A Quantitative Determination of Allocative Efficiency in Broiler Production in Delta State, Nigeria

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Summary

In order to determine the allocative efficiency of broiler production enterprises in Delta State, Nigeria, panel data were collected for the period from January 2003 to September 2004, from 96 farmers, using a three – stage selection process. A production function incorporating inputs such as feed expenses, broiler stock size, operating and fixed costs, with value of matured broilers as output was fitted to the data. The results indicate that the average size of holdings is small, with a mean size of 680; average revenue per farm was ₦507,774.70 (US$3761.29) while net revenue per broiler was ₦ 127.59 (US$0.95). Costs of feeds, day – old chicks and other capital inputs significantly influenced the revenue generated by farmers ($P < 0.05$) except for fixed capital expenses ($P > 0.05$). However, variable expenses were negatively related to output. Estimates of allocative efficiency were 24.9, 24.8, – 4.6 and 11.9 for stock size, feed expenses, variable expenses and fixed capital inputs respectively. The implications are that though the farmers are generally and allocatively efficient, they need to increase the quantity of inputs in order to maximize profits. Farmers should be supported to expand the size of their holding and make better use of their resources by enhanced access to production credits and on-farm training.

Key words

small-holder broiler production; resource use; allocative efficiency; production credit; net revenue

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Introduction

In Nigeria, animal protein, especially meat is expensive, in short supply and is out of – reach to the majority of the population. The effect of inadequate animal protein intake is felt more by a larger proportion of the population especially in the rural areas, whose inhabitants constitute over 70% of the Nigerian population, and who constitute over 85% of the extreme poor in the country (FOS, 1995; Chukwuji et al, 2002). For this reason, and because expanding population will increase demand for animal protein, different sources, one of which is poultry production (particularly broiler), are exploited towards meeting these needs.

Broiler production is carried out in all parts of the country, with no known religious, social or cultural inhibitions associated with their consumption. Specifically, investment in broiler enterprises is attractive because the production cost per unit is low relative to other types of livestock, poultry meat is very tender and broiler enterprises have short production cycles. Owing to these obvious advantages of broiler enterprises, large numbers of farmers, men and women go into their production, many of whom do so for income generation purposes (Nwajiuba and Nwoke, 2000), besides meeting the protein needs of the households. The evidence of this is the preponderance of producer – hawkers of broiler products in urban and rural markets particularly during festive periods, when their demands are highest and selling prices favourable. The industry is one of the sub – sectors of agriculture in Nigeria that has developed to the status of agribusiness as distinct from subsistence production, for which the primary objective is profit maximisation (Nwajiuba and Nwoke, 2000). In order to formulate policies that would adequately address the specific needs of broiler producers as they relate to enhancing their productive capacity, information collection and dissemination of enterprise-disaggregated data is inevitable.

While it is obvious that more than economic profits are made, a condition necessary for more producers to enter the business under competitive enterprise environment, the question is, are they efficiently allocating their scarce resources to enable them realise maximum profits from their investments? That is, are they able to achieve maximum profit for a given set of output? Although, some studies on efficiency in poultry industries have been made (Ojo and Afolabi, 2000; Ojo, 2003), not much of such studies have been specifically documented on allocative efficiency in broiler production in Delta State, Nigeria. An understanding of these relationships would definitely provide working tools for policy makers to design programmes that can contribute to measures needed to expand broiler production in the state in particular and the country in general. Given this backdrop, this study seeks to determine whether and to what extent resources are efficiently allocated by broiler producers in the state.

Theoretical concepts

Allocative efficiency is a measure of firms' success in choosing an optimal set of inputs. It is an indication of the gains that can be obtained by varying the input ratios on the bases of certain assumptions about future price structure of the product and factor markets and the goals of the broiler farm - firms. These assumptions are that broiler producers in the state seek to maximise their profits by choosing the best input combinations according to their relative prices in order to produce profit maximising levels of output. Secondly, there exists perfect competition in the input and output markets. Also, the producers are assumed to be price takers and they have perfect information about the market. Finally each production input is assumed to have the same quality for all producers. Oh and Kim (1980) defined allocative efficiency as the ratio of total cost of producing one unit of an output, using actual factor proportion in a technically efficient manner, to total cost of producing the same unit of output, using optimal factor proportions in a technically efficient manner. According to Yotopoulos and Lau (1973), a firm is said to be allocatively efficient if it maximises profit, which implies that it was able to equate the value of marginal product (MVP) of each resource employed to its unit cost. This is the condition for profit maximisation under perfectly competitive markets, which requires that the extra revenue generated from the employment of an extra unit of a resource must be equal to its unit cost (Bishop and Toussaint, 1959; Henderson and Quandt, 1980; Olayide and Heady, 1982; Sankhayan, 1988, Onyeneweaku et al, 2000; Akanni and Adeokun, 2004).

