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Effect of Disease Management on Profitability of Chicken Egg Production in Southwest Nigeria

[1]O.K. Akintunde, [1]A.I. Adeoti, [1]V.O. Okoruwa, [1]B.T. Omonona and [2]A.O. Abu
[1]Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria
[2]Department of Animal Science, University of Ibadan, Ibadan, Nigeria

Corresponding Author: O.K. Akintunde, Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria

ABSTRACT

Poultry diseases remain one of the major threats to poultry production in Nigeria. The cost of disease treatment and control tends to increase production cost and hence reduced profit earned by poultry farmers. In the light of this, this study was designed to estimate the level of poultry disease management in southwestern Nigeria and examine its effect on profitability of egg production. Primary data was obtained with the aid of structured questionnaire from a cross section survey of 403 poultry farmers drawn through multi-stage sampling procedure. Descriptive statistics, Fuzzy logic model, Budgetary techniques and Stochastic Profit Frontier model were used to analyze the obtained data. Majority (81.4%) of the chicken egg farmers were males. Majority (85.6%) were married with an average household size of 5.4±1.7 members. The average age and mean years of experience were 45.5±9.1 and 10.0±5.05 years, respectively. Majority (68.0%) of the chicken egg farmers operated at low level of poultry disease management, 26.3% at moderate level while few (5.7%) was at high level. Gross return per Naira invested (₦1.06) for small scale farms; both medium and large farms (₦1.10). Quantity of feed (β = 0.8106), stock size (δ = 0.54) and poultry disease management index (δ = 0.2712) had strong positive effect on profit efficiency. This study recommends regular training of farmers by extension agents on modern methods of disease prevention and control. Government should formulate a policy of that will make livestock insurance more affordable by poultry farmers and encouragement of farmers on stock expansion.

Key words: Disease management, egg production, profit efficiency, Nigeria

INTRODUCTION

In Nigeria, livestock resources consists of 13,885,815 cattle; 34,453,742 goats; 22.096,602 sheep, 3,406,381 pigs and 104,247,960 poultry (Amos, 2006). From this figure, poultry accounted for 58.2% of the total livestock production. In Nigeria, production of eggs and poultry birds occupies a prime position for improving animal protein consumption of both rural and urban households (Ologbon and Ambali, 2012). Nigeria has a poultry industry with about 160 million birds estimated at US$ 250 million. The industry contributes up to 10% to the country's agricultural GDP and accounts for 36% of total protein intake of the country. The overall sector attracts investment and yields a net worth of US$ 1.7 billion a year (FRN., 2007). The poultry sector offers the quickest returns to investment outlays in livestock enterprise by virtue of its short gestation period, high feed conversion ratio alongside being one of the cheapest, commonest and best sources of animal protein in the country (Ojo, 2002). Poultry production is the most efficient and cost-effective way of increasing the availability of high-protein food, as eggs are known to provide the most perfectly balanced food containing all the essential amino acids, minerals and vitamins (Branckeart *et al.*, 2000).

In Nigeria, poultry contributes about 15% of the total annual protein intake with approximately 1.3 kg of poultry products consumed per head per annum (Ologbon and Ambali, 2012). In the past decades, there has been a recorded improvement in poultry production in Nigeria with its share of the Gross Domestic Product (GDP) increasing in absolute terms. It was reported that the contribution of chicken egg and meat to the livestock share of the GDP increased from 26% in 1995 to 27% in 1999 with an increase in egg production alone accounting for about 13% during the period (Ojo, 2003). In spite of the significance of the poultry industry to the national economy, poultry farms face challenges inimical to the growth of the industry. Poultry production in general is faced with low capital base, inefficient management, disease and parasite, housing and marketing problems, etc (Alabi *et al.*, 2000).

Diseases remain one of the major threats to boosting poultry production in Nigeria (Adewole, 2012). The major diseases are the Newcastle disease, Avian influenza, Avian pox, Infectious Bursal disease, Colisepticemia, Coccidiosis and Worm infestation (Usman and Diarra, 2008) with, Newcastle Disease being the most recognized by poultry farmers (Adene and Oguntade, 2006). Diseases reduce productivity resulting in less meat, less milk or fewer eggs. It provides less draught power and poorer-quality food and fibre. In economic terms, output declines, costs rise and profits fall (Farooq *et al.*, 2000). Economic losses experienced by poultry farmers for the years 2009-2011 amounted to over three billion Nigerian currency due to Infectious Bursal Disease outbreaks alone (Musa *et al.*, 2012). Poultry disease management involves taking steps to ensure good hygiene and increasing the standards of cleanliness as well as containment to reduce the risk of introducing disease into a flock. It involves biosecurity practices, medication and mitigation (Fasina *et al.*, 2012). Application of standard biosecurity measures is vital in protecting poultry birds from any disease (Dorea *et al.*, 2010). Biosecurity is security from transmission of infectious diseases, parasites and pests (Zavala, 2011). Biosecurity has focus on maintaining or improving the health status of animal and preventing the introduction of new disease pathogens by assessing all possible risks to animal health (Fraser *et al.*, 2010; Julien and Thomson, 2011). Augustine *et al.* (2010) reported that the implementation of sound biosecurity measures will go a long way in minimizing the problems of disease outbreak and spread in the Nigerian poultry industry and also maintain consumers' confidence in Nigerian poultry products.

