International Journal of Poultry Science 5 (12): 1164-1171, 2006
ISSN 1682-8356

Vertical Integration and Technical Efficiency in Poultry (Egg) Industry in Ogun and Oyo States, Nigeria

Olasunkanmi M. Bamiro[1], Dayo O.A. Phillip[2] and S. Momoh[2]
[1]Department of Agricultural Economics, Olabisi Onabanjo University, Yewa Campus, Ayetoro, Nigeria
[2]Department of Agricultural Economics and Farm Mnagement, College of Agricultural Management, Rural Development and Consumer Studies, University of Agriculture, Abeokuta, Nigeria.

Abstract: This study aims at analyzing economics of vertical integration in poultry industry in Ogun and Oyo States. The study examines the production systems and analyses costs and returns to non-integrated and vertically integrated poultry farms. Primary data were generated using structured questionnaires in a field survey of 100 non-integrated poultry farms, 70 partially integrated poultry farms and 40 fully poultry integrated farms. The analytical techniques employed include descriptive statistics and stochastic production frontier function. Predicted technical efficiencies range between 65% and 97%. The results show that about 49% of the sampled poultry farms have technical efficiencies greater than 90% operating close to the technology frontier. The higher the level of vertical integration the greater the technical efficiency.

Key words: Poultry industry, Ogun and Oyo States, production systems

Introduction

Poultry (egg) production is one of the major sub-sectors in Nigerian agricultural industry. Poultry egg, apart from supplying protein is also a good source of lipids and vitamins of high zoological 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 bookbinding. Poultry production, in addition contributes to the nation's gross domestic product (GDP), it provides gainful employment and income to sizeable proportion of the population. In spite of this nutritional importance of egg, egg production is grossly inadequate because demand for egg in the country is much greater than supply. This scenario implies that egg production has to be increased to a sustainable level. To achieve sustainability in egg production in Nigeria, the present level of productivity and technical efficiency in the poultry industry should be examined for the purpose of improvement.

The crux of the problem of growth in agriculture in developing countries is how to increase output per unit input (Singh, 1975). One way of approaching the problem of increasing production is to examine how efficient the farmers are using their resources, if resources use is inefficient, production can be increased by making adjustment in the use of factors of production in optimal direction. In case it is efficient, the only way for increasing production would be the adoption of modern inputs and improved technology of production Singh (*Op. cit*).

In neoclassical economics, efficiency refers to making the optimum use of a given set of resources for a given set of prices and output markets. Growth can occur either by moving from a less efficient to a more efficient use of resources or by increasing productivity of resources so that more output can be obtained from a given level of resources. Efficiency is a measure of producer performance, which is very often useful for policy purposes. There are numerous types of efficiency namely: Economic, technical, allocative, marketing and managerial efficiency. These are defined to measure the use of the resources in a particular manner and the measure selected to analyze efficiency depends on what use the result are to be put. According to Kelly (1977), considerable confusions have arisen between economists because the efficiency definitions adopted for individual efficiency analyses rather than being uniform are generally based upon the objectives of the research. Economic efficiency is a term applied to the concept of the overall efficiency with allocative and technical efficiency forming its component parts.

Technical efficiency on the other hand, refers to achievement of maximum potential output from a given quantity of input taken into account the physical production relationship. It is possible for resources to be allocated optimally, yet the actual realized output may be below potentially expected output (Kelly, 1977). Thus, producers may allocate the resources correctly but obtain a sub-optimal output relative to some benchmark. He concludes that this may occur through the use of some inferior techniques or through technical inefficiency and may occur even where a decision maker is free to select and implement his own course of action. The measurement of inputs does present serious problems for measuring technical efficiency and in our traditional agricultural setting; we are limited by data availability. There are two basic methods of measuring technical efficiency: the classical approach and the frontier approach.

