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OPTIMAL LAYING PERIOD FOR PROFITABLE AND SUSTAINABLE EGG PRODUCTION

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Abstract

Profitability and sustainability of investment in a business calls for determining the optimum period of production to maximize profit. This study attempts to determine the optimum age of laying birds in egg production. Taking the Ijebu-Ode Local Government Area in Ogun State as a case study, thirty-nine (39) poultry (chicken) farmers were surveyed over a period of 12 weeks to obtain necessary data. Budgetary and regression analyses were conducted. The budgetary analysis revealed feed as a major cost item in egg production, constituting about 68 percent of the total cost of production. The result of the regression analysis for the determination of the optimum age of birds in lay suggests 43 weeks of lay as optimum period and 46 weeks of lay as maximum period for profit maximization.

It was, therefore, recommended that for the farmers to sustain their investment in chicken egg production through optimum yield approach, they should cull their birds between 10 and 11½ months of lay. Keeping birds beyond this period will result in reduction in profit, which will threaten the sustenance of the investment.

Introduction

Poultry products (meat and eggs) have assumed the role of providing much needed animal protein to mankind. Poultry egg, apart from supplying protein is also a good source of lipids and vitamins of high biological value to man. The importance of egg is also observed in its contribution as a major ingredient in the baking of confectioneries and the use of the egg albumen in the making of shampoo and in book binding.

Poultry production also contributes to the nation's gross domestic product (GDP) as it provides gainful employment and income for a sizeable proportion of the population. Together with other livestock, the contribution to the GPD at 1984 factor cost increased from 3,822.3 million naira in 1981 to 5,160.0 million naira in 1993 and further to a projected value of 5.74 billion naira in 1997 (CBN, 1994; CBN, 1998). It is, therefore, imperative for the poultry industry to be sustained so as to prevent social disequilibrium, which can result from its collapse.

In recent times, the experiences of farmers have shown that poultry has been suffering some set backs caused by increasing cost of

feeds, among others, thus reducing the net returns from the business significantly. Also, many of the existing poultry farms are folding up and prospective investors are becoming increasingly reluctant to invest. This situation threatens the survival of poultry industry and thus calls for concerted efforts to save the industry from total collapse. Failure to do this could lead to a serious reduction in poultry production and protein intake of people resulting into malnutrition and ill health which again transforms into lower productivity and output.

There is, therefore, the problem of finding adequate means of increasing net returns to farmers in the poultry business. The net-returns must be significant enough to retain the farmers in the business and attract more participants.

Given the fact that the farmer has little or no control over the demand and price of the products, because of the nature of the market which is close to being perfectly competitive, a more plausible approach to increasing the net returns is to reduce the cost of production. This can be achieved by determining the optimum age at which the profit from the business is maximized and beyond which the unit cost of production increases, thereby reducing the profit margin. Keeping and feeding birds beyond this optimum age could mean higher costs to receive lower returns which is economically unwise.

Determining the optimum age and selling the birds at this age increases the turnover in the business thus increasing the number of batches that can be raised over time. The need to identify the optimum age of laying birds to maximize the net-returns from egg production is, therefore, paramount to the success of poultry farmers and sustenance of the industry.

Review Of Relevant Literature

Ogun State was reported as having a 16 percent involvement in poultry keeping; the lowest among the states in Nigeria (FOS, 1996). This may be probably connected with profitability level of the business in the state.

Most of the past studies on profitability of poultry production have focused on nutritional aspects emphasizing the need to improve feed efficiency since feed cost constitutes 50-80 percent of total cost in commercial poultry production (depending on the level of management efficiency). This assertion derives from studies like those of Abaelu (1964), Clayton (1964), Adesimi (1979) and Olomu (1979) among others. While both Clayton (1964) and Abaelu (1964) put the feed cost in egg production at 63 percent of the total cost, Olomu(1979) recorded cost of feed as 50 percent of the total cost. Adesimi (1979) investigated