The impact of livestock disease on animal husbandry is typically assessed in quantitative terms. In poultry industry, these terms include for example loss of revenues; costs of vaccination/prevention, eradication and restocking. These have been referred to as negative inputs (Thrusfield, 1995). The cost of disease treatment and control tends to increase production cost and hence reduced profit earned by poultry farmers in Nigeria (Achoja *et al.*, 2010). Available empirical studies in Nigeria on management issues associated with poultry disease are mostly descriptive analysis on assessment of prevalent diseases and mortality in chicken layers; evaluation of biosecurity status of poultry farms; evaluation of awareness and biosecurity practices towards highly pathogenic avian influenza (Etuk *et al.*, 2004; Usman and Diarra, 2008; Augustine *et al.*, 2010; Ameji *et al.*, 2012). This study however examined the contribution of some disease management measures in a multidimensional context through the use of the fuzzy logic model. Also, literature is vast with the economic analysis of poultry production in Nigeria (Akpabio *et al.*, 2007; You and Diao, 2007; Obi *et al.*, 2008; Fasina *et al.*, 2008; Ajetomobi and Adepoju, 2010; Bawa *et al.*, 2010). However, none of these studies has taken into account the assessment of level of poultry disease management and its effect on poultry farm profit in Nigeria. It is against this background that the study examined the effect of disease management on profitability of egg production in southwest Nigeria. The specific objectives are to:

- Estimate the level of poultry disease management
- Estimate the profit from chicken egg production
- Examine the effect of disease management on egg farm profit

MATERIALS AND METHODS

Study area: The study was carried out in Osun and Oyo states, southwest Nigeria. Osun State has 30 Local Government Areas with an estimated population of 3.4 million (NPC., 2006) and land area of 14,875 km^2 on latitude 5°N and 8°N; between longitude 4 and 5°E. The climate is humid tropical type with a mean annual temperature of about 28°C and a mean annual rainfall of over 1600 mm. Oyo State has 33 Local Government Areas with an estimated population of 5.6 million (NPC., 2006). The land area is 35,743 km^2 located within latitude 3 and 5°N; between longitude 7°E and 9.3°E. The average temperatures are between 24 and 25°C. Rainfall figures over the state vary from an average of 1200 mm at the onset of heavy rains to 1800 mm at its peak in the southern part of the state to an average 800 and 1500 mm at the northern part of the state.

There are two distinct ecological zones in both states; the rainforest and derived savannah zones. Major crops found in these states are yam, cassava, maize, rice, vegetables and cash crops like cocoa, rubber, kolanut and citrus. Rural households in the states rear sheep, goats, local chickens and pigs. Also, intensive rearing of exotic breeds of cockerels, layers and broiler birds have become popular in the study areas.

Source and type of data: The primary data was obtained with the aid of well-structured questionnaire that captured socio-economic/demographic characteristics of chicken egg farmers and farm characteristics. These include age of the chicken egg farmer, gender, level of education, poultry farming experience, household size and sources of credit. It also includes information about practice of various biosecurity measures; routine vaccination and medication by the poultry farmers in the study areas. Also, information were sought on various fixed and operating costs incurred in the production of eggs such as labour, transportation, medication (drugs, vaccination and sanitation), feed, cost of point of lay birds, day old chicks, insurance premium and access to credit, insurance and extension services. Production data, price of crates of eggs and culled birds were also collected.

Data collection and sampling technique: A multistage sampling technique was employed in selecting the chicken egg farmers in the study areas. The first stage was the purposive selection of Osun and Oyo States from the six states that made up the southwest Nigeria; based on the highest exotic-poultry population distribution in Southwest, Nigeria (FDLPCS., 2007). The second stage involved purposive selection of 6 Local Government Areas (LGAs) from Osun State and 8 local governments from Oyo State. The size of the local governments chosen from each state was based on available records of number of registered members of the Poultry Association of Nigeria (PAN) in which Oyo State has the highest number of poultry farmers than Osun State. The purposive selection of the local governments in each state was based on those with the highest number of registered members of the Poultry Association of Nigeria (PAN). They are Iwo, Ejigbo, Irewole, Ayedire, Irepodun and Ilesa West in Osun State and Afijio, Egbeda, Lagelu, Akinyele, Atiba, Oyo East, Ona Ara and Oyo West in Oyo State.

The third stage was the random selection of 240 and one 180 poultry farmers selected from Oyo and Osun States, respectively proportionate to the size of registered members of the Poultry Association of Nigeria (PAN) in each State. Also, the number of poultry farmers selected in each selected Local Governments Area is proportionate to the size of registered members of the Poultry Association of Nigeria (PAN) in each LGAs. In all, total of 420 poultry farmers. However, due to incomplete responses, only 403 questionnaires were used for the analysis.

Analytical techniques: Data collected was subjected to fuzzy logic model, budgetary techniques and stochastic profit frontier model. Fuzzy logic model was used to determine the level of poultry disease management and estimate the relative contribution of biosecurity measures; medications and livestock insurance to the poultry disease management. Also, multinomial logit model was employed to determine the factors affecting the level of poultry disease management while the stochastic profit function was utilized to examine the effect of disease management on farm profit.