The classical approach: This method is based on ratio of output to particular input and is termed partial productivity measure because the output is compared with only one input at a time. The most commonly used ratios are output per man-hour, i.e. the labour productivity and output per unit of capital, i.e. the capital productivity, as well as crop yield from a unit of farm land i.e. land productivity.

The frontier approach: The shortcomings of the classical approach propelled economists to develop advanced econometrics, statistical and linear programming methods aiming at analyzing technical efficiency and related issues. Consequently, the frontier approach emerged. All these methods have in common the concept of a frontier. Efficient farms are those operating on the production frontier while inefficient farms are those operating below the production frontier. A stochastic frontier production function comprises a production function of the usual regression type with composite disturbance term equal to the sum of two error components (Aigner *et al*., 1977; Ajibefun and Daramola*,* 2000). One error component represents the effect of statistical noise (e.g. weather, topography, disruption of supplies, measurement error,). The other error component captures systematic influences that are unexplained by the production function and are attributed to the effect of technical inefficiency.
Consider a farm using *n* inputs (x_1, x_2, . . . x_n) to produce a single ouput *y*. efficient transformation of inputs into output is characterized by the production function f(*x*), which shows the maximum output obtainable from various input vectors,
The stochastic frontier production assumes the presence of technical inefficiency of production and may be expressed as:

$$Q_i = f(x_i;b)\ \exp(V_i - U_i) \qquad I = 1, 2, \ldots N$$

Where Q_i is the output of the I-th farm; x_i is a vector of inputs; b is a vector of parameters to be estimated; f(x) is a suitable functional form, such as the Cobb-Douglas or translog, V is a symmetric random error that is assumed to account for measurement error and other factors not under the control of the farmer, U_i accounts for technical inefficiency in production 'Exp' stands for exponential function.
Technical efficiency of an individual farm is defined in terms of the ratio of the observed output to the corresponding frontier output, given the available technology.

$$\text{Technical efficiency (TE)} = Y_i / Y_i^*$$
$$= f(xi;b)\ \exp(V_i - U_i) / f(x_i;b)\ \exp(V_i)$$
$$= \exp(-Ui)$$

Vertical integration can be defined as the combination of two or more stages of a production marketing chain under single ownership. Vertical integration may be backward or forward. Backward integration occurs when a firm decides to make rather than buy an input from an independent supplier. Forward integration occurs when a firm decides to use rather than sell one of its products to independent customers. Conversely, vertical disintegration involves a decision to buy rather than make an input or to sell rather than use an input.
The practice of vertical integration is designed to increase efficiency, lower expenses and produce additional values (Araji, 1976; Kelly, 1977). It was predicted that "Integration will increase in future due to increased efficiency, lower costs and higher profits". Araji (1976) also emphasized differences in production efficiency due to the adoption of technological innovations and organizations strategies like vertical integration by a critical causal force behind increasing system of farms. He outlines how large farms that have increased their efficiency tend to acquire land and other aspects from farmers who can no longer compete. Large operators then utilize this land for efficient production and increase the supply of poultry or livestock. In this way, large farms that have higher productivity can accept lower prices that could otherwise put smaller less efficient farms out of business.
Vertical integration is an alternate structure for organizing the firm's ability to absorb labour efficiently in a vertical production unit such that resulting firm is worth more after vertical integration than both units were worth before vertical integration. The net efficiency of vertical integration depends on the potential cost savings of eliminating the external market compared to the cost of internalizing the production unit. The net cost of internalizing the production unit is dependent on the potential reduction in production costs and the costs associated with internally managing the new production unit.

Materials and Methods

Study area and data collection: This study was carried out in Ogun and Oyo states in the southwest geo-political region of Nigeria. Data collection was by personal administration of a questionnaire designed to obtain information on poultry farmers or the decision maker's characteristics, flock size, production characteristics and economic aspect of production. Two sets of primary data were collected, one set from the vertically integrated poultry farms and the second set from poultry farmers that operate non-integrated farms. Data was collected from 114 poultry (egg) farms, which consists 79 non-integrated poultry farms, and 35 vertically integrated poultry farms.