the structures of costs, output, gross margin and profits on two poultry enterprises located at different locations (Ondo and Ibadan) of Western Nigeria. He discovered that feed alone accounted for an average of 61 percent and 50 percent on the two farms respectively, and that the productivity differentials in egg production on the farms may derive from the differences in the level of management practices in use on both farms. It was then concluded that poultry enterprises, if well managed, could be a profitable investment. Olowe (1977) and Olusegun (1984), employed the multiple regression procedure to investigate major factors that contribute significantly to variations in egg output apart from feeds. These were observed to be water, drug, and depreciation charge on the stock of birds. Depreciation charge on the stock, however, is directly related to age in lay. Their results also suggest that the farmers should find means of utilizing their inputs more efficiently in order to maximize their profits. A similar study by Adewumi (1983) suggested that maximum profit was achieved in the ninth month of lay of the birds. His approach was however, based on a simple budgetary technique. A more rigorous analysis requires using a more sophisticated tool like the regression technique to complement the conventional budgetary analysis.

Such an approach as described above will put together all the factors that affect egg production to determine the economic age at which laying birds should be disposed off thus addressing the issue of profit maximization in a more justifiable manner. This, therefore, is the goal of this present study.

Theoretical Framework

In a perfectly competitive market situation, the demand curve of a firm also represents the average and marginal revenue curves. Similarly, both the marginal cost (MC) and average cost (AC) curves are U-shaped reflecting the law of variable proportion operating in the short run when some inputs are fixed in use. The MC curve cuts the AC curve at its lowest point which implies that MC is equal to AC at the point of least cost. But the firm is in equilibrium at the output level where MC and marginal revenue (MR) curves intersect. This is the point at which the firm maximises its profit. Before this point of intersection, MR is greater than MC indicating that profit is yet to be maximized. Similarly, beyond the point of intersection, MR is less than MC indicating that additional output is adding more to the cost than to revenue (Leftwich, 1979)

However, the condition for profit maximization under perfectly competitive market system does not yield the same solution as the criterion for maximisation of profit per unit of time in a production period

with variable length. Under such a situation the appropriate criterion is to maximise profit per unit of time and not per output. Maximising profit per unit of time requires maximising the average profit with respect to time i.e. Average Net Revenue.

$$(ANR) = \frac{NR}{t}$$

Maximisation of the ANR, therefore, requires finding the first differential of ANR subject to time (t) and equating this to zero. i.e.

$$\frac{\delta ANR}{\delta t} = 0$$

This is equivalent to maximising average profit with respect to time (Henderson and Quandt, 1980)

Data And Analytical Framework

A total of 39 functional farmers were interviewed out of the list of 47 poultry farmers obtained from the veterinary office of the Ministry of Agriculture and Natural Resources (MANR) in Ijebu-ode LGA of Ogun State in 1996. The remaining farmers on the list were no longer in business. The farms of the interviewed farmers are located in some villages around Ijebu-Ode town. These include Ogbogbo, Ilese, Idomila, Ibido, Ikoto, Oke-Owa, Igan and Odo-Aye. The primary data were collected on weekly basis between the months of February and May with the aid of a structured questionnaire. Information was collected on both socio-economic characteristics of the farmers as well as on costs incurred and revenue obtained.

Apart from descriptive statistics, budgetary and regression techniques were employed in the analysis of the data.

(a) Budgetary Technique

The estimation of total cost and revenue for the different ages of birds was based on a unit of 1750 birds, the mean stock size. The farmers' gross margins and profits were computed in relation to each crate (30 pieces) of eggs produced. Variable costs were composed of feed, water, drugs and veterinary services, labour and transportation. On the other hand, depreciation on stock, buildings, cages, stores and interest on loan constitute fixed costs. The straight line method was used to estimate depreciation charges. The formula used to compute gross margin is as expressed in equation (1):

$$\text{Gross Margin per crate of eggs} = \frac{TR - TVC}{A} \times \frac{30}{1} \quad \text{.....(1)}$$

Where:

TR (Total Revenue) = $Y_1 + Y_2 + Y_3$

TVC (Total variable cost) = $X_1 + X_2 + X_3 + X_4 + X_5$

A = Number (pieces) of eggs laid per week (30 eggs make a crate of eggs)
Y_1 = revenue from sales of eggs
Y_2 = revenue from sales of culled birds
Y_3 = revenue from sales of empty used feed bags
X_1 = cost of feed
X_2 = cost of water
X_3 = cost of drugs and veterinary services
X_4 = cost of labour
X_5 = transportation cost