Fuzzy logic model: Fuzzy logic model was adopted to estimate the poultry disease management level. The term fuzzy was proposed by Zadeh (1965), when he published the famous paper on Fuzzy Sets. Fuzzy sets was used to estimate the farm's level of poultry disease management based on poultry farmers' decisions in the use of biosecurity measures for poultry disease prevention; medications (prevention and control) and insurance for mitigation.

For a brief mathematical exposition of the fuzzy set theory, following Dagum and Costa (2004) and Appiah-Kubi *et al.* (2007) to proceed as follows: let X be a set and x an element of X. A fuzzy subset P of X can therefore be defined as follows:

$$P = \{x, F_p\ (X)\}, \text{ for all } x \in X \quad (1)$$

where, F_p is a membership function which takes its values in the closed interval [0, 1]. In other words, the fuzzy sub-set P of X is characterized by a membership function $F_p(x)$ associating a real number in the interval [0, 1] to each point of X. The value F_p represents the degree of belonging to P. That is, each value F_p (x) is the degree of membership of x to P.

In a simple application to measurement of level of poultry disease management, let X be a set of n poultry farms (i = 1, 2, 3... n) and P, a fuzzy subset of X, the set of low. In the fuzzy approach $F_p(x)$, the membership function of the level of poultry disease management of exotic-layer chicken farm i is defined as:

$$x_{ij} = 1; \text{ if farm i is of high level poultry disease management} \quad (2)$$

$0 \le x_{ij} \le 1$; if farm i reveals a moderate level of poultry disease management.

Ordinal or categorical discrete variables are those that present several modalities (more than two values). The lowest modality is denoted as c_{infj} and the highest modality as $c_{sup,j}$, then following Cerioli and Zani (1990), Costa (2002) and Dagum and Costa (2004) to express the membership function of the a_i-th poultry farm as:

$$\begin{aligned} &F_p(a_i) = \text{if } 0 < c_{ij} \le c_{inf,j} \\ &F_p(a_i) = \frac{c_{sup,j} - c_{ij}}{c_{sup,j} - c_{inf,j}} \text{if } c_{inf,j} < c_{ij} < c_{sup,j} \\ &F_p(a_i) = 0 \text{if } c_{ij} \ge c_{sup,j} \end{aligned} \quad (3)$$

The degree of attainment of the selected poultry disease management is express by Eq. 4:

$$F_p = \frac{\sum_{j=1}^{m} x_{ij} w_j}{\sum_{j=1}^{m} w_j} \quad (4)$$

where, w_j is the weight given to the j-th attribute:

$$w_j = \log \frac{n}{\sum_{i=1}^{n} x_{ij} n_i} \geq 0 \quad (5)$$

$$F_p = \frac{\sum_{i=1}^{n} F_p(a_i) n_i}{\sum_{i=1}^{n} n_i} = \frac{1}{n} \sum_{i=1}^{n} F_p(a_i) n_i \quad (6)$$

$$F_p x_j = \frac{\sum_{i=1}^{n} x_{ij} n_i}{\sum_{i=1}^{n} n_i} \quad (7)$$

From Eq. 6 the poultry disease management index of the population F_P is expressed as a weighted average of $F_P(X_j)$ with the weight w_j as defined in Eq. 5.

The level of poultry disease management was estimated from the index generated. The level of poultry disease management was categorized following Lestari *et al.* (2011) as: (1) Low level (0 up to 0.33), (2) Moderate level (0.34-0.66) and (3) High level (0.67-1.0). The three dimensions (Biosecurity practices, Medications and Insurance) and attributes as shown on Table 1 were selected following Ritz (2011).

Stochastic profit frontier: Production inefficiency is usually analyzed by its two components-technical and allocative efficiency. However, it has been argued that a production function approach to measure efficiency may not be appropriate when farmers face different prices and have different factor endowments (Ali and Flinn, 1989). This led to the application of stochastic normalized profit function models to estimate farm specific efficiency directly (Ali and Flinn, 1989; Wang *et al.*, 1996). Profit efficiency is defined as the ability of a firm to attain the highest possible profit given the prices and levels of fixed factors of that firm while profit inefficiency in this framework is defined as loss of profit from not operating on the frontier (Ali and Flinn, 1989). The profit function approach combines the concepts of technical and allocative efficiency in the profit relationship and any errors in the production decision are assumed to be translated into lower profits or revenue for the producer (Ali *et al.*, 1994). The stochastic profit function is defined as:

$$\pi_j = f(P_{ij}, Z_{ik}). \text{Exp. } ej \quad (8)$$

where, π_j is profit of the j-th farm and it is computed as gross revenue less variable cost, P_{ij} is the price of j-th variable input faced by the i-th farm, Z_{ik} is level of the kth fixed factor on the i-th farm, e_i is an error term and i = 1, ..., n, is the number of farms in the sample.