Model specification: In agriculture, a wide range of functional specifications-linear, Cobb-Douglas, Translog, etc. are commonly adopted. This study adopts the Cobb-Douglas specification for its wide acceptance/use, and for its theoretical fitness, manageability and suitability when dealing with small farms (Singh, 1975; Tshibaka, 1994; Mputela and Kraft, 1994; Aihonsu, 1999; Ajibefun and Daramola, 2000).

The general form of a Cobb-Douglas production function is given as:

$$Qi = AX_{1i}^{\$1}\ X_{2i}^{\$2} \ldots\ldots\ldots\ldots X_{4i}^{\$4} \qquad (1)$$

When linearised, the estimable form of Cobb Douglas production function becomes:

$$\ln Q_i = \$_o + \$_1 \ln X_{1i} + \$_2 \ln X_{2i} \ldots\ldots\ldots + \$_4 \ln X_{4i} + e_i \qquad (2)$$

Where:

Q = Output of eggs in trays
X_1 = Flock size in Numbers
X_2 = Quantity of feed in bags of 25 kilograms
X_3 = Labour in mandays
X_4 = Veterinary cost in Naira
e = random error term

Test for structural differences in production functions: To enable the study gain insight into the appropriate way of reflecting vertical integration in the general Cobb-Douglas production function specified in equation 2, a Chow test of structural differences in the production function of vertically integrated and non-integrated poultry farms was conducted.

The result of the tests for equality of coefficients shows that significant differences exist in the production functions of vertically integrated and non-integrated poultry farms. These differences are reflected in terms of significant differences in the slope parameters (marginal productivity or production elasticities of the various factors (feed, labour, veterinary costs etc) and not much in terms of any significant differences in intercept (total factor productivity).

A candidate estimable form of the Cobb-Douglas production, in this case, becomes:

$$\ln Q_i = \$_o + 8_o D_i + \$_1 \ln X_{1i} + 8_1 D_i \ln X_{1i} + \text{-----} + \$_4 \ln X_{4i} + 8_4 D_i \ln X_{4i+} e_i \qquad (3)$$

Where:

D_i is a dummy variable that takes on value of 1 if the i[th] farm is vertically integrated and 0 if otherwise;

8_k (k= 0, 1, …,4) is the change in the parameter of the kth variable for vertically integrated farm; all other variables and parameters are as earlier defined.

Stochastic production frontier and technical efficiency assessment: One of the widely used methods for assessing technical efficiency difference across production units is the Stochastic Production Frontier approach. The stochastic frontier production function proposed by Battese and Coelli (1995) builds hypothesized efficiency determinants into the inefficiency error component so that one can identify focal points for action to bring efficiency to higher levels.

A stochastic production frontier, following Battese and Coelli (1995), may be defined as:

$$Q = f(X_i, \$)\ \exp(V-U) \qquad (4)$$

Where Q_i is the output of the I-th farm; x_i is a vector of inputs; b is a vector of parameters to be estimated; f(x) is a suitable functional form, such as the Cobb-Douglas or Translog, v is a symmetric random error that is assumed to account for measurement error and other factors not under the control of the farmer, u_i is a non-negative error component that accounts for technical inefficiency in production; while 'exp' stands for exponential function.

