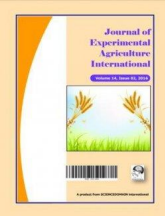

Journal of Experimental Agriculture International

28(5): 1-9, 2018; Article no.JEAI.17888
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Comparative Economic Analysis of Battery Cage and Deep Litter System of Poultry Production in Osun State, Nigeria

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Authors' contributions

This work was carried out in collaboration by the authors. Author AOB designed the study, wrote the protocol, performed the statistical analysis and wrote the first draft of the manuscript. Author OEO designed the survey, supervised data collection and managed the analyses of the study. The authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2018/17888
Editor(s):
(1) Dr. Mirjana Bulatovic-Danilovich, Professor, Consumer Horticulture, State Extension Master Gardener Program Coordinator, West Virginia University, USA.
Reviewers:
(1) O. Adejumo Isaac, Landmark University, Nigeria.
(2) Vecdi Demircan, Suleyman Demirel University, Kazakhstan.
(3) Abubakar Maikasuwa Mohammed, Usmanu Danfodiyo University, Nigeria.
(4) Sara Shields, USA.
Complete Peer review History: http://www.sciencedomain.org/review-history/27430

Original Research Article

Received 28 March 2015
Accepted 03 July 2015
Published 27 November 2018

ABSTRACT

The study appraised the economic performance of battery cage and deep litter systems of poultry production. The study was carried out in Osun State, Nigeria. Six areas (Iwo, Ejigbo, Awo, Ede, Sekona and Osogbo) were purposively selected due to their high concentration of poultry farmers. From each of the selected areas, 10 battery cage and 10 deep litter poultry farmers were randomly selected giving a total of 120 farmers used for the study. The study showed that the net farm income was ₦1472899.358 and ₦320985.074 per annum for battery cage and deep litter system of production respectively. The total production cost for battery cage system was ₦141529.642 while that of deep litter system was ₦75616.626. Gross margins were ₦1494614.608 and ₦321095.974 for battery cage and deep litter system respectively. Costs of feed constituted the largest share of the total cost for the two system of production. Cost of feed, cost of drugs and cost of labor were the significant determinants of gross margin earned by poultry farmers in the study area.

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Keywords: Economic performance; deep litter; battery cage; poultry production; Osun State.

1. INTRODUCTION

Nigeria has the highest number of poultry farms in Africa. The poultry population in Nigeria is estimated at 104.3 million comprising of 72.4 million chickens, 11.8 million ducks, 4.7 million guinea fowls, 15.2 million pigeons and 0.2 million turkeys [1,2]. Poultry meat and eggs are the most consumed animal protein; unrestricted by any religion or culture in Nigeria. Poultry has the highest contribution to animal protein intake of rural dwellers in Nigeria [2]. It is recorded that the poultry industry contributes between 10 to 25 percent of the country's agricultural GDP and engages approximately 20 million people through direct and indirect employment (Odeh, 2010).

Livestock production is an important part of farming in Nigerian agriculture. People depend on livestock production for food, clothing, fuel, fertilizer and draught power to sustain the economy. Livestock farming also serves as a subsidiary occupation to supplement the income of small and marginal farm families. Eggs and poultry meat has emerged second to milk as a contributor to the output from livestock sector in recent years. According to the Global poultry trend, poultry expands in Africa by 3.2% against Global figure of 2.2%. Egg production in Africa is targeted to reach 3 million ton per year in 2015 and Nigeria is leading on the expansion with South Africa, both expanding at 4% annual increase [3]. Nigeria has the potential to produce a wide range of livestock based on its climate and agro-ecological conditions. The Northern part and middle belt can guarantee the production of sheep, cattle, goat and poultry, while the Southern part of the country has the potential to produce goat, pig and poultry. Thus poultry production is feasible in all parts of the country.