The error term ei is assumed to behave in a manner consistent with the frontier concept (Ali and Flinn, 1989) i.e.,:

Table 1: Dimensions and attributes for poultry disease management index measurement

Dimensions	Attributes	Categories
Biosecurity practices (Prevention)	Location of farm	Poultry farm's distance from public roads, poultry farm's distance from the next poultry farm and poultry farm's distance from a pond or lake
	Traffic on and off the farm	Poultry farm has a gate; poultry farm is surrounded by a fence and disinfection of vehicles that come to the poultry farm
	Pest management of other livestock and animals	Rodent control plan, keeping grass and weeds trimmed around the poultry house, regular checking and repairing of wire screening on the sides of the house and control of other livestock within 50 m of the poultry houses
	Poultry house cleaning disinfection	Total cleanout of facility, the time interval of litter removal, litter that is removed is stored in a covered shed, litter is composting in an approved composting facility, spreading of litter on fields adjacent to the poultry houses and regular cleaning and disinfection of feed bin and boot
	Poultry farmer's personal hygiene	Wearing the street clothes or shoes in the poultry houses, separate cap and of coveralls for each house, separate pair of boots for each house, disinfectant pair dip pans at every poultry house entrance, the time interval of changing the disinfectant and visitors who wish to enter the poultry houses must wear clean, sanitized caps, coveralls, gloves and boots
	Flock health care and monitoring	The taken time to learn more about the types of diseases that affect poultry, stocking multiple age groups of birds on the farm and specific employees caring for different age group
Medications (Prevention and control)	Vaccination	Vaccination of birds for agents known to have caused problems on the farm in the past and vaccination of day old chicks is done at hatchery
	Vaccination programmes	Application of Immucox vaccine at 1-5 days, Marek vaccine at 1 day old, Newcastle Disease Vaccine 1/0 at one day old chicks, 1st Gumboro vaccine at 8-10 days old and 2nd vaccination a week after, Newcastle Disease Vaccine Lasota at 2nd week and 5th week, vaccination against Fowl Pox at 8 weeks, Newcastle Disease Vaccine Komorov at 12th week and routine Newcastle Disease Vaccine Lasota every month
	Drugs	The time interval of routine deworming, time interval of routine application of antibiotics and weeks at which delousing is done
	Veterinary services	Contact with veterinary doctor and regular examination of sick or dead birds.
Insurance (Mitigation)		Use of livestock insurance

Source: Adapted from Ritz (2011)

$$e_i = v_i - u_i \tag{9}$$

The v_i is the symmetric error term and it is assumed that it is an independently and identically distributed two sided error term representing the random effects, measurement errors, omitted explanatory variables and statistical noise. The u_i is the one sided error term. It is a non-negative one-sided error term representing the inefficiency of the farm. Thus it represents the profit shortfall from its maximum possible value that will be given by the stochastic profit frontier. If $u_i = 0$, the farm lies on the profit frontier obtaining maximum profit given the prices it faces and levels of fixed factors. If $u_i>0$; the farm is inefficient and loses profit.

In the inefficiency effects model, the u_i term in Eq. 9 is assumed to be a function of a set of non-negative random variables that reflect the efficiency of the farm. They are assumed to be independently distributed, such that efficiency measures are obtained by truncation of the normal distribution with mean, $\mu = \delta_0 + \Sigma_d \delta_d Z_{di}$ and variance δ_u^2 where Z_{di} is the d-th explanatory variable associated with inefficiencies on farm i and σ_o and σ_i and are the unknown parameters.

For this study, the production technology of chicken egg farmers in Southwest, Nigeria is assumed to be specified by the Cobb Douglas frontier production function defined as follows:

$$\text{In}Y_i = \beta_0 + \beta_1 \text{In}X_1 + \beta_2 \text{In}X_2 + \beta_3 \text{In}X_3 + \beta_4 \text{In}X_4 + v_i\text{-}u_i \quad (10)$$

Where:

$$u_i = \delta_0 + \sum_{d=1d}^{D} \delta_d Z_{di} + e_i \quad (11)$$

In these equations:
Y_i = Gross margin in naira per enterprise.
X_1 = Quantity of Feeds consumed (kg)
X_2 = Expenses on drugs and medication (₦)
X_3 = Expenses on stocking (₦)
X_4 = Labour cost (₦)
u_i = Profit inefficiency
v_i = Statistical disturbance term

The model specified in Eq. 12 is formulated and estimated jointly with the stochastic frontier profit model (Battese and Coelli, 1995) to determine factors influencing observed profit efficiency. In addition to the general model, this inefficiency model was defined to estimate the influence of some farmer's socio-economic variables on the profit inefficiencies of the farmers. The model is defined by:

$$u_i = \delta_0 + \delta_1 z_1 + \delta_2 z_2 + \delta_3 z_3 + \delta_4 z_4 + \delta_5 z_5 + \delta_6 z_6 + \delta_7 z_7 \quad (12)$$

Where:
U_i, = Profit inefficiency
Z_1 = Age (years)
Z_2 = Years of formal education
Z_3 = Gender (dummy = 1 if female, 0 otherwise)
Z_4 = Poultry farming experience measured in years
Z_5 = Stock size (number of birds)
Z_6 = Poultry system (dummy = 1 if battery cage, 0 otherwise)
Z_7 = Poultry disease management index
β_o, β_i, δ_0, δ_i are the parameters to be estimated

RESULTS

Socio-economic characteristics of chicken egg farmers and farm characteristics: Table 2 presents socio-economic characteristics of chicken egg farmers. Majority (70.5%) of the poultry farmers were below 50 years of age with an average age of 45.5±9.1 years. Poultry farmers were mostly male (81.4%). Most of the poultry farmers were married (85.6%) with average household size of 5.4±1.68 persons. Majority had secondary education (45.2%) followed by those with tertiary education (36.7%). More than half (56.3%) of the poultry farmers had between 5-10 years of poultry farming experience with the mean years of experience being 10.0±5.1 years. Majority (70.0%) of the poultry farmers had an access to credit while the remaining (30.0%) were