In this application, the Cobb Douglas stochastic production frontiers of poultry (egg) production is specified as follows:

$$\ln Q_i = \$_o + 8_o D_i + \$_1 \ln X_{1i} + 8_1 D_i \ln X_{1i} + \text{----------------------} + \$_4 \ln X_{4i} + 8_4 D_i \ln X_{4i} e_i + v_i - u_i \qquad (5)$$

The v_i's are the random variables associated with disturbances in production and the u_is are the non negative random variables associated with technical inefficiency of the ith farmer and are obtained by truncation at (zero) of the normal distribution mean u_i and variance $*^2 u_i$ such that:

$$\mu_i = *_o + \overset{7}{\underset{Z=I}{3}} *_i Z_i \qquad (6)$$

$*_i$ is a vector of the parameters of the inefficiency model to be estimated, and the z_is, z= 1, 2, …….., 7 are the farm and farmer-specific socio economic variables as well as the forms of integration and level of integration hypothesized to influence efficiency of resource use in poultry production in Ogun States and Oyo States. The explicit form of the inefficiency model is presented in the following equation

$$\mu_i = *_o + *_1 \ln Age + *_2 \ln Edu + *_3 \ln Exp + *_4 \ln Fls + *_5 D_1 + *_6 D_2 + *_7 (VA/S) \qquad (7)$$

Where, age represents the age of farmers or decision makers measured in years, Edu represents the level of education of the decision maker of the poultry enterprise measured as years of formal education, Exp represents the experience of the decision maker of the poultry enterprise measured in years, Fls represents the flock size of the poultry farms measured in numbers, D_1 is a dummy variable that takes on the value of 1 if the farm is privately producing feed used in the farm and 0 if otherwise, D_2 is a dummy variable that takes on the value of 1 if the poultry farm own a feed mill and 0 if otherwise and VA/S represents Value-Added-Sales ratio, a proxy for the extent of vertical integration

The parameters of the model and associated technical inefficiency terms for each farm were estimated by the Stochastic Production Frontier procedure in the computer program FRONTIER 4.1 (Coelli, 1994). The estimation procedure employed the Maximum Likelihood techniques, which is asymptotically efficient, consistent and asymptotically normally distributed.

The technical efficiency index for each poultry farm was estimated from the conditional distribution of the residual terms as follows:

A-piori, it is expected that coefficients associated with feed, flock size, labour, veterinary services cost and other inputs cost should have positive signs, since increase in quantity of feed consumed by the birds, the flock size, labour force, veterinary cost and other inputs cost are expected to cause increases in the output (trays of eggs) of poultry egg farms. In the same vein the coefficient of dummy variable D that stands proxy for vertical integration is also expected to be positive because the more a poultry farm is vertically integrated the higher the expected output.

With respect to the determinants of technical efficiency, the coefficients associated with Edu, Exp, Fls, VA/S and $D_1$and D_2 should have positive signs because improvement in farmers' education, accumulated experiences, increase in flock size, increase in the level of integration, utilization of privately produced feed and production of feed from owned feed mill are expected to increase technical efficiency. However, age of poultry farmer is expected to be associated with negative signs since productivity declines with age. One of the widely used methods for assessing technical efficiency difference across production units is the Stochastic Production Frontier approach. The stochastic frontier production function proposed by Battese and Coelli (1995) builds hypothesized efficiency determinants into the inefficiency error component so that one can identify focal points for action to bring efficiency to higher levels. A stochastic production frontier, following Battese and Coelli (1995), may be defined as:

$$Q = f\,(X_i,\$)\ \exp(u+v) \qquad (8)$$

Where Q_i is the output of the I-th farm; x_i is a vector of inputs; b is a vector of parameters to be estimated; f(x) is a suitable functional form, such as the Cobb-Douglas or Translog, v is a symmetric random error that is assumed to account for measurement error and other factors not under the control of the farmer, u_i is a non-negative error component that accounts for technical inefficiency in production; while 'exp' stands for exponential function.

In this application, the Cobb Douglas stochastic production frontiers of poultry (egg) production is specified as follows:

$$\ln Q_i = \$_o + 8_o D_i + \$_1 \ln X_{1i} + 8_1 D_i \ln X_{1i} + \text{----------------------} + \$_4\ \ln X_{4i} + 8_4 D_i\ \ln X_{4i} e_i + v_i - u_i \qquad (9)$$

Where all the variables and parameters are as earlier defined.