Increased consumption of eggs and poultry meat brings substantial benefits to the human population in developing countries [4]. Chicken is usually the cheapest of all domestic livestock meats. Those living in low-income countries, such as in sub-Saharan Africa and South Asia, are particularly at risk from a number of diseases as a consequence of consuming a poor-quality diet [4]. Poultry foods are usually without taboos and can be consumed by a family in a single sitting. A comparison of chicken meat with other meats shows that it is a healthy meat. It is low in total fat and in the undesirable fats, but high in the desirable monounsaturated fats – which make up about half of the total [4]. It is not difficult to enrich both eggs and chicken meat with the important omega-3 fats and with other critical nutrients such as selenium, iodine and folic acid, which are often deficient in the diet of people living in developing countries [4].

Poultry are capable of converting feed into digestible protein in form of meat and egg [5]. The benefits of eggs and poultry meat in meeting the requirements for essential amino acids and some or all of the other essential nutrients can be shown with an example of an infant on a typical high-starch low-protein diet [3,6]. Folic acid in eggs can help to reduce the incidence of neural tube defects in pregnancy; a common occurrence for many disadvantaged women in low-income countries [3,6]. Apart from its contribution to the Gross Domestic product and provision of employment opportunities, poultry production is a major source of protein in the country [7].

Poultry production has a relevant role in Nigerian animal production due to its economic impact and to its ability to adapt to the market and consumers demands. In recent years, food safety and naturalness are becoming increasingly important consumer demands. This has resulted in the development of different production methods in order to satisfy consumer requests regarding product quality, while also taking into consideration animal welfare and environment protection in the whole production chain (Michel and Huonnic, 2003). The environments to which poultry are exposed include the housing system, the feed they consume, climatic factors and management systems which affect the performance of the birds [8,9]. Two major housing systems used in commercial poultry production in Nigeria include the deep litter system (where the birds are restricted to the rearing house) and the battery cage system. The deep litter system is based on the repeated spreading of straw or sawdust material on the concrete floor of a well-ventilated building. The water and feeding troughs are kept at strategic points on the litter in the building. Stocking density is dependent on the floor size. A 50cm by 50cm nest boxes are placed on the litter for egg laying. The major function of these nest boxes is to prevent contact of the eggs with droppings. The birds reared are exotic. Egg collection is by hand as it is laid inside the nest

boxes, and sometimes on the litter. The droppings fall on the litter and are later removed when it can no longer hold the droppings. The battery cage system involves the arrangement of rows and columns of identical cages connected together, sharing common divider walls in a well-ventilated building. Cages are of different types, the wooden type or metal, each unit having drinking and feeding trough attached to it. Each cell can accommodate one, two, three or more birds depending on the dimension of the cells. A two tier cage can accommodate about 240 birds. The cages are arranged in stacks in the poultry house, making the battery cage system to have more birds. The birds kept are exotic breeds. The eggs are collected from the cage by hand as it rolls down the cage to the collection point. The droppings fall on concrete floor and are later scrapped up and taken away from the poultry house. Each of the systems has its own peculiarities; however, what is important is the revenue accruing to the farmers under these production systems. This was investigated in this study.

2. MATERIALS AND METHODS

The study appraised the economic performance of battery cage and deep litter system of poultry egg production. The study was carried out in Osun State, Nigeria. Six areas (Iwo, Ejigbo, Awo, Ede, Sekona and Osogbo) were purposively selected due to high concentration of poultry farmers in them. From each of the selected areas, 10 battery cage and 10 deep litter poultry farmers were randomly selected giving a total of 120 farmers used for the study.

Data in this study were collected through a structured interview schedule, which was administered to the poultry farmers. Information on fixed and variable costs of production such as cost of stock, expenditure on feed drugs, hired and family labor man-days, electricity and depreciation on assets were obtained from the poultry farmers. The information was verified from their farm records.

Data in this study was analyzed with both descriptive and inferential statistics. The descriptive statistics that were employed in the study are given in means and percentages while the inferential statistics that were utilized are budgetary analysis and ordinary least square regression analysis (as employed by Oladeebo and Ojo [10].