The efficient method of producing a product is that which uses the least amount of resources to get a given amount of the product. A production method that uses more of all physical resources than the alternatives in the production of a unit output is technically inefficient. Once technically inefficient methods of production have been eliminated, the issue of allocative efficiency would arise; that is, choosing among the technically efficient alternatives, the one that uses more of one input and less of another. This implies considering the cost of the inputs concerned in relation to the expected revenue they would generate. The least cost method is the most efficient. Firms, which are able to use the least cost method of production, are said to be perfectly allocatively efficient, implying that they operate at the point of tangency between an *isoquant* and *iso – cost* line in

their production frontier (Heady, 1952; Henderson and Quandt, 1982; Sankhayan, 1988).

Study area and data collection

This study assesses productivity and allocative efficiency of broiler farms in Delta State of Nigeria. Delta State is one of the 36 states in Nigeria. The State lies roughly between longitude 5^0 00' and 6^0 45' and latitude 5^0 00' and 6^0 30' north of the Equator. It is bounded by Edo, Ondo, Anambra, Rivers and Bayelsa States to the north, north – west, east and south – east respectively. It is made up of 25 local government areas (LGAs), with a censures figure (1991) of about 2,570,181. The vegetation varies from mangrove swamp along the coast in the southern parts to evergreen forest in the central parts and savannah in some parts of the northern ecological zones. Although Delta State is currently the largest producer of petroleum products in the country, agriculture is the dominant aspect of the rural economy, as it is in most parts of the country. Commercial poultry production is carried out by a large number of farmers in rural, urban and semi – urban centres of the state. The scale of holding by each farmer is characteristically small.

Panel data of three batch broiler production cycles were collected for a period of over 22 months (January 2003 to September 2004) from 96 farmers, using a three – stage selection process. The first stage involved the selection by simple random technique of 8 out of the 25 local government areas of Delta State. The second stage involved purposive selection of four communities from each of the selected local government areas where broiler production is known to be carried out on commercial basis. The final stage involved the selection of three broiler producers from each community earlier selected using simple random sampling technique, thus given total sample respondents of 96. The state has a total of 1969 registered broiler farmers, thus the sample size represents about 5% of the registered farms. With three production batch observations on each respondent, total sample observation was 288, which constituted the final sample size of the study.

Data collected relate to number of broilers raised for each batch, quantities of feeds used (kilograms), cost of medications, marketing costs, inputs of labour (man day and monetary equivalents (₦)), capital input (annual cost of fixed inputs, consumable inputs other than feeds and medications and interest on loans and advances where applicable), socio – economic characteristics of respondents (such as age, number of years of broiler production experience, level of formal educational attainment), volume of credit used, marketing channels and other variable characterizing broiler production in the area.

To describe the production technology, a production function incorporating as production inputs broiler stock size (St), feed expenses (Fe), variable and operating costs (Ve) and fixed costs (Fc) and value of matured weight of broilers (Q) as output was fitted to the data set generated. Implicitly, the production function can be stated as:

$$Q = \alpha St^{\beta_1} Fe^{\beta_2} Ve^{\beta_3} Fc^{\beta_4} e^{\mu} \quad (1)$$

where:

Q is the value of matured broiler produced (₦);
α is the intercept of the function;
St is the value of stock of broiler (₦), which is a reflection of the stock size;
Fe is the expenses on feeds (₦);
Ve is the sum of variable and operating expenses(₦), which includes the expenses on labour, drugs, and transportation;
Fc is the sum of expenses on fixed inputs (₦) which includes Fixed Factors representing Capital inputs (use is made of annual amortized cost in the 3 batch production, using simple amortization with the assumption of linear depreciation) and other non- capital inputs, which were used in production, for periods more than one year and
βi are the coefficients to be estimated.

