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Profitability and Efficiency of Small Scale Layer Farmers in Osogbo Agricultural Development Programme Zone of Osun State, Nigeria

KEYWORDS: DEA, efficiency, Gross margin, Poultry egg, Tobit regression model

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ABSTRACT The study examined the profitability and efficiency of small scale poultry farms in Osun state, Nigeria. Primary data were used for the study which was collected with the aid of well structured questionnaire. Multistage sampling technique was used for the study with a sample size of 65 poultry farmers. Descriptive statistics, Gross margin principle, Data Envelopment Analysis (DEA) and Tobit regression model were used for the analysis of socio economic characteristics, costs/returns, efficiency measure and determinants of efficiency respectively. The results revealed that majority of the poultry farmers were literate and married. The study further revealed that poultry egg production in the study area was profitable during the course of the study. Majority of the poultry egg famers were technically and relatively efficient in their use of resources, with mean technical efficiency being 0.848. The mean input slack for stock, labour and feed were 2.248, 652.690, and 2.861 respectively. All the farmer specific variables had positive effect on technical efficiency at 1 percent level.

Introduction

Nigeria is predominantly an agro-based economy with majority of her Labour force engaged in agricultural practices. Before oil boom in 1973, Agriculture is the main stay of the country's economy. Agriculture has two major aspects; rearing of animals and growing of crops, (Afolabi and Ojo, 2000). The ultimate aim of these practices is to produce food for animal use and human consumption. The movement of people out of agriculture sector has brought about low animal intake due to consequent fall in animal production (Oluwole, 2008). The production of food has not increased at the rate that can meet the increasing population. While food production increases at the rate of 2.5%, food demand increases at a rate of more than 3.5% due to high rate of population growth of 2.83%. The apparent disparity between the rate of food production and demand for food in Nigeria has led to increasing resort to food importation and high rates of increase in food prices (Central Bank of Nigeria CBN, 2004). Poultry meat and eggs offer considerable potential for meeting human needs for dietary animal supply (Folorunsho and Onibi, 2005). The demand supply gap for animal protein intake is so high.

According to the Food and Agricultural Organization (FAO 2006), Nigeria's poultry stock of 140 million chicks constituted about 0.8% world stock and its 476,000 metric tones of eggs constituted 0,8% world stock in 2004. Ekunwa et al., (2006) revealed that the 0.3% growth rate in 2003 rose to 10.3% in 2004, mainly due to increased local demand, arising from the national government's ban on imported poultry products. Adebayo and Adeola (2005) asserted that the poultry sub-sector has fallen short of its aim of self sufficiency in animal protein production. The small scale farmers are not finding it easy at all on this astronomical rise in the cost of poultry feeds. Rising cost of feed, removal or reduced use of antibiotic growth promoters and the search for viable alternatives, finding more cost effective feed ingredients for poultry, constant supply of quality water, implementing feed mill bio security (as part of the whole farm bio security measures), nutrition-related environmental concerns, and inconsistency in laboratory analyses of feed ingredients and compound feed samples are among challenges that the industry is facing. Also, Akintunde *et al.,* (2015) posit that the cost of disease treatment tends to reduce profitability of the business by increasing the production cost of the poultry farmers. The objectives of the study are to analyse profitability and efficiency of layer farmers as well as factors affecting their efficiency in the study area.

Literature Review

Yusuf and Malomo (2007) revealed that farmers with large farm size are most technically efficient with a mean of 0.8877 followed by medium farm size with a mean of 0.8687 while small farm size has the least mean of 0.8638. The study concluded that the poultry egg production is profitable in the study area and that majority of the farmers were relatively efficient. Bamiro (2008) found out that in all enterprise combinations, farmers that operate on large scale have highest gross margins. On the basis of enterprise combinations, the egg production enterprise records the highest gross margin while the broiler production enterprise records the lowest gross margin. This depicted poultry business a profitable one.

Ojo (2003) in his study on technical efficiency of poultry egg production in Osun State using the stochastic frontier production function analysis showed that poultry egg production was in the rational stage of production (Stage II) as derided by the returns to scale of 0.771. The technical efficiencies of the farmers varied widely between 0.239 and 0.933 with a mean of 0.763 and about seventy nine percent of the farmers had technical efficiency exceeding 0.70. Ukoha, (2006) showed that labour, farm size, feed costs, capital and utilities had positive and significant impact on output with a mean technical efficiency of 0.58.