Budgetary analysis was used to evaluate the economic performance of the two systems of poultry production while ordinary least square regression was used to determine the significant variables influencing the gross margin of poultry farmers. Depreciation of fixed assets was estimated using the straight line method. The gross margin (GM) was estimated from:

$$GM = TR - TVC \quad (1)$$

Where, GM represents gross margin, TVC represents total variable cost and TR represents total revenue. Following, the method employed by Oladeebo and Ojo [10], economic ratios employed to measure economic performance of the two systems of production were: Rate of return on investment (ROI), operating ratio (OR), fixed asset turn over (FAT) and total asset turn over (TAT). They are analyzed as follows:

1. Rate of return on investment (ROI) shows the amount gained on every naira (N) invested, measured as:

$$ROI = \frac{E}{C} \times 100 \quad (2)$$

Where, E represents the profit before tax (₦) and C represents the total production cost (₦).

$$\text{Operating ratio (OR)} = \frac{\text{Total Operating Expenses}}{\text{Net Sales (₦)}} \quad (3)$$

$$\text{Fixed assets turnover (FAT)} = \frac{\text{Total Sales (₦)}}{\text{Fixed assets (₦)}} \quad (4)$$

The fixed assets are buildings and cage for battery cage system and buildings for deep litter system.

$$\text{Total assets turnover (TAT)} = \frac{\text{Total Sales (₦)}}{\text{Total assets (₦)}} \quad (5)$$

The relationship between the factors involved in cost and gross margin obtained from poultry egg production was investigated by the use of regression technique of analysis.

The empirical model for the proposed study is specified as follows:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, e_t) \quad (6)$$

Where, Y represents the gross margin of the poultry egg farmer producers (₦)

X_1 represent the amount of feed (kg)

X_2 represents the cost of water (₦)

X_3 represents veterinary services (₦)

X_4 represents the amount of labor (man-days)

X_5 represents electricity cost (₦);

X_6 represents the costs of purchase of day old chicks (₦)

e_t represents the stochastic error term.

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of Poultry Farmers

Table 1 reveals that majority of the battery cage poultry egg farmers (40.00%) and deep litter poultry egg farmers (43.00%) were in the age range of 40-49 years, with a mean age of 4.10 years and 48.33 years respectively. The mean age for both farmers was 48.75 years, showing that the farmers are still in their productive years.

The gender distribution of poultry farmers as shown in Table 1 showed that 71.67 percent and 58.33 percent of the farmers were male for battery cage and deep litter systems respectively, while 28.33 percent and 41.67 percent were female. However, more female are involved in the deep litter system than the battery cage system. This result revealed the deep litter system is more suited for women. More male are involved in poultry egg production than female.

Table 1 showed that majority (54.17%) of the poultry egg farmers are married. The deep litter system engaged more disadvantaged women such as divorced and widowed than the battery cage system. This may probably due to low initial investment required under the deep litter system.

In terms of years of formal education of the poultry egg farmers, Table 1 indicated that farmers operating under the batter cage system are more educated than farmers operating under the deep litter system. The mean years of formal education for farmers operating under the battery cage system and deep litter system were 12.10 years and 9.40 years respectively.

Table 1 showed that the mean flock size for battery cage and deep litter systems were 1,650 birds and 1,100 birds respectively. According to Omotoso and Oladele [11], Subhash et al. [12] and Ojo [13], poultry with flock size less than 1000 birds are classified as small scale, those having a flock size of between 1000 to 3000 birds as medium scale and those having a flock size of above 3000 birds as large scale. Based on the above, the mean for both systems was 2,208 birds, indicating that poultry egg farmers in the study area are operating under the medium scale.

The mean years of poultry farming experience for both system as revealed in Table 1 was 8.74 years, with farmers operating under battery cage system having more years (7.83) of poultry farming experience than farmers operating under the deep litter system (6.73 year).