The parameters of the model and associated technical inefficiency terms for each farm were jointly estimated by the Stochastic Production Frontier procedure in econometrics software 4.1 Program (Coelli, 1994). The estimation procedure employs the maximum likelihood techniques, which is asymptotically efficient, consistent and asymptotically normally distributed.

The technical efficiency index for each poultry farm was estimated from the conditional distribution of the residual terms as follows:

$$TE = \exp\,(-u_i) \qquad (10)$$

In order to determine the factors that influence technical efficiency in poultry farms, the technical efficiency index, following Ajibefun and Daramola (2000), was regressed against some factors that are likely to influence technical efficiency. The relationship is presented in equation (11)

$$TE = b_o + b_1 \ln Age + b_2 \ln Edu + b_3 \ln Exp + b_4 \ln Fls + b_5 D_1 + B_6 D_2 + B_7 (VA/S) \qquad (11)$$

Where, Age represents the age of farmers or decision makers; Edu represents the level of education of the decision maker of the poultry enterprise; Exp represents the experience of the decision maker of the poultry enterprise; Fls represents the flock size of the poultry farms; D_1 is a dummy variable that takes on the value of 1 if the farm is privately producing feed used in the farm and 0 if otherwise; D_2 is a dummy variable that takes on the value of 1 if the poultry farm own a feed mill and 0 if otherwise; VA/S represents Value-Added-Sales ratio, a proxy for the extent of vertical integration

A-piori, it is expected that coefficients associated with feed, flock size, labour veterinary services cost and costs of other inputs cost should have positive signs. In the same vein the coefficient of dummy variable D that stands proxy for vertical integration is also expected to be positive because the more a poultry farm is vertically integrated the higher the expected output. With respect to the determinants of technical efficiency, the coefficients associated with Edu, Exp, Fls, VA/S and $D_1$and D_2 should have positive signs

Results and Discussion

Socio-economic characteristics of sampled farms: The socio-economic characteristics of poultry farmers and production systems of poultry farms considered in this study include the age, sex, educational satus and

Table 1: Age of sampled poultry farmers

Age of sampled Poultry farmers	Oyo State		Ogun State		Pooled (Both States)	
	No	%	No	%	No	%
Below 40	42	36.5	36	37.5	78	37
40-<50	32	29.6	26	27.1	60	28.4
50-<60	18	15.7	24	25	42	19.9
60 & above	21	18.3	10	10.4	31	14.7
All	115	100	96	100	211	100

Source: Computed from field survey data (2004)

Table 2: Distribution of Respondents by Sex

Sex of Sampled Poultry Farmers	Oyo State		Ogun State		Pooled (Both states)	
	No	%	No	%	No	%
Male	94	81.7	86	89.6	180	85
Female	21	18.3	10	10.4	31	14
All	115	100	96	100	211	100

Source: Computed from field survey data (2004).

Table 3: Main Occupations of Sampled Poultry Farmers in Ogun and Oyo States

Main Occupation	Oyo State		Ogun State		Pooled (Both States)	
	No	%	No	%	No	%
Farming	44	38.3	44	46.8	88	42.1
Civil service	12	10.4	16	17	28	13.4
Retirees	2	1.7	22	21.3	24	10.5
Others	57	49.6	14	14.9	71	34
All	115	100	96	100	211	100

Source: Computed from field survey data (2004).

occupation of the poultry farmers or that of the farm manager as well as the flock size and the extent of integration. The results are presented in Tables 1-7.

Poultry farms are relatively young men and women. About 37 per cent of poultry farmers in both States are below 40 years of age, the single largest age class (group) in both states. Poultry business in both states is gender biased. Occupational distribution of the poultry farmers shows that 38.3 per cent of poultry farmers in Oyo State and 46.8 per cent in Ogun State have their main occupation as farming. About 31.3 per cent of poultry farmers in Oyo State have 6-10 years production experience while the bulk of poultry farmers (37.5 percent) in Ogun State have 1-5 year's production experience. About 59% of the poultry farmers have tertiary education.