Table 2: Socio-economic characteristics of poultry farmers

Characteristics	Frequency	Percentage
Age (Years)		
<30	33	8.2
30-39	99	24.6
40-49	152	37.7
≥50	119	29.5
Mean = 45.5		
S.D = 9.1		
Gender		
Male	328	81.4
Female	75	18.6
Marital status		
Married	343	85.1
Single	37	9.2
Divorced	7	1.7
Widowed	16	4.0
Household size		
1-3	44	10.9
4-6	290	72.0
>6	69	17.1
Mean = 5.4		
S.D = 1.7		
Level of education (Years)		
No formal education	7	1.7
Adult education	4	1.0
Primary education	62	15.4
Secondary education	182	45.2
Tertiary education	148	36.7
Poultry farming experience (Years)		
<5	36	8.9
5-10	227	56.3
11-16	105	26.1
>16	35	8.7
Mean = 10.0		
S.D = 5.1		
Access to credit		
No	121	30.0
Yes	282	70.0
Use of livestock insurance		
No	355	88.1
Yes	48	11.9
Access to livestock extension		
No	105	26.1
Yes	298	73.9

Source: Field survey data (2013)

discovered not to have access to any source of credit. Only 11.9% of the chicken egg farmers insured their poultry farms. Also, majority (73.9%) of the poultry farmers had access to livestock extension services.

Poultry farm characteristics: Table 3 shows that half (50.4%) of the chicken egg farmers preferred to raise Harco breed of hen while a few (2%) raised Rhode Island Red. Majority (87.3%)

Table 3: Poultry farm's characteristics and system of management practice by the farmers

Parameters	Frequency	Percentage
Breeds of hen		
Harco	203	50.4
Bovan nera	104	25.8
Dominant black	29	7.2
Rhode island red	8	2.0
Isa brown	59	14..6
Stock type		
Day old chicks	51	12.7
Pullets	352	87.3
Stock size		
500-2000	129	32.0
2001-9999	235	58.3
≥10000	39	9.7
Mean = 4924.2		
S.D = 3838.9		
Poultry system		
Deep litters	97	24.1
Battery cage	306	75.9
Mortality rate		
<5	110	27.3
5-10	216	53.6
11-20	70	17.4
>20	7	1.7
Mean = 7.7		
S.D = 4.9		

Source: Field survey data (2013)

of the farmers stocked pullets. Farm size was classified following Adene and Oguntade (2006), Obi *et al.* (2008) and Arowolo *et al.* (2012). Farms having between 500 and 2000 birds were considered as small scale commercial farms, those farms having more than 2000 birds and flock size which is less than 10000 birds were regarded as a medium commercial farm while those having 10000 birds and above is classified as large commercial poultry farms. The result shows that the medium scale chicken egg farmers constituted more than half (54.3%) of the farmers. Also, the least number (13.6%) of the farmers are large scale operators while the small scale constituted 32.0% of the chicken egg farmers.

The average flock size was 4924.2±3838.9 layers. Majority (75.9%) of the chicken egg farmers operated battery cage system while lesser number (24.1%) of the farmers reared their birds on deep litter system. The average mortality was 7.7±4.9%, 27.3% of the farmers had less than 5% of mortality, 53.6% of the chicken egg farmers had 5-10% of mortality rate, 17.4% of the farmers had 11-20% of mortality rate while 1.7% of the farmers had more than 20% of mortality rate.

Fuzzy analysis and level of disease management: The contribution of each dimension to the multidimensional poultry disease management index shows that biosecurity practices dimension contributed largely (81.6%) to explaining overall degree of poultry disease management as shown on Table 4. Medications dimension contributed 16.0% while contribution of livestock insurance was the lowest in the category being (2.4%). Following the Lestari *et al.* (2011), the poultry disease management index using the fuzzy set analysis was classified. The level of poultry disease

Table 4: Absolute and relative contributions to poultry disease management index by attributes