Profit per crate of eggs is defined as the difference between total revenue and total cost.

$$\text{i.e} \quad \text{Profit/crate of eggs (NR)} = \frac{TR - TC}{A} \times \frac{30}{1} \quad \text{.....(2)}$$

Total cost (TC) was composed of the variables X_1 to X_5 as defined above and other fixed costs:

X_6 = depreciation on buildings and cages
X_7 = depreciation on storage facilities
X_8 = loan charges (interest on loans)
X_9 = depreciation on stock.

(b) Regression Analysis

The regression analysis was carried out to examine the effect of different ages of the birds on the TC and TR. Hence, the model can be specified as

TC = f (N) ....(i)

and TR = g (N) .....(ii)

where N represents the age of birds in weeks.,

The functional forms tried are, explicitly:

Linear: $TR = b_o + b_1 N + e$ .....(iii)

Quadratic: $TR = b_o + b_1 N - b_2N^2 + e$ .....(iv)

Cubic: $TR = b_o + b_1 N - b_2N^2 + b_3N^3 + e$ .....(v)

Double log: $\log TR = \log b_o + b_1 \log N + e$ .....(vi)

Likewise, the functional forms were tried on total costs wherein TC was substituted for TR in each case. This means that both TC and TR were made to respond to the age of the birds.

The choice of the lead equation was based on the value of multiple determination (R^2) and the significance of the regression coefficients as judged by the values of t-ratio.

Following Faris (1960) the farmer (producer) here is assumed to be concerned with maximising his average net revenue (ANR). Mathematically, the average age net revenue (AaNR) over time is calculated as total net revenue divided by age i.e

$$AaNR = {}^{NR}\!/_{N} \quad \text{.....(vii)}$$

Similarly, marginal age revenue (MaR) is derived as the first (partial) derivative of total revenue function with respect to age: i.e

$$MaR = \frac{\delta TR}{\delta N} \quad \text{.....(viii)}$$

Marginal age cost (MaC) is likewise stated as:

$$MaC = \frac{\delta TC}{\delta N} \quad \text{.....(ix)}$$

Marginal age net revenue (MaNR) is the difference between MaR and MaC i.e.

$$MaNR = MaR - MaC \quad \text{.....(x)}$$

From the model, the optimum age is obtained when ANR is maximised. That is, the age where AaNR = MaNR

i.e. $$MaNR = \frac{\delta NR}{\delta N} = \frac{NR}{N} = AaNR \text{.....(xi)}$$

AaNR is average net revenue with respect to age; and

MaNR is marginal net revenue with respect to age.
AaNR is maximised at the point where marginal AaNR = 0, noting that:

$$\text{Marginal AaNR} = \frac{\delta AaNR}{\delta N} = 0 \text{ .....(xii)}$$

The age N is represented by (a) on the left hand side of equation (xii).

Results And Discussion

The analysis of the socio-economic characteristics of the farmers revealed that about 63 percent of the farmers are between the age of 40 and 60 years, with the mean at 47 years. The farmers of whom 87percent were male were therefore, considered old enough to have responsibilities that would make them profit oriented. Over 56 percent of the farmers had post-secondary education: also majority of the respondents had not less than 8 years of production experience. These attributes are expected to influence their performance positively.

About 67percent of the farmers rely on finished feed over whose quality and cost they have little or no control. This no doubt affects the level of profitability. Availability of good water is quite important in poultry production as it reduces disease outbreak and improves feed intake for improved laying capacity. The survey revealed that 72 percent of the respondents use pipe-borne water from taps and water tankers.

It was observed that about 80 percent of the farmers used hired labour only, while about 10 percent each relied on family and both family and hired labour. Hence, availability of hired labour would be an important factor in determining the success of poultry business in the area as most of the farms were being operated principally as commercial ventures. This, together with capital availability would

determine the stock sizes of the farms, since the farmers acquire their stock as day old chicks which are reared through laying period. The frequency distribution of the farmers by their stock sizes is shown in Table 1.