Majority of the farmers in Oyo state have a flock size that ranges between 1000 -<3000 while their counterparts in Ogun state have flock size that is less than 1000. These represent 34.8% and 47.9% of the sampled poultry farmers in Oyo state and Ogun state respectively.

Farms are classified into three categories, namely, non-integrated, partially integrated and fully integrated poultry farms. Non-integrated poultry farms are commercial feed users, partially integrated farms use privately compounded feeds, but mill their feeds at commercial feed milling centres. Fully integrated farms use privately compounded feeds that are milled in their own feed mill. In Oyo State, about 46 per cent of the farms are partially integrated while poultry industry in Ogun State is dominated by non-integrated farms. Out of 211 farms sampled farms, 65 per cent and 33 per cent of poultry farms in Ogun State and Oyo State respectively make use of commercial feed. This accounts for 47.4 per cent of poultry farms in both states. About 35 per cent and 67 per cent of poultry farms in Ogun State and Oyo State respectively privately produced their own feeds. This accounts for about 53 per cent of sampled poultry farms in both states.

Technical efficiency of the poultry farms: The appropriate production function, which modelled the effect of vertical integration on the slope parameters, equation 9, was estimated by Ordinary Least Square (OLS) and Maximum Likelihood Estimates and the results are shown in Table 3.

The coefficients of flock size, feed and the dummy variables in flock size, feed and labour are statistically significant at 1 percent level while labour is statistically significant at 5 percent level in the OLS method. In Maximum Likelihood Estimates (MLE), the coefficients of the flock size and feed are significant at 1 percent level while the coefficients of all other variables are not significant. The variance ratio defined as
$(= *^{2}_{U}\ '\ *^{2}_{U} + *^{2}_{V}$ is estimated to be as high as 99 percent, suggesting that systematic influences that are unexplained by the production function are the dominant source of random errors. The generalized likelihood ratio test reported in Table 3 is highly significant $[P^2(7) = 120]$ suggesting the presence of one-sided error component. This means that the effect of technical inefficiency is significant and a classical regression model of production function is an inadequate representation of the data.

The coefficients of flock size and feed have positive signs, indicating that an increase in the flock size and bags of feed will increase the output (trays of eggs) in both vertically integrated and non-integrated poultry farms. To be specific, a percentage increase in flock size and feed will increase the output (trays of eggs) by about 0.7 percent and 0.3 percent respectively in non-integrated poultry farms while the same percentage increase in flock size and feed will respectively increase the output of poultry farms by 1.2 percent and reduce the output of eggs by 0.21 percent in vertically integrated poultry farms. The sign of the coefficient of feed is contrary to apriori expectation, however, this result might be due to excessive usage of feed because the vertically integrated poultry farms mill their feeds unlike the non-integrated poultry farms that utilize commercial feeds and are therefore conscious of the quantity that must be

Table 4: Distribution of Poultry Farmers by Experience in Poultry Production

Number of years of poultry farming	Oyo State		Ogun State		Pooled (Both states)	
	No	%	No	%	No	%
1-5	32	27.8	36	37.5	68	32.2
6-10	36	31.3	20	20.8	58	26.5
11-15	24	20.9	16	16.7	40	19
16-20	12	10.4	16	16.7	28	13.3
20 & above	11	9.6	8	8.3	19	9
All	115	100	96	100	211	100

Source: Computed from field survey data (2004).