To enable the estimation of the allocative efficiency of the broiler farms, the following physical production relationships were derived from the Cobb – Douglass production function of Equation (1).

$$MP_{x_i} = \frac{\partial Q}{\partial x_i} = \frac{\partial(\alpha St^{\beta_1} Fe^{\beta_2} Ve^{\beta_3} Fc^{\beta_4} e^{\mu})}{\partial x_i} = \frac{\beta_i \alpha St^{\beta_1} Fe^{\beta_2} Ve^{\beta_3} Fc^{\beta_4} e^{\mu}}{x_i} = \frac{\beta_i Q}{x_i} \quad (2)$$

$$AP_{x_i} = \frac{Q}{x_i} = \frac{\alpha St^{\beta_1} Fe^{\beta_2} Ve^{\beta_3} Fc^{\beta_4} e^{\mu}}{x_i} = \frac{\alpha St^{\beta_1} Fe^{\beta_2} Ve^{\beta_3} Fc^{\beta_4} e^{\mu}}{x_i} \quad (3)$$

$$A\ell = \frac{MP_{x_i} * p_q}{r_{x_i}} = \frac{(\beta_i Q/x_i) * p_y}{r_{x_i}} \quad (4)$$

where:

MP_{x_i} is the marginal physical product of ith input that is the first derivative of the production function of Equation (1) with respective to the ith input;

AP_{x_i} is the average physical product of i^{th} input;

AI is a measure of the allocative efficiency of the farms. It is given in Equation 4 as the ratio of the value of the marginal product (MVP) to the marginal factor cost (MFC). The VMP is the product of the marginal product (MP) and the selling price per unit of output, while the MFC is the cost of the i^{th} input per unit;

p_y is the selling price per unit of output and was determined as total revenue divided by the total quantity of output produced;

r_{x_i} is cost per unit of input and was determined as the total cost of i^{th} input divided by the quantity employed of the input

Q and x_i are the mean values of out produced and i^{th} input employed by the farmers respectively.

Results and discussion

Summary statistics for production characteristics and allocative efficiency – related variables of broiler producers are presented in Table 1. Overall, broiler production is carried out on small scale basis following the classification of size made by Omotosho and Ladele (1988), with mean number of birds kept being about 680 and with some farmers raising just about 50 birds at a time. The poor capital bases of the farmers, inadequate storage facilities and seasonal trend in the demand for poultry meat among majority of the population were identified as the major constraints to large scale production by the farmers. Net revenue (profit) per bird ranged from a loss of about ₦15.00 to a surplus of about ₦225.00. On the average, each farmer produced broilers worth about ₦ 507,774.70 with average value of stock, expenses on feed, variable and operating expenses and fixed capital expenses of about ₦84140, ₦169342, ₦102962, ₦63961 respectively. The mean net revenue per farm and per broiler produced was about ₦86706 and ₦127.59 respectively.

The average age, formal level of educational attainment, family size, volume of credit used per farm, were about 40, 8, 7, and ₦96693 respectively. These indicate that farmers were relatively of low educational status, with many of them attaining below secondary education. They were relatively advanced in age in addition to having large family sizes. Most of them indicated engaging in broilers production mainly for income and family protein needs. The volume of credit employed was definitely low in comparison to the financial requirements for broilers production and in recognition of the poor income status of the farmers. This probably brought about the small number of birds kept per farmer.

Regression analysis and estimates of allocative efficiency

Linear, semi – log and double log functional forms of the production function of equation (1) were estimated. All models were significant ($P < 0.05$) with the F – values being 49.63, 29.86 and 19.45 and R^2 of about 0.79, 0.72 and 0.59 for the linear, semi – log and the double log forms respectively and the coefficients had the *a priori* expected signs except for variable and operating expenses. On the basis of the R^2, the linear functional form was adopted as the best fit to the data set used for the study and is therefore reported as shown in Table 2. The estimated regression equation is given as:

$$\hat{Q} = 10894.362 + 0.684St + 2.661Fe - 0.198Ve + 0.173Fc$$
$$(299.021)^{**} \quad (3.39)^{*} \quad (3.51)^{**} \quad (-8.25)^{**} \quad (1.23)$$

where the variables are as defined in equation (1), and the figures in parentheses are t-ratios. The results indicate that about 79% variation in broiler output can be accounted for by variations in the explanatory variables used. The estimates further indicate that while stock size, expenses of feed, and fixed costs of production (not significant; $P>0.05$) were positively related to output and revenue of the farms, variable and operating costs were negatively related to them. The low level of usage of capital by the farmers may have resulted in the inverse relationship it had with output as Abang and Agom (2004) had noted is the case with small holder farmers.