Table 1: Stock Size Distribution of Poultry Farms in Ijebu-Ode Local Government Area

Stock Size	No. of farmers	Percentage of Total No. of farmers
< 1,501	23	58.97
1,501 – 3,000	10	25.64
3,001 – 4,500	2	5.13
4,501 – 6,000	2	5.13
6,001 – 7,500	0	0.00
7,501 – 9,000	2	5.13
Total	**39**	**100.00**

Source: Field Survey, 1996.

From the above information, the mean stock size was 1,750 birds, modal size range was 1501 or less.

Budgetary Analysis

Costs and revenue items are the components in budgetary analysis.

(a) Cost Composition in Poultry Production

The total cost of production consists of all items of variable and fixed costs. The cost composition based on a unit of 1750 birds in the study area is shown in Table 2.

The total number of eggs laid (A) per week was 7012 while TR per week = 4,890.55. This translates to 4.01 eggs per bird per week. This compares with the findings of Adesimi (1979) which ranges from 10.68 eggs per month to 21.68 per month.

Table 2 shows that feed was the major cost item, constituting about 68 percent of the total costs of egg production. It is therefore, imperative that farmers should find a way of increasing the efficiency of feed utilization, in all its ramifications. The cost of storage facilities was found to constitute the lowest proportion of costs of production showing that very little provision (if any) were made for egg storage.

(b) Profit and Gross Margin Analyses

The gross margin (GM)/crate of eggs =

$$\frac{4890.55 - 3545.27}{7012} \times \frac{30}{1} = ₦5.76$$

The gross margin of ₦5.76 per crate of eggs indicates that the farmers can cover their variable costs of production and could therefore remain in business. The profit per crate of eggs was calculated as 2.62. This implies that the farmers can cover the fixed costs of production and had surplus.

Table 2: Percentage Composition of Total Cost per Week Per unit of 1750 Birds

Cost Item	Average Cost /Week (₦)	Percentage of Total Cost (percent)	Average cost per bird/week
Feed	3059.23	71.50	1.75
Water	101.38	2.37	0.06
Drugs	177.92	4.16	0.10
Labour	139.42	3.26	0.08
Transportation	67.32	1.57	0.04
Total Variable Costs	**3545.27**	**82.86**	**2.02**
Building and Cages	43.61	1.02	0.02
Storage facilities	1.76	0.04	0.001
Loan charges	14.06	0.33	0.01
Depreciation on stock of laying birds	673.98	15.75	0.38
Total fixed Costs	**733.41**	**17.14**	**0.42**
Total Costs (TC)	**4278.68**	**100.00**	**2.44**

Source: Data analysis

Table 3: Regression Coefficient for TC and TR equations

Independent Variable	Total cost	Total Revenue
Constant	326.0263	-1625.9162
Age (N)	2.7823	116.6282***
	(5.5330)	(7.3369)
N^2	-0.0364	-2.0415***
	(0.1045)	(0.1385)
N^3	0.0001	0.0112***
	(0.0006)	(0.0008)
R^2	0.0294	0.8425
Adjusted R^2	0.0168	0.8350
F- ratio	0.6360	112.3550

Source: Data Analysis – figures in brackets are standard errors.
***Significant at 1percent level

(c) Results of Regression Analysis for Determining Optimum Age of Birds

The empirical results of the analysis of total cost and total revenue equations are presented in Table 3.

The cubic functional form gives the best fit for analysis, therefore it has been chosen as the lead model.

The adjusted coefficient of multiple determination for the TR equation shows that about 84 percent of the variation in revenue obtained was explained by the age of the birds. The remaining 16percent could be due to genetic, environmental and other factors. On the other hand only about 2 percent of the variation in cost incurred was explained by age. This implies that some other factors apart from age are more important in explaining variation in cost of egg production in the area. Such factors could include feed cost and utilization, managerial ability of the farmers and efficiency of labour utilization among others.