3.2 Productivity of the Poultry Farms

Table 2 showed the selected productivity indicators for both categories of poultry production systems. The average flock size is higher under the battery cage system than the deep litter system. Similarly, egg production per day is higher for the battery cage system, so is, egg yield, which is 72.73 percent and 65.45 percent for battery cage and deep litter systems respectively. However, both categories of poultry production systems recorded an average of 2 eggs per hen in every 3 days. The mortality rate is higher (6%) under the deep litter system as compared with that of battery cage system which was 4%.

3.3 Budgetary Analysis

Table 3 shows the cost comparison of an average poultry farmer for the two systems of production. The results showed that an average poultry farmer invested about ₦141529.642 and ₦75616.626 as total costs of production for battery cage and deep litter farmers, respectively. These are the costs of feed, water, drugs/ veterinary services, flock, labor, electricity and other necessary materials.

Table 1. Socio-economic characteristics of poultry farmers

Variable	Battery cage		Deep litter		Both	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Age (years)						
20-29	4	6.67	6	10.00	10	8.33
30-39	15	25.00	13	21.67	28	23.33
40-49	24	40.00	26	43.33	50	41.67
50-59	12	20.00	10	16.67	22	18.34
60-69	3	5.00	4	6.67	7	5.83
70 and above	2	3.33	1	1.66	3	2.50
Total	60	100	60	100	120	100
Mean	49.10		48.33		48.75	
Gender						
Male	43	71.67	35	58.33	78	65.00
Female	17	28.33	25	41.67	42	35.00
Total	60	100	60	100	120	100
Marital status						
Married	40	66.67	25	41.67	65	54.17
Single	10	16.67	10	16.66	20	16.67
Divorced	5	8.33	10	16.67	15	12.50
Widowed	5	8.33	15	25.00	20	16.66
Total	60	100	60	100	120	100
Years of formal education						
No formal education (0)	2	3.33	10	16.67	12	10.00
Primary (6)	10	16.67	10	16.67	20	16.67
Secondary (12)	30	50.00	35	58.33	65	54.17
Tertiary (17)	18	30.00	5	8.33	23	19.16
Total	60	100	60	100	120	100
Mean	12.10		9.40		10.83	
Flock size						
<1000	10	16.67	40	66.67	50	41.67
1000-3000	40	66.67	10	16.67	50	41.67
>1000	10	16.66	10	16.66	20	16.66
Total	60	100	60	100	120	100
Mean	1650		1100		2208	
Poultry farming experience (years)						
1-3	5	8.33	10	16.67	15	12.50
4-6	10	16.67	5	8.33	15	12.50
7-10	30	50.00	25	41.67	55	45.83
11-15	10	16.67	10	16.67	20	16.67
16 and above	5	8.33	10	16.66	15	12.50
Total	60	100	60	100	120	
Mean	7.80		6.73			8.74

Source: Field Survey, 2014

The cost of feed for the two categories of farms constituted the largest share of the cost (about 58.50% and 60.47% for battery cage and deep litter system, respectively). These results support the findings of Yusuf and Malomo [14] and also Oladeebo and Ojo (2011) that feed cost is the major important cost item associated with poultry production. According to (Oladeebo and Ojo (2011). This is probably due to increase in cost of feed ingredients. The cost of feed was followed

by cost of drugs/veterinary services for battery cage system (16.44%) and deep litter system (13.37%) and labor costs for battery cage system (about 14.97%).and deep litter system (13.00%).

The cost of feed is higher in deep litter system due to enormous feed wastage in course of feeding. A large proportion of the feed is lost during the scrambling of the birds to get feed from the feeding troughs. The lost feed cannot be converted into eggs by the birds. The cost of water is higher for battery cage system; large volume water is needed to maintain good sanitary and hygiene condition under battery cage system than in deep litter system. The cost of drugs for battery cage system is higher, as more birds can be kept per unit area under the system than deep litter system. Obviously, for the same reason, the cost of labor (manual feeding, watering, droppings and litter collection and egg collection) is higher for battery cage system. The cost of electricity (used mainly for lighting and water pumping) is higher for battery cage system. The cost of stock (point of lay pullets), which are acquired from established breeding farms is higher for battery cage system due to the fact that more birds can be accommodated per unit area under the system. The depreciation cost (calculated by straight line method with the recommended life span of 20 years and 5 years for buildings and battery cage respectively) is higher under the battery cage system.