The estimates of the farmers' allocative efficiency of their production resources are presented in Table 3. To enable the estimation of the allocative efficiency of the farmers, the marginal revenue, marginal physical products, marginal value products and marginal factor costs were also determined. The marginal revenue and therefore selling price per broiler was estimated as the average selling price as reported by the farmers. The figure was ₦747.20. The marginal factor cost for each input was determined as the average farm cost of an input per unit output (average total cost of an input over the mean number of broilers produced). As the table shows, the marginal physical products, marginal value products and marginal factor costs were 4.13, ₦3085.94 and ₦123.79 for stock size, 8.28, ₦6186.82 and ₦249.19 for feed expenses, –0.91, – ₦679.95 and ₦148.51 for variable expenses and 1.56, ₦1165.63 and ₦98.12 for fixed costs respectively.

The allocative efficiency which is given as the ratio of the marginal value product and marginal factor cost was 24.929, 24.828, – 4.578 and 11.880 for stock size, feed expenses, variable expenses and fixed costs respectively. These results indicate that stock size and feed expenses had the highest efficiency index of about 25 each while

Table 1. Socio – economic characteristics of broiler producers (n = 288)

Mean value of Variable per farm	Mean	Standard deviation	Minimum	Maximum
No of matured Broiler produced	680	954.08	49	2255
Value of matured broilers (₦)*	507774.70	73549.35	33612.80	1685770.35
Value of stock (₦)	841123.97	44204.52	60359.41	107983.67
Feed expenses (₦)	169342.05	26549.69	102683.03	348734.94
Variable and operating expenses (₦)	110844.66	7337.09	27522.58	215518.83
Fixed capital expenses (₦)	56485.86	11410.15	19435.70	133216.61
Mean net revenue (₦)	86706.34	36778.33	10125.59	152971.21
Mean net revenue per broiler produced (₦)	127.59	54.12	–14.90	225.10
Age (Years)	40.29	6.9	24	61
Formal Ed. (Years)	7.86	4.48	0	18
Family size(No.)	7.12	3.87	2	21
Credit (₦)	96693.09	0.18	0	350000

Source: Authors' survey data, 2004; *USD$1 = ₦135 (Nigerian Naira) by 2004 average exchange rate.

Table 2. Linear production function estimates for broiler production Naira

Variable	Coefficient	Estimate	Standard error	Significance
Constant	α	10894.362	36.411	**
Stock size	β_1	0.684	0.202	*
Feed expenses	β_2	2.661	0.759	**
Variable and operating expenses	β_3	–0.198	0.024	**
Fixed costs	β_4	0.173	0.141	NS
R^2	0.79			
F–Value	49.63			

* Significant at (P < 0.05); ** Significant at (P < 0.01); NS: Not significant at (P > 0.05); Source: Authors' survey data, 2004.

Table 3. Estimation of MP, MVP, MFC and allocative efficiency

Variable	Marginal physical product		Marginal value product (₦)	Marginal factor cost (₦)	Allocative efficiency
	Expression	Estimate			
Stock size	$\beta_1 * Q/St$	4.13	3085.94	123.79	24.929
Feed expenses	$\beta_2 * Q/Fe$	8.28	6186.82	249.19	24.828
Variable expenses	$\beta_3 * Q/Ve$	–0.91	–679.95	148.51	-4.578
Fixed costs	$\beta_4 * Q/Fc$	1.56	1165.63	98.12	11.880

Source: Computed from regression parameters, and field data 2004; US$1 = ₦135 by 2004 average exchange rate.

fixed capital was next with about 12 . The least efficiency index was recorded for variable and operating capital, with a negative value of about – 4.6. These results show that the farmers are efficient in the allocation of their resources except in the case of fixed capital items. However, with the ratio MVP/MFC being greater than unity, the farmers appear to be underutilizing their resources. This is evident from the fact that the scales of their holding are small. These call for the expansion their broiler stock, increasing the quality and quantity of feeds and medications. This could be actualized if production credits are made available to them at affordable conditions.

Conclusion and recommendations

The study had looked at broiler production in Delta State, Nigeria. It was found that the farmers were characteristically small holders as majority of stock were less than 1000 birds at a time. It was also observed that while majority of the farmers were able to make profits, some made as much as about ₦15 loss per broiler produced. The seasonal demand for broiler product, low product prices and high input costs particularly feed and day old chicks were attributable to these low profitability performance of the farms. The results of the regression analysis show that while stock size, feed expenses and

fixed capital inputs were positively related to output, variable expenses were negatively related to it. These were further confirmed by the allocative efficiency indices estimated which were about 24.9, 24.8, – 4.6 and 11.9 for stock size, feed expenses, variable expenses and fixed capital inputs respectively. The implications are that while the farmers are generally and allocatively efficient, they need to increase the quantity of the inputs to enable them to maximize profits.