Attributes	Absolute contributions	Relative contributions
Biosecurity practices (Prevention)		
Poultry farm's distance from public roads	0.0117	3.4514
Poultry farm's distance from the next poultry farm	0.0120	3.5425
Poultry farm's distance from a pond or lake	0.0120	3.5588
Poultry farm has a gate that restricts vehicle access	0.0119	3.5143
Poultry farm is surrounded by a fence	0.0118	3.4940
Disinfection of vehicles that come to the poultry farm	0.0313	9.2565
Rodent control plan	0.0125	3.7016
Keeping grass and weeds trimmed around the poultry house	0.0099	2.9359
Regular checking and repair of wire screening on the sides of the house	0.0099	2.9393
Control of other livestock within 50 metres of the poultry houses	0.0095	2.8011
Recent total cleanout of facility	0.0053	1.5610
Time interval of litter removal	0.0105	3.0996
Litter that is removed is stored in a covered shed	0.0092	2.7110
Composting litter in an approved and properly managed composting facility	0.0086	2.5465
Litter is not spread on fields adjacent to the poultry houses	0.0065	1.9186
The feed bin, boot, and auger are regularly cleaned and disinfected	0.0104	3.0681
Wearing of street clothes or shoes in the poultry houses	0.0124	3.6580
Separate cap and pair of coveralls for each house	0.0098	2.8814
Separate pair of boots for each poultry house	0.0098	2.8814
Disinfectant dip pans at every poultry house entrance	0.0058	1.7230
Time interval of changing the disinfectant	0.0116	3.4359
All visitors who enter poultry houses must wear clean, sanitized caps, coveralls and gloves	0.010	2.948
Time taken to learn more about poultry diseases	0.0109	3.2160
Multiple age groups of birds on the farm	0.0116	3.4223
Specific employees caring for different age group	0.0113	3.3355(81.60)
Medication (Prevention and control)		
Birds are only vaccinated for agents known to have caused problems on the farm in the past	0.0125	3.6848
Vaccination of day old chicks is done at hatchery	0.0038	1.1352
Application of Immucox vaccine at 1-5 days	0.0013	0.3711
Application of Marek vaccine at 1 day old	0.0007	0.1997
Newcastle Disease Vaccine 1/0 at one day old chicks:	0.0007	0.2120
Vaccination of 1st Gumboro vaccine at 8-10 days old and 2nd vaccination a week after	0.0012	0.359
Application of Newcastle Disease Vaccine Lasota at 2nd week and 5th week	0.0009	0.2613
Vaccination against Fowl Pox at 8 weeks	0.0007	0.2059
Application of Newcastle Disease Vaccine Komorov at 12th week	0.0008	0.2490
Routine Newcastle Disease Vaccine Lasota every month	0.0006	0.1812
Time interval of routine deworming	0.0036	1.0577
Time interval of routine application of antibiotics	0.0008	0.2428
Weeks at which delousing is done	0.004	1.2064
Frequency of contact with veterinary doctor	0.0123	3.6543
Regular examination of sick or dead birds	0.0101	2.9833(16.00)
Use of livestock insurance (Mitigation)	0.0081	2.3947(2.40)
Total	0.3383	100%

Source: Field survey data (2013)

Table 5: Distribution of the level of poultry disease management

Poultry disease management level	Frequency	Percentage
Low (0-0.33)	27	68.0
Moderate (0.34-0.66)	106	26.3
High (0.67-1.0)	23	5.7
Total	403	100.0

Source: Field survey data (2013)

Table 6: Cost analysis in chicken egg production per annum

	Small		Medium		Large	
Costs	₦	TC (%)	₦	TC (%)	₦	TC (%)
Variable costs						
Cost of stock of birds	1,451,573.64	17.15	6,029,081.84	18.74	14,104,102.56	18.12
Cost of feeds	5,411,003.10	63.91	21,970,877.44	68.27	54,033,269.23	69.44
Cost of vaccines and drugs	273,780.00	3.23	792,488.51	2.46	1, 932,692.31	2.48
Labour cost	503,968.99	5.95	1,323,788.09	4.11	2,875,743.59	3.70
Repairs and maintenance	318,092.25	3.76	325,070.00	1.01	438,846.15	0.56
Other variable costs	222,623.76	2.62	521,339.06	1.62	1,045,451.28	1.34
Total variable Cost (TVC)	8,181,041.74	96.63	30,962,644.94	96.22	74,430,105.12	95.64
Fixed costs						
Depreciation cost	116,617.29	374,466.64	712,008.64			
Rent	22,773.49	26,074.47	38,000.00			
Interest on capital	115,572.37	346,098.68	945,810.81			
Insurance premium	30,000.00	470,769.07	1,691,556.67			
Total fixed cost (FC)	284,963.15	3.37	1,217,406.86	3.78	3,387, 376.12	4.35
Total Cost (TVC+FC)	8,466,004.89		32,180,051.80		77,817,481.24	

Source: Field survey data (2013)

management was categorized as follows: (1) Low level (0-0.33); (2) Moderate level (0.34-0.66) and (3) High level (0.67-1.0). Table 5 revealed that majority (68%) of the poultry farmers operated at low level of poultry disease management, 26.3% of the poultry farmers practiced at moderate level of disease management while a few (5.7%) of the farmers operated at high level of disease management.

Gross margin analysis: The result in Table 6 revealed that feed cost constituted 63.91, 68.27 and 69.44% of total production costs for small, medium and large size poultry farms, respectively. From Table 6, the cost of stock ranked second highest in the total cost. For small farm sizes, (17.15%); medium farm sizes (18.74%) and large farm sizes (18.12%) while the labour cost ranked third for small farm sizes (5.95%); medium farm sizes (4.11%) and large farm sizes (3.70%). Vaccines and drugs cost ranked the fourth most important production cost which constitutes about 3.23, 2.46 and 2.48% of total production costs for small, medium and large poultry farms, respectively. Three profitability indicators were estimated as shown on Table 7. These were profit, gross margin and gross return per naira invested. The profit was calculated to be ₦468,484.34; ₦3,327,729.48 and ₦7,580,041.83 in small, medium and large chicken egg farms, respectively. The gross margin were ₦753,447.49; ₦4,545,136.34 and ₦10,967,417.95 for small, medium and large farms, respectively. The gross return per naira invested showed that every naira invested in small scale chicken egg farms earned ₦1.06 while it was ₦1.10 for both medium and large scale chicken egg farms.