The first analysis of efficiency measure started with Farell (1957) whose drawing inspiration from Debreu (1951) and Koopmans (1951) proposed a division of efficiency into 2 components; technical efficiency which represents a firm's ability to produce maximum level of output from a given level of inputs and allocative efficiency which is the ability of a firm to use inputs in optimal proportions, given their respective process and available technology. The combination of these two measures yields the level of economic efficiency.

Data Envelopment Analysis (DEA)

DEA is a linear programming methodology which uses data of input and output quantities of a Decision Making Units (DMU) such as individual firms of a specific sector, to construct a piecewise linear surface over data points (Ajao and Ogunniyi, 2010). In this study, the poultry farmers were used as the DMU. The DEA method is closely related to Farells (1957) original approach and it is widely regarded in the literature as an extension of that approach. This approach was initiated by Charnes *et al.,* (1978) and in a related work of Fare *et al.,*

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(1985). The frontier surface is constructed by solving a sequence of linear programming problems. The degree of technical inefficiency of each DMU, which is represented by the distance between the observed data point and the frontier, is obtained as a product of the frontier construction method.

Ajao and Ogunniyi (2010) revealed that DEA can either be input or output oriented depending on the objective. The input oriented method defines the frontier by seeking the maximum possible proportional reduction in input usage, while the output is held constant for each DMU. The output oriented method on the other hand, seeks the maximum proportional increase in output production with input levels held fixed. But the two provide the same technical efficiency score. Input –oriented DEA was used to determine how much input mix the farmers would have to change to achieve output level that coincides with the best practice frontier.

Concept of efficiency

Technical efficiency refers to the ability to produce maximum potential output from a given sets of inputs, given the available technology. Other types of efficiency which are being adopted by researchers upon the objective of research are economical, allocative, market and economic efficiency. These are defined to measure the use of resources in a particular manner and the measure selected to analyze efficiency depends largely on what result are to be put. The distinction between the above efficiency types should be known. Economic efficiency is a term applied to the concept of overall efficiency with allocative and technical efficiency forming its component parts. Allocative efficiency refers to the allocation of resources taking into account the price of factors and implies equalization of the marginal product of each input to its price. Technical efficiency means that resources must be allocated optimally in order to realize output, actual output may be below potential expected output. Thus, as producer may allocate a resource correctly but obtain a sub-optimal output relative to some benchmarks. This may occur through the use of some interior technique or through technical inefficiency and may occur because even when a decision maker is free to select method used to measure efficiency is inadequate.

Materials and Methods

The study was conducted in Osun State. The state had a land area of 8802 squared kilometer and a population of 2.2 million (FOS, 1996), it is on latitude 7.70N and longitude 1.050E of the equator. It is a rainforest zone with the distribution of rainfall between the month of April and early May when the farmers starts planting. The weather is characterized by hot and bright days except on raining days. The annual rainfall is between 1000mm and 1500mm with high daily temperature of about 300C. The people are predominantly peasant farmers cultivating food and cash crops. The people also embark on small, medium and large scale livestock production such as rearing of goats, sheep, pigs, rabbits and poultry as well as marketing of their products. Primary data were used for the study. The study made use of questionnaire for data collection. Multistage random sampling technique was employed for the study. The first stage involved selection of one out of three (3) Agricultural Development zone (ADP) in the state. The second stage involved random selection of one ADP zone out of three. The third stage involved random selection of three local government area from the selected ADP zone and lastly proportionate selection of poultry farmers from each local government area selected.

Analytical techniques

Descriptive Statistics

This study employed the of tabular presentation, frequency count and percentages

Profitability Analysis

Gross Margin analysis was used for the profitability analysis.