Arising from these findings, the following recommendations were made:

1. Extension of the present ban on importation of broiler products into the country will bring about higher demand for locally produced broilers with the associated higher prices, thus bringing about higher profit.
2. Also, effectively harnessing the potentials in alternative but cheaper sources of poultry feed ingredients away from the traditional ones will lower the cost of production leading to more profits per broiler sold.
3. To enable the farmer to increase the size of their holdings and employ more of other inputs, more favorable conditions should be created to enable them source for and acquire production credits. These could be in terms of lower interest rate and establishment of agencies to stand as guarantors for loans sort for by farmers.
4. On – the farm training and general education of the farmers should be pursued with more vigor, because, education brings about greater awareness on the part of the farmers and adoption of better production techniques, use of improved inputs and better marketing opportunities for their products, and thus brings about higher output and profits.

References

Abang S. O., Agom D. I. (2004): Resource use efficiency of smallholder farmers: the case of cassava production in Cross Rivers State, Nigeria. Faman Journal 7(1)102– 113

Akanni K. A., Adeokun O. A. (2004): Resource efficiency differential in small-scale food crop production in Obafemi Owode Local Government Area, Ogun State. Faman Journal 7 (1)1–15.

Bishop C. C., Toussaint W. D. (1958): Introduction to agricultural economic analysis, John Wiley and Sons, Inc, New York.

Chukwuji C. O., Inoni O. E., Osuagwu C. N. (2002): Family size, purchasing power and strategies for increasing rural household protein intake in Delta State, Nigeria. In: Aletor V. A. and Onibi G. E. (eds) Proceedings of the 27th Annual Conference of the Nigerian Society of Animal Production. Akure, Nigeria, pp 380–382.

Federal Office of Statistics (FOS) (1995): Poverty alleviation in Nigeria Federal Office of Statistics, Lagos, Nigeria.

Heady E. O. (1952): Economics of agricultural production and resource use. Prentice – Hall, Inc., New York.

Henderson J. M., Quandt R. E. (1980): Microeconomic theory: A mathematical approach. McGraw – Hill Book Company Ltd, Singapore.

Nwajiuba C, Nwoke E. (2000). Inflation and the poultry industry in Nigeria: implications for profitability. In: Oji U.I, Mgbere O.O. (eds) Proceedings of the 5th Annual Conference of the Animal Science Society of Nigeria. Port Harcourt, Nigeria, pp 206–208.

Oh H. S. and Kim J. B. (1980):A partial analysis of technical efficiency and returns to scale in Korean rice production. Journal of Rural Development, 3 (April):1–10.

Ojo S. O. (2003). Productivity and technical efficiency of poultry egg production in Nigeria International Journal of Poultry Science 2 (6)459–464.

Ojo S. O., Ajibefun I. A.(2000). Effects of Training on Labour productivity and Efficiency in Oil Productivity in Ondo State, Nigeria. J. Sustainable Agric. and Environ., 2:270–279.

Ojo S. O, Afolabi J. A. (2000). Economic analysis of replacing the fish-meat component in broiler starter mash with Gliricidia sepium In: Ukachuckwu S. N., S. I. Ibe (eds) Proceedings of the 25th Annual Conference of the Nigerian Society of Animal Production. Umudike, Nigeria, pp 264–268.

Olayide S. O., Heady E. O. (1982). Introduction to agricultural production economics. University press, Ibadan, Nigeria.

Omotosho O. A., Ladele A. A. (1988). Management problems in large scale poultry business in Nigeria. Faman Journal, 3:27–35.

Onyeneweaku C. E., Agu S. E., Obase S.E. (2000): Economics of small – holder Rice farming under different production systems in southeastern Nigeria. Nigerian Journal of Agribusiness and Rural Development, 1 (1)1–11.

Sankhayan P. L. (1988): Introduction to the economics of agricultural production. Prentice – Hall of India Private Ltd, New Delhi.

Yotopoulos P. A., Lau L. J. (1973): A test for relative economic efficiency; some further results. The American Economic Review (63)214–223.

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