Table 5: Distribution of Sampled Poultry Farms by Flock Size

Flock Size	Oyo State		Ogun State		Pooled (Both state)	
	No	%	No	%	No	%
Below 1000	34	29.6	46	47.9	80	37.9
1000<3000	40	34.8	34	35.4	74	35.1
3000<5000	14	12.2	12	12.5	26	12.3
5000 or more	27	23.5	4	4.2	31	14.7
All	115	100	96	100	211	100

Source: Computed from field survey data (2004)

Table 6: Distribution of farms by extent of vertical Integration adopted

Extent of integration	Oyo State		Ogun State		Pooled (Both state)	
	No	%	No	%	No	%
Non-integrated	38	33	62	64.6	100	47.4
Partially integrated	53	46.1	18	18.8	71	33.6
Fully integrated	24	20.9	16	16.7	40	19
All	115	100	96	100	211	100

Source: Computed from field survey data (2004).

used each day. With respect to labour input, the coefficient is negative and significant at 5 percent level in both non-integrated and vertically integrated poultry farms. This implies that an increase in labour utilization in both production systems will reduce output. A 1 percent increase in labour will reduce output of poultry (egg) farms by about 0.05 percent and about 0.04 percent in non-integrated and vertically integrated poultry farms respectively. Reduction in output as labour utilization increases in vertically integrated poultry farms might not be unconnected to the fact that labour input is over utilized since the same set of workers are used as poultry attendants and workers in the feed mill and other farm activities which without doubt reduced the labour efficiency. The coefficient of the veterinary cost is negative and not significant even at 10 percent probability level.

In conclusion therefore, vertical integration with respect to flock size increases the output of poultry (eggs) farms while it reduces the trays of eggs produced with respect to feed and labour.

Technical efficiency estimates of the poultry farm: The frequency distribution of the Technical efficiency of the estimate obtained is presented in Table 2. Predicted technical efficiencies range between 65% and 97%. The results show that about 49% of the sampled poultry farms have technical efficiencies greater than 90% operating close to the technology frontier. About 36% of the sampled poultry farms have technical efficiencies that is equal to 80% but less than 90%. About 15% of the sampled poultry farms have technical efficiencies that is below 80%. The mean technical efficiency of the entire sample was estimated at 88% indicating substantial efficiencies in poultry production. This signifies that there exists a 12% potential for poultry farmers to increase their production vis-a-vis their income at the existing level of resources and technology. This suggests that by operating at full technical efficiency level poultry producers can increase their production by an average of 12% with the available farm resources and technology.

Determinants of technical efficiency: The study endeavours to find out the determinants of technical efficiency in poultry farms in the study area. The determinants of the technical efficiency of the poultry farms are presented in Table 4. The Table reveals that age of the decision maker and flock size are significant at 1% level. The value added sales ratio, which is used as a measure of the extent of integration, following Buzzel (1985), also have a significant effect on the technical efficiency of the poultry farms in Ogun and Oyo States. The feedtype, which stands as a proxy to the use of private feed, which is a measure of a form of integration is significant at 5% level. The adjusted R^2 reveals that all the independent variables in the model account for about 34% of the variation in the technical efficiency with the joint effect of the explanatory variables being significant at 1% level as revealed by the F- ratio value. The age of the farmer has a negative significant influence on the technical efficiency of the farms. This implies that the older the farmer, the less efficient he is. This could be attributed to the fact that some of the old farmers are retirees, who had used their useful life as employees; hence, they do not possess the vigour requirement of poultry farming. This is consonance with the findings of Aihonsu, 1999, that productivity and efficiency of farmers decreases with age, which he states, is in line with the law of diminishing productivity. The second major factor, which has significant positive influence on the technical efficiency of poultry farms in the study area, is the extent of vertical integration proxy by value added-sales ratio. The positive effect of the extent of vertical integration implies that the greater the level of integration, the higher the level of technical efficiency in the poultry (egg) farms. The coefficient of the use of private feed is positive, indicating that poultry farms that

Table 7a: Feed Type Used by Sampled Poultry Farmers in Ogun And Oyo States

Feed type	Oyo State		Ogun State		Pooled (Both state)	
	No	%	No	%	No	%
Commercial feed	38	33	62	64.60	100	47.4
Privately produced feed	77	67	34	35.40	111	52.6
All	115	100	96	100.00	211	100

Source: Computed from field survey data (2004).