Table 7: Cost and returns analysis in chicken egg production per annum

Items	Small 500-2,000 birds (₦)	Medium 2001-9,999 birds (₦)	Large >10,000 birds (₦)
Eggs sales	7,939,702.02	31,506,546.17	75,091,702.56
Culled layers sales	994,787.21	4,001,235.11	10,305,820.51
Total revenue (TR)	8,934,489.23	35,507,781.28	85,397,523.07
Total variable Cost (TVC)	8,181,041.74	30,962,644.94	74,430,105.12
Gross margin (TR-TVC)	753,447.49	4,545,136.34	10,967,417.95
Total cost (TVC+FC)	8,466,004.89	32,180,051.80	77,817,481.24
Profit (TR-TC)	468,484.34	3,327,729.48	7,580,041.83
Return on investment (TR/TC)	1.06	1.10	1.10

Source: Field survey data, 2013

Table 8: Maximum likelihood estimates of Stochastic frontier profit function

Variables	Parameters	Coefficients	Std. error	t-ratio
General model				
Constant	β_0	0.0181	0.1417	0.1277
Feed (kg) (X_1)	β_1	0.8106***	0.0455	17.8154
Medications (₦) (X_2)	β_2	0.0645*	0.0330	1.9545
Stock of birds (₦) (X_3)	β_3	0.0893***	0.0225	3.9689
Labour (₦) (X_4)	β_4	-0.0335	0.0400	-0.8375
Inefficiency function				
Constant	δ_0	1.2762***	0.4575	2.7895
Age (years)	δ_1	0.0069**	0.0040	1.7250
Female gender	δ_2	0.0332	0.0344	0.9651
Education (years)	δ_3	-0.0032	0.0077	-0.4156
Experience (years)	δ_4	-0.0663**	0.3347	-1.9809
Stock size	δ_5	-0.5400**	0.2754	-1.9608
Poultry system	δ_6	-0.1183	0.0793	-1.4918
Poultry disease management (Index)	δ_7	-0.2712**	0.1296	-2.0926
Diagnostic statistics				
Sigma-square (δ^2)		0.1056**	0.0500	2.1120
Gamma (γ)		0.8568***	0.0712	12.0337
Log likelihood function		-189.2378		
LR test		48.6508		
Mean profit efficiency		0.90		

Field survey data, 2013, *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level

Stochastic frontier profit analysis: Table 8 shows the result of the maximum likelihood estimate of stochastic frontier profit function of egg production in Southwest, Nigeria. The result showed that the sigma square (δ^2) is 0.1056 and is statistically significant at 5% level. Also, the variance ratio defined as gamma (γ), is estimated as 0.8568 which is significant at 1% level. The result shows the relative importance of the variable inputs in egg production. The coefficients of the variables X_1, X_2, X_3 and X_4 are interpreted as the elasticity. All the coefficient of significant variables were positive. The elasticity estimates of quantity of feed, expenses on medication and stocking were statistically significant at 1, 10 and 1% levels, respectively.

Table 9: Frequency distribution of efficiency estimates of chicken egg farmers

Efficiency range	Frequency	Percentage
Less than 0.60	1	0.20
0.61-0.70	4	1.00
0.71-0.80	19	4.70
0.81-0.90	85	21.10
Above 0.90	294	73.00
Total	403	100.00
Minimum	0.57	
Maximum	0.98	
Mean	0.90	
Std. deviation	0.06	

Source: Field survey sata (2013)

Table 10: Elasticity of productive resource and returns to scale

Inputs	Elasticity
Feed	0.8106
Vaccines and drugs	0.0645
Cost of stock of birds	0.0893
Labour	-0.0335
Returns to scale	0.9300

Source: Field survey data (2013)

The parameter estimates of the relationship between profit inefficiency and poultry farm's characteristics and farmers' socio-economic characteristics are shown under the inefficiency function section of Table 8. The results show that the coefficients of poultry farming experience, stock size and disease management were negative and significant at 5% levels while age of the poultry farmer was positive and significant at 10% level. The distribution of profit efficiency estimates of chicken egg farmers is presented in Table 9. Majority (94.1%) of the poultry farmers operated on profit efficiency above 0.80. The mean profit efficiency of farm is 0.90. The Returns to Scale (RTS) which is the summation of the elasticity of production of the variables involved in the production process of the chicken egg production is 0.93 as shown on Table 10. It is positive and less than unity.

DISCUSSION

Most of the poultry farmers were in their active and productive years who can easily adopt new innovations that could enhance poultry production. The result implied that modern poultry farming is still predominantly a male occupation likely because of the high level of risk involved, labour intensive and other husbandry processes which are not attractive to most women. Consistent with this finding are the studies of (Lawal *et al*., 2009; Adisa and Akinwumi, 2012; Uzokwe and Bakare, 2013). Most of the poultry farmers were married (85.6%) with average household size of 5.4±1.68 persons. More than half of the poultry farmers had between 5-10 years of poultry farming experience. This expected to manifest in high level of disease management as the longer the years of poultry farming experience, the more exposed the farmer becomes and the more efficient the farmer is expected to be in disease management. The result indicates a preponderance of low participation in agricultural insurance by the poultry farmers in the study areas.