The positivity and significance of the regression coefficient of age (N) at one percent level indicate that from point of lay, the revenue realised was initially increasing with increases in age of the birds. However, the negative and positive signs of N^2 and N^3 respectively indicate that the revenue yield dropped after the initial increases with age before picking up at a later age. The drop in revenue could be due

to decrease in egg yield during the period of moulting as dictated by biological and physiological nature of the birds, level of management of capabilities, and/or decrease in egg prices. Adesimi (1979) had opined that such productivity differentials may derive from the differences in the level of management practices.

The TC equation has a positive intercept which indicates that costs were already incurred even before the birds started laying i.e. fixed costs. However, the regression coefficient of age (N) is not significant. Other factors like management capabilities and environmental factors are, therefore more important.

(d) Determination of Maximum Age of Layers through Maximisation of Net Revenue (NR)

$NR = TR - TC = -1951.9425 + 113.8459N - 2.0051N^2 + 0.0111N^3$ ... .(xiii)

In this study, maximisation of revenue is determined by equating marginal age cost (MaC) with marginal age revenue (MaR), i.e. MaC = MaR which is synonymous to MC = MR of perfect competitive market situation.

$$MaR = \frac{\delta TR}{\delta N} = 116.628 - 4.083N + 0.0336N^2 = 0 \quad \text{.....(xiv)}$$

$$MaC = \frac{\delta TC}{\delta N} = 2.782 - 0.073N + 0.0039N^2 = 0 \quad \text{.....(xv)}$$

MaR – MaC = Ma NR which is equivalent to MNR

Therefore $MaNR = 113.846 - 4.010N + 0.03ON^2$ .....(xvi)

Solving for N, we have 45.83 weeks or 74.59 weeks. These imply that profit would be maximised when the birds were 46 weeks or 75 weeks old in lay. To confirm the rational age for profit maximisation, the values of N were substituted into the net revenue equation to find the age at which NR would be truly maximized. The maximum net revenue realized when the birds were 46 weeks and 75 weeks old were ₦122.62 and –₦9.44 respectively thereby indicating that 46 weeks is the rational age of profit maximisation since negative net revenue does not make economic sense.

(e) Determination of Optimum Age of Birds from Optimum Profit

Optimum profit is realised by maximising average net revenue.

The AaNR per time is derived as NR/N

Hence

AaNR = NR/N = $-1951.942N^{-1} + 113.8459 - 2.0051N + 0.0111N^2$

To obtain optimum profit, AaNR is differentiated with respect to age and the derivative equated to zero.

i.e. $dANR/dN = 0$, synonymous to $dAaNR/dN = 0$,

where, $dAaNR/dN = 0$, represents maximisation of average age net revenue (AaNR) i.e.

MAaNR = dAaNR = $1951.942 N^{-2} - 2.0051 + 0.0222N = 0$

Solving for N, shows the optimum age as 43.2 weeks and 74.45 weeks. The optimum profit realised for these two ages after substituting into NR equation were ₦110.11 and -₦9.43 for 43 weeks and 74 weeks respectively. This indicates that the optimum age for laying birds in egg production is 43 weeks from the point of lay.

Summary And Implications

The major objective of the study was to determine the optimum age of laying birds in egg production. For this purpose, 39 poultry farmers were randomly sampled and surveyed, in the Ijebu-Ode Local Government Area of Ogun State over a period of 12 weeks to collect data used in the study.

The result of the analysis of socio-economic characteristics of the farmers showed that majority of the farmers had one form of education or the other. Majority of the farmers depended on finished purchased feeds and had access to good water. On the average, most of the farmers individually had less than 1501 birds in stock.

The budgetary analysis shows feed as a major cost item constituting about 72 percent of total cost of production. The farmers made on the average, a gross margin of ₦5.76 and profit of ₦ 2.62 per crate of eggs during the period of study.

The regression analysis revealed 43 weeks of lay as optimum age for profit maximisation. Similarly, 46 weeks was calculated to be the maximum laying period for profit maximisation. The results, therefore, imply that poultry farmers should find means of increasing efficiency of feed utilisation even though egg production was found profitable in the area. Also, it is best for the farmers to sell off their laying birds starting from 43 to 46 weeks of lay.

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