GM = TR – TVC, Where, GM = Gross Margin, TR = Total Revenue, TVC = Total Variable Cost. Therefore, TR = P.Q, Where P = Output Price of trays of egg in naira, Q = Output Quantity measured in trays of eggs, ∏ = GM – TFC

And TFC = Total Fixed Cost outlay of the poultry farms and ∏ = Profit in naira, Net returns (NR), Total Cost (TC),

Profitability Ratio

Benefit cost ratio = TR/TC
Rate of Return = NR/TC
Expense structure ratio = FC/TC
Gross revenue ratio = TC/TR
Gross margin ratio = TR/NR

Efficiency and its determinants analysis

DEA is non-parametric method which involves the use of linear programming to construct a piecewise linear envelopment frontier over the data points such that all observed points lie on or below the production frontier. Let X be a K * N matrix of inputs, which is constructed by placing the input vectors xi, of all N firms side by side and Y denotes the M * N output matrix which is formed in analogous manner.

The input – oriented VRS DEA frontier is defined by the solution to N linear programs of the farm.

MinY
YT
Subject to - yi + YT > 0 .....(1)
xi /Y - XT > 0
N /T = 1
T > 0

Where Y is the input distance measure. Also note that 1 < Y< ∞ and that 1/ Y is the proportional reduction in inputs that could be achieved by the i+e firm, with output quantities held constant.

The technical efficiency measure under CRS, also called the "overall" technical efficiency measure, is obtained by solving N linear programs of the form.

Min CRS
¡CRS
Subject to - YT + Yi > 0 .....(2)
¡CRSxi - XT > 0
T > 0

Where ¡CRS is a technical efficiency measure of the ith firm under CRS and 0 ¡CRS 1.

The output and input oriented models will estimate exactly the same frontier surface and therefore, by definition, identify the same set of firms as being efficient. The efficiency measures may, however, differ between the input and output orientations. Under the assumption of CRS, the estimated frontier and the efficiency measures remain unaffected by the choice of orientation (Coelli and Perelman, 1999). Output is defined as trays of eggs and spent layers while inputs included size of stock (number of birds), labour (mandays), feed (kg), amount spent on vaccination (naira) and farm land (ha). This study uses the intermediation approach and thus, the inputs used are size of stock and labour, and the outputs are trays of eggs and spent layers.

DEA Frontier Model

Input Variable:

Input 1: Size of stock (number of layers)
Input 2: Labour (mandays)

Output Variable:

Output 1: Sales from trays of eggs (naira)
Output 2: Sales from spent layers (naira)

DEA is a relative measure of efficiency where the general problem is given as;

$$\frac{\sum_{r=1}^{s} j\, yij}{\sum_{r=1}^{m} I\, Xij}$$

i = 0, r = 1...s; l = l....m

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Where X_y and y_{ij} respectively are quantities of the ith input and rth output of the jth firm

Inputs = Number of birds, labour, feed, Vaccine, farmland.

Output = crates of egg and spent layers.

Firm = 1....65.

$$\text{MaxTE} = \frac{\sum_{r=1}^{s} r - yij}{\sum_{r=1}^{m} q} = \frac{q}{\sum I Xij}$$

Subject to:

$$\sum_{r=1}^{s} r - y_{ij} < 1 = j = 1, \ldots, n$$

$$\sum_{r=1}^{m} I X_{ij}$$

'r' 'i' = 0, r = 1, ..., s; l = l,..., m (Coelli and Battese, 2001)

Where Xij and yij respectively are, quantities of the ith input and rth output of the jth firm.

Inputs = number of bird, labour, feed.

Output = trays of egg

Firm = 1.... 65

'i' and 'r' are input and output weight respectively

The variables of data envelopment model are further educated upon below.

Y_{ij} = Output

X_{ij}'s are: Farm size, labour, and feed.

Farm size: - The output of a poultry farm is poultry dependent on the number of birds in the farm. Labour; Family & hired labour play an important role in agricultural production especially in developing economics where capital is less significant. Labour is expressed as adult male –equivalent man-day and is the summation of family labour and hired labour. Female equivalent man-day is 0.75 while that of children equivalent man-day is 0.50. This is done to take into consideration different capacity of labour categorization. Feed: This is the compounded feed stuff given to the bird. It is one of the major determinants of production in poultry egg production.