Table 3 also reveals that total revenue of ₦1614429 was earned by an average battery cage poultry farmer and about ₦396601.7 was earned by an average deep litter poultry farmer. These are revenue generated from the sales of egg and spent layers. The analysis in Table 2, further shows that the net farm income received by an average battery cage poultry farmer was about ₦1472899.358 and ₦321095.974 was received by an average deep litter poultry farmer. The budgetary analysis for the battery cage and deep litter system of poultry production revealed that poultry production was profitable and the level of performance depends on the system of production where farmers face same market conditions, where wholesalers visits the farm to buy in bulk to sell to retailers who eventually distribute to the consumers. The results obtained are in line with the findings of Okafor et al. (2006), Amos (2006) and Yusuf and Malomo [14].

Table 2. Productivity of the poultry farms

Variable	Battery cage	Deep litter
Flock size	1650	1100
Eggs per day	1200	720
Egg per hen per day	2/3	2/3
Egg yield (%)	72.73	65.45
Mortality	4	6

Source: Field Survey, 2014

Table 3. Annual cost and return analysis per poultry farmer

S/N	Item	Battery Cage		Deep Litter	
A	Revenue(TR)	1614429		396601.7	
B	Variable Cost		% of TVC		% of TVC
	Cost of feed	26907.2	58.50	47668.33	60.47
	Cost of water	1157.895	5.11	118.333	1.50
	Cost of drugs	24642.50	16.44	10543.33	13.37
	Cost of labor	43023.33	14.97	10246.67	13.00
	Electricity cost	3458.667	1.61	1380.833	1.75
	Cost of stock	20624.8	3.37	5548.23	9.91
C	Total variable cost(TVC)	119814.392	100	75505.726	100
D	Gross margin(TR-TVC)	1494614.608		321095.974	
E	Fixed cost				
	Depreciation cost	21715.25		110.90	
F	Total production cost	141529.642		75616.626	
G	Net farm income	1472899.358		320985.074	

Source: Calculated from Field Survey, 2014

3.4 Economic Performance Analysis

Table 4 shows the economic performance for both systems. The result reveals that battery cage system had higher rate of return on investment (ROI) than the deep litter system of poultry production. The deep litter poultry farmers obtained ₦25.17 return on a naira invested while the battery cage poultry farmers obtained ₦78.43 return on every naira invested. This is an indication of the fact that battery cage poultry farmers were able to manage production resource at their disposal efficiently than their deep litter poultry farmers. The estimates obtained for operating ratios for deep litter poultry farmers and for battery cage poultry farmers were 0.46 and 0.19 respectively. Thus, in terms of net farm income, battery cage system of poultry production had better performance than the deep litter system.

3.5 Results of Regression Analysis

Tables 5 and 6 present the results of regression analysis for battery cage and deep litter poultry farmers respectively. The results showed that there was goodness of fit of the production function based on their significant F-values. Table 4 revealed that 58 percent of the adjusted variability in the net returns obtained by battery cage poultry farmers was explained by the included explanatory variables in comparison with 76 percent of the adjusted variability in the net returns obtained by their deep litter counterparts (Table 6). The coefficients of cost of feed (X_1), cost of drug (X_3) and cost of labor (X_4) are significant determinants of net returns of battery cage poultry farmers at 5 percent level. Cost of feed (X_1) negatively affected net returns of battery cage poultry farmers, showing that spending high amount of money on feed will reduce net returns drastically, but, cost of drug (X_3) and cost of labor (X_4) positively affected the net returns of the battery cage poultry farmers showing that embarking on prompt and adequate vaccination and avoidance of disease causing conditions lowering the costs of labor will increase the net returns of the battery poultry farmers. Similarly, the coefficients of cost of labor (X_4), cost of electricity (X_5) and cost of day old chicks (X_6) are significant determinants of net returns of the deep litter poultry farmers at 5 percent level. The variables affected the net returns of the deep litter poultry farmers positively showing that spending more on cost of labor (X_4), cost of electricity (X_5) and cost of day old chicks (X_6) will improve the net returns on investment for the deep litter poultry farmers.