Majority of the poultry farmers had access to livestock extension services. This implies, that majority of these poultry farmers had access to advisory services and adequate information on improved disease management techniques. Table 3 shows that the medium scale chicken egg farmers constituted more than half of the farmers. Also, the least number (13.6%) of the farmers are large scale operators while the small scale constituted 32.0% of the chicken egg farmers. Majority of the chicken egg farmers operated battery cage system while lesser number of the farmers reared their birds on deep litter system.

The finding of this study revealed that the relative contribution of biosecurity practices (disease prevention) to disease management is high relative to medication and insurance. The reason is that biosecurity practices are routine management which are easily practiced by the poultry farmers in which minimal cost is incurred unlike medication and insurance that requires high cost of operation. This finding contradicts the findings of Obi *et al.* (2008) who reported that poultry production in Nigeria is predominantly backyard poultry with little or no biosecurity and peri-urban and urban commercial poultry production with minimum to moderate biosecurity.

The result revealed that feed cost constituted the largest share of the total cost irrespective of the farm size and this increases with the scale of production. This result agrees with the findings of Oladeebo and Ambe-Lamidi (2007), Bamiro (2008), Oladeebo and Ojo (2012) and Afolabi *et al.* (2013) who reported that feed cost is the major important cost item associated with chicken egg production. High profit was recorded in the large farm size which may be due to economies of scale, while the lowest profit was found in the small size farm. The profit, in accordance with a priori expectation increases with the scale of production which is consistent with the findings of Oladeebo and Ojo (2012). The values obtained for profitability indicators showed that poultry production is a profitable business in Southwest zone of Nigeria.

The result of the maximum likelihood estimate of stochastic frontier profit function showed that the sigma square (δ^2) is 0.1056 and is statistically significant at 5% level. This indicates a good fit and the correctness of the specified distributed assumption of the composite error term. Also, the variance ratio defined as gamma (γ), is estimated as 0.8568 which is significant at 1% level implied that the existence of profit inefficiency amongst the chicken egg farmers in south west, Nigeria. It means that variations in farm profits mainly arose from differences in farm practices. Therefore, profit can be optimized if the inefficiency effects among the poultry farmers are minimized.

The result showed the relative importance of the variable inputs in egg production. The coefficients of the variables X_1, X_2, X_3 and X_4 are interpreted as the elasticity. All the coefficient of significant variables was positive. The elasticity estimates of quantity of feed, expenses on medication and stocking were statistically significant at 1, 10 and 1% levels, respectively. The quantity of feed X_1 with a coefficient of 0.8106 appears to be the most important variable determining profit efficiency. This means that for a 10% increase in the quantity of feed, the profit obtainable from egg production will increase by 8.1%. The estimated coefficient of medication expenses is 0.0645 which implies that a 10% increase in the amount incurred on vaccines and drugs will lead to an increase in profit by 0.6%. Also, the estimated coefficient for stocking expenses is 0.0893 which also implies that a 10% increase in the money incurred on stock expansion will result in an increase in profit of 0.89%. This result indicates that, the higher the feed intake of layers and increase in money spent on medication and stock expansion, the greater the profit efficiency of the chicken egg farmers. The positive sign and significant of quantity of feed and medication expenses is consistent with the findings of Ohajianya *et al.* (2013).

The parameter estimates of the relationship between profit inefficiency and poultry farm's characteristics and farmers' socio-economic characteristics are shown under the inefficiency function showed that the coefficients of poultry farming experience, stock size and disease management were negative and significant at 5% levels while age of the poultry farmer was positive and significant at 10% level. The negative and significant coefficients of poultry farming experience, stock size and disease management indicates that more years of poultry farming experience; increase in stock size and higher levels poultry disease management reduce profit inefficiency. Also, positive and statistically significant relationship found between age of the poultry farmer signifies a positive effect on profit inefficiency. This indicates that poultry farmers who have become of age tend to exhibit higher levels of profit inefficiency. Therefore, years of poultry farming experience, stock size and disease management are found to significantly increase the profit efficiency of the poultry farmers, while the profit efficiency of the farmers decreased as they grew older. This result agrees with the findings of Ologbon and Ambali (2012) who reported that increasing age would lead to decrease in profit efficiency since aging farmers would be less energetic to work in the farm.

The mean profit efficiency of farm was 0.90 indicating substantial efficiencies in chicken egg production. This implies that there exist a 10% potential for poultry farms to increase their production in relation to income at the existing level of technology. This also means that poultry farms in the area can become more efficient by increasing their production by 10% at the current level of technology and resources. The Returns to Scale (RTS) was positive and less than unity indicating that eggs production was in stage II (rational stage) of the production function. This means that if all the variables are each-increased by a unit, the profit will increase by 0.93. This nature of returns confirms the findings of Oladeebo and Ambe-Lamidi (2007), Binuomote *et al.* (2008) and Afolabi *et al.* (2013).

The study recommends that policy focus should be geared towards enlightenment global campaigns on the significance of biosecurity as a crucial component of poultry disease management. It can therefore be recommended that each country of the world should improve the level of extension services in order to improved biosecurity practices and better medication techniques that will improve the global level of poultry disease management. Also, Government of each country should formulate a policy of livestock inputs subsidy programme and encouragement of poultry farmers on stock expansion.

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