Tobit Model Specification

In order to estimate the effect of environmental variables, Tobit model was employed because of its advantage in specifying the intensity of the factors that influence efficiency of poultry farmers. In the absence of a theoretical recommendation for using an alternative specification, the model expresses the efficiency of poultry farms as a function of a linear combination of observable explanatory variables, and an error term ( ). The simple model can be presented as:

$$Y^* = bxi + mj \quad (1)$$

Algebraically expressed for the Ith firm operator:

$$Y_i = b0 + b1X1 + \text{---} + bNX_N, I = 1, \text{---} N \quad (2)$$

Such that: b

$$Yt = \begin{cases} 0 \text{ if } Y_i \leq T \\ Yt^* \text{ if } 0 < Yt^* < 1 \ (I = 1 \text{----} n) \\ T \text{ if } Yt^* > T \end{cases} \quad (3)$$

Where Yi is the observed dependent variable, i.e the number of poultry farms considered in this study, Yt* is the non-observable representing the technical efficiency of poultry farms, T is the critical (cut-off) value which translates into Yt* > T, as firms are not efficient, and n is the number of observations. Tobit analysis is used to estimate the environmental factors that influence the efficiency of the poultry farms. Tobit is preferable to Ordinary Least Squares (OLS) estimation because it allows for the inclusion of all observations. Unlike the OLS case, the value of a Tobit coefficient does not directly correspond to the expected change in an explanatory variable, rather the Tobit model estimates a vector of normalized coefficients which can be transformed into the vector of first derivatives. Additionally, elasticities calculated at the mean of the variables can be decomposed into two parts; the elasticity of the probability of being above the limit, and elasticity of the conditional expected value, summing them the total elasticity or the percent change in the dependent variable given a 1% change in the independent variable is obtained (Ajao and Ogunniyi, 2010).

Results and Discussion of the findings

Table 1 showed that majority of the poultry farmers 40 percent fell between the ages of 40-49 years. The mean age of the farmers in the study area was 42years which imply that most of the farmers were in their middle age of 42years and these make them to be more active. The table showed that, 90.77 percent of the respondents were married. These showed that most of the poultry farmers in the study area were settled family men and women with responsibilities. These responsibilities would likely make them to seek innovations so as to increase their income earning capacity and improve their standard of living. This corroborated with the findings of Adewumi, (2002) that majority of the poultry farmers in the study area were married. The largest percentage (63.08%) of the poultry farmers had their household size between 5 and 9 members with mean value of 6, this indicated that most of the farmers had relatively moderate households' size and this might be that they were aware of family planning. The table also showed that 67.69% of the farmers had not more than 10 years experience in poultry farming. The year of experience is expected to influence efficiency of poultry farmers. The average experience of 9.67 years of the respondents means that the poultry farmers had enough experience which helped them to identify their prevailing problems over the years and to develop their skills and creating a sustainable income with very low inputs. This study corroborated with the study of Afolabi *et al.,* (2013) which reported an average experience of poultry egg farmers as 8.72. Table 1 also showed that 69.23 percent of the respondents were male while 30.77 were female. This implies that more men were involved in the poultry production than women in the study area.

Table 1: Frequency Distribution of Respondent's by Socioeconomic Characteristics

Socioeconomic	Frequency	Percentage	Mean
Age	**42**		
<30	3	4.62	
30-39	21	32.30	
40-49	26	40.00	
50-59	13	20.00	
60 and above	2	3.08	
Total	**65**	**100.00**	
Marital Status			
Single	5	7.69	
Married	59	90.77	
Divorced	0	0.00	
Separated	1	1.54	
Total	**65**	**100.00**	
Household Size			
1-4	21	32.21	6
5-9	41	63.08	
Above 10	3	4.61	
Total	**65**	**100.00**	
Year of Experience			

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≤ 10	44	67.69	9.67
11-20	13	20.00	
Above 20	08	12.31	
Total	**65**	**100.00**	
Sex			
Male	45	69.23	
Female	20	30.77	
Total	**65**	**100.00**	

Source: Field survey, 2015

Costs and Return Analysis

The items of costs were divided into fixed cost and variable cost. The fixed cost in this study included cost of poultry buildings, land, cages, and factory vans, feeding troughs/ water troughs and warehouses while the variable cost items included cost of foundation stocks, feed, vaccine and labour. The strait line depreciation method was employed for the fixed cost items. Total fixed cost items were depreciated at N 267280.69 while N 1651648.00 was estimated for the total variable cost for a production year in the study area.

