria as a whole by directing policy focus on the significant inefficiency factors.

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