Table 4. Comparison of performance ratios for the two systems

Ratio	Battery cage	Deep litter
ROI	78.47	25.17
OR	0.19	0.46
FAT	2.75	15.85
TAT	1.95	1.42

ROI rate of return on investment, OR operating ratio, FAT fixed asset turnover, TAT total asset turnover.

Table 5. Regression analysis of Battery cage system of production

Variable	Coefficient	t-value
Constant	173202.2	0.602
Cost of feed (X_1)	-3.591	-2.481**
Cost of water (X_2)	36.615	0.372
Cost of drug (X_3)	21.646	2.244**
Cost of labor (X_4)	30.884	4.156**
Electricity cost (X_5)	-68.983	-1.898
Cost of day old chicks (X_6)	0.025	0.216

R^2 = 0.628, Adjusted R^2 = 0.583, F = 13.792, Significant at 5%*

Table 6. Regression analysis of Deep litter system of production

Variable	Coefficient	t-value
Constant	-364217.3	-3.472
Cost of feed (X_1)	1.141	1.451
Cost of water (X_2)	-83.084	-0.593
Cost of drug (X_3)	14.8411.771	
Cost of labor (X_4)	16.2112.791**	
Electricity cost (X_5)	177.4872.401**	
Cost of day old chicks (X_6)	0.2113.675**	

R^2 = 0.787, Adjusted R^2 = 0.763, F = 32.631, Significant at 5%*

4. CONCLUSIONS

This study analyzed and compared, economically, battery cage and deep litter system of poultry production in the study area. The study revealed that most of the poultry farmers are middle-aged, married male. More female are engaged in deep litter system than the battery cage system. The battery cage farmers are more experienced in poultry farming than their deep litter counterparts. The cost of feed, cost of drugs and cost of labor are the significant factors influencing gross margin earned by poultry farmers in the study area. The study shows that poultry production in the study area is profitable; however the level of profit is a function of the system of production and type of poultry enterprise. In both systems identified in this study, the battery cage poultry farmers was observed to have had a higher profit level than their deep litter counterparts.

The study showed that poultry farming especially, on medium scale is capable of reducing the animal protein demand supply gap, as well as providing continuous flow of income for poultry farmers, especially disadvantaged women such as divorcees and widows who are found to be operating more under the deep litter system in this study. The enterprise is also capable of contributing significantly to the much sought food security (availability and affordability).

The economic analysis favors battery cage production, however, depending on the market structure; these operations could compete directly with small scale producers. Besides, the battery cage production is characterized by high initial capital outlay, high expertise and high risk of production. The deep litter production though with lower profitability may attract farmer's interest with its lower investment costs and flexibility of place of production, for example near a market place.

The study recommends that farmers should minimize feed wastage by bird and embark on routine hygiene practices in order to minimize their expenses on drugs and reduce mortality rate drastically. The poultry farmers should be assisted by the government through subsidies so as to ensure that they buy poultry feeds at a lower price. This will encourage many unemployed youth of Nigeria to venture into poultry farming. Also, policy focus should be geared towards how deep litter poultry farmers will transform their system of operation in order to enjoy the benefits of economies of scale in order to maximize their profit and at the same time meeting the increasing demand for poultry products. Finally, government at all levels (federal, state and local) should organize regular training for poultry farmers in a systematic and continuous process in order for them to produce high quality products which will enable them to earn maximum profit.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/27430