Cost Analysis

Table 2: Showed the Total Fixed Costs (TFC) and Total Variable Costs (TVC)

Fixed item	Number (ha)	Amount (N)	Life span(yrs)	Depreciation(N)
Land	2.08	116069.23	10.5	11054.21
Stores	1	15509.23	2.5	6203.69
Buildings	1	500500.00	12.5	40040.00
Factory van	1	426150.38	2.5	170460.15
Feeding trough	43	12587.62	3.5	3596.46
Water trough	43	9978.46	3.5	2850.99
Cages	4	132300.77	4	33075.19
Total				**267280.69**
Total variable cost				
Variable items	**Number**	***Amount (N)***		
Feed	10975.35	1,054,807.62		
Bird	911.54	500,555.38		
Vaccine	1757.58	2,250.00		
Labour	156	94,035.00		
Total		**1651648.00**		

Source: Field Survey, 2015.

Gross Margins and Net Farm Income Analysis

But, Total Revenue (TR) = Selling price x Qty sold

$TR_{spent\ layers}$ = N1150 X 822

= N 945,300.00

Tr_{egg} = 531 x 11,625 trays of eggs

= N6,172,875

Therefore, the total revenue = N6,172,875 + N945,300

= N7,118,175.00

Gross margin = Total Revenue – Total Variable Cost

Gross Margin = N7118175.00 - N1651648.00 = N5,466,527

Profit = Gross Margin – Total Fixed Cost

= N5,228,328.16 – N267,280.69

= N5,2015948.47

Table 3 Profitability analysis of poultry farms in the study area

Variable	Average Amount(N)
Total Revenue	7118175.00
Total Variable Cost	1651648.00
Gross Margin	5228328.16
Total Fixed Cost	267280.69
Profit	52015948.47

Source; Field Survey, 2015.

Profitability Ratios

Table 4 revealed the analysis of profitability ratio and it was discovered that benefit cost ratio is above one. This implies that poultry production in the study area is profitable. The rate of returns N2.64 implies that for every one Naira invested, N2.64K was gained. Also the expenses structure ratio 0.14 showed that 14% of the total cost of poultry production was made up of fixed cost items which were relatively low and reflect a rural area for the study area. A gross revenue ratio of 0.27 indicated that for every N1.00 returns to poultry production 0.27k are being spent. The gross margin ratio of 1.43 implies that the business is profitable. The result corroborated the findings of Adebayo *et al.,* (2015) in which 0.21 naira was returned to broiler farmers as net income on every naira earned as revenue.

Table 4: Profitability Ratios for poultry farms in the study area.

Ratios	Value
Benefit Cost Ratio TR/TC	3.77
Rate of Return NR/TC	2.64
Expense Structure Ratio FC/TC	0.13
Gross Revenue Ratio TC/TR	0.53
Gross Margin Ratio TR/NR	2.13

Source: Field Survey, 2015.

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Efficiency Indices

This study employed multistage input-oriented DEA model using inputs and outputs, as mentioned earlier. The multistage input-oriented DEA model was used to find out the overall technical efficiency. The empirical exercise starts with the measurement of efficiency scores of each class of farms from its frontier, i.e, assuming that the technology (input) used by each class of the farm varies. The results were summarized in Table 5. Three types of efficiency scores were generated based on the assumptions of CRS and VRS. The third efficiency score (scale efficiency) was generated based on the relationship between the two-stated assumption (Udoh, 2006). The mean efficiency of TE vrs, TE crs and SE were 0.40, 0.85 and 0.46, respectively. This implies that there is about 60%, 15% and 54% potential respectively, for the sampled poultry farms to be on the frontier and realize their potentials based on the assumption of return to scale. Table 5 revealed that 0.90 – 1.00 interval class is the most efficient farm with about 49.23% of the farmers in this class. This rather high degree of technical efficiency suggested that very little marketable output were sacrificed to resource-waste. Further, it showed that efficiency scores of technical efficiency of Constant Return to Scale (TE crs), Variable Return to Scale (TE vrs), and Scale Efficiency (SE) vary among the farms. The mean score showed high efficiency score of TE vrs, but TE crs and SE showed low efficiency scores in comparison to TE vrs (Ajao and Ogunniyi, 2010).

Table 5: Efficiency Scores of poultry farms in the study area

Range	CRSTE	VRSTE	SCALE			
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
0.05-0.19	22	33.85	_	_	14	21.54
0.20-0.29	13	20	_	_	11	16.92
0.30-0.39	8	12.31	_	_	9	13.85
0.40-0.49	4	6.15	_	_	9	13.85
0.50-059	5	7.69	7	10.77	3	4.62
0.60-0.69	1	1.54	7	10.77	4	6.15
0.70-0.79	1	1.54	8	12.31	1	1.54
0.80-0.89	2	3.08	11	16.92	3	4.62
0.90-1.000	9	13.85	32	49.23	11	16.92
Mean	0.400	0.848	0.464			

Source; Field Survey, 2015.

The input slacks, which represent excess input used, showed that on the average the sampled farm had an excess of 2.248, 652.690 and 2.861 number of birds, labour and feeds respectively. This implies that the input could be decrease by those units and still produce the same level of output. Thus the farms were said to be radically inefficient in input usage by the said factors. The farmers were underutilizing their resources. With input slack, it means more output could be produced with the same quantity of inputs than what is being produced. The farmers were not optimizing their outputs. From the result, number of birds had the least input slack, which means that the number of birds is more effectively utilized than other inputs.

Table 6: Summary of input slacks

Inputs	Number of farms	Mean slack	Mean input use
Size of stock	15	2.25	912
Labour	34	652.69	0.98
Feeds	33	2.86	10975.35
Vaccine	9	100.22	1757.58
Farm size	36	2960.72	2.08

Source; Field Survey, 2015.

Factors affecting technical efficiency of the poultry farmers

All the coefficients of the farmer specific variables in the Tobit estimation were found to be positively related with the efficiency index with contact with extension, years of experience and years of education being the only significant variables in the model The implication is that farmers with more years of contact with extension agents as well as more literate tend to be more efficient in poultry production. Continuous practice of an occupation for a long period presumably makes a person more experienced and more productive in practice. This agrees with Akintunde et al., (2015) who reported that a year of experience of poultry farmers reduces farmers' inefficiency.

Table 7: Determinants of farmer's efficiency in poultry egg production.

Variables	Standard error	t-value
Constant	0.70	0.03
Age of farmers(Z1)	0.35	1.13
Contact with extension agent(Z2)	0.94*	2.89
Family size(Z3)	0.19	1.23
Years of experience(Z4)	0.15*	3.11
Level of education(Z5)	0.79*	3.32
Log-likelihood Estimate	19.65	
Adjusted R-squared	0.81	

Source: Field Survey, 2015. * t- value significant at 1%,

Conclusion and Recommendation

In this study both descriptive statistics; gross margin analysis, input-oriented DEA model and Tobit regression model were employed to evaluate the performance of poultry farms in Ifelodun Local Government Area of Osun state, Nigeria. DEA offers numerous benefits that reveal the target areas of relative efficiency between poultry farms. A total number of sixty five farmers were randomly sampled. Majority of the respondents were literate and married in the study area. Poultry egg production in the study area was found to be profitable during the course of the study. The study further showed that, farming experience; years of education and contact with extension agent had significant impact on the farmers' efficiency. Using Data Envelopment Analysis, size of stock, feeds and vaccines were found to be more efficiently used in the technical efficiency model while in the inefficiency factors are labour and farmland size. The study further revealed that all the farmer specific variables had positive influence on the technical efficiency of farmers. Based on the study, the following recommendations are suggested to improve their productivity/technical efficiency.

- People should be encouraged to start poultry farming since it had been revealed from the study that the business is profitable in the study area.
- Inputs such as balanced compounded feed should be subsidized and made available to poultry farmers through farmers association so that the level of production can be improved.
- Medicines and vaccines should be provided at affordable prices to the farmers.
- Farmers should therefore be encouraged to have more time to supervise their poultry farms to improve on their technical efficiencies while adequate enlightenment program on the benefit of egg consumption should be introduced to the rural areas to stimulate the consumption of eggs.

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