Table 7b: Distributions of Poultry Farmers by Educational Status

Highest education	Oyo State		Ogun State		Pooled (Both states)	
	No	%	No	%	No	%
No formal education	8	7.00	0	0.00	8	3.80
Primary	4	3.50	0	0.00	4	1.90
Secondary	20	17.40	22	22.90	42	19.90
Diploma/NCE	25	21.70	8	8.30	33	15.60
Degree	58	50.40	66	68.80	124	58.80
All	115	100.00	96	100.00	211	100.00

Source: Computed from field survey data (2004).

Table 8: Estimates of Stochastic Production Frontier by Ordinary Least Square (OLS) and Maximum Likelihood Estimators (MLE) and Inefficiency Function

Explanatory Variables	Ordinary Least Square (OLS) Estimates	Maximum Likelihood Estimates (MLE)
Production Function		
Constant	2.222* (19.911)	0.225* (12.61)
Ln Flock Size	0.701* (5.73)	0.750* (11.72)
Ln Feed	0.320* (2.63)	0.242 (4.03)
Ln Labour	-0.52** (-2.05)	-0.012 (0.066)
Ln Vet Cost	-0.0117 (-0.939)	-0.059 (-0.303)
Dln flock size	0.515* (2.85)	-0.026 (-0.075)
Dln Feed	-0.528*(-3.06)	0.0019 (0.0057)
Dln Labour	0.090 (2.82)	0.344 (0.23)
Inefficiency Function		
$*_0$ constant		0.155* (3.03)
$*_1$ (ln Age)		-0.322* (-2.23)
$*_2$ (ln Education)		-0.144 (-2.23)
$*_3$ (ln Experience)		0.029 (0.87)
$*_4$ (ln Flock size)		0.0632* (2.74)
$*_5$ (D_1)		-0.0186* (-6.73)
$*_6$ (D_2)		0.202* (3.23)
$*_7$ (ln Value added-Sales ratio		-0.0317 (-0.395)
Diagnosis Statistics		
Sigma – square ($*^2= *u^2+*v^2$)	0.0139	0.0305* (5.162)
Gamma (($=*^2U / *^2U + *^2V$)		0.99
Log of likelihood function	107.826	156.00
LR test		109.47

Computed from field survey (2004), Figures in parenthesis are t values. *Significant at 1% level. ** Significant at 5% level

Table 9: Frequency Distribution of Technical Efficiency Estimates for Sampled Poultry Farmers in Ogun and Oyo States

Level (%)	Number of Poultry Farms	% of poultry farms	Cumulative % of Poultry Farms
Less than 70	2	1.4	1.4
70 - 79	20	13.9	15.3
80 - 90	52	36.1	51.4
Above 90	70	48.6	100

Source: Computed from field survey (2004)

Mean = 88. Minimum = 65. Maximum = 97

privately produced their feeds are technically efficient because technical efficiency index increases with utilization of privately produced feed. However, another form of integration, which is the production of feed from installed feed mills that are owned by the poultry farms, does not significantly influence the technical efficiency. This might not be unconnected with the underutilization of the installed capacity of the feed mill. In the same vein, the experience of the farmers or the decision makers does not significantly influence the technical efficiency in poultry farms.

The result of the step-wise regression shows the relative importance of the explanatory variables. The value added-sales ratio is the most important of all the variables because it was the first variable that entered into the system when the regression analysis was carried out in a step-wise manner. This confirms the importance of vertical integration as a major determinant of technical efficiency in poultry production. The relative importance of other explanatory variables is in this order, flock size, age, and feedtype. The result in Table 3 reveals that the higher the value added- Sales ratio, which implies high level of vertical integration, the greater the technical efficiency.

Conclusion: The regression analysis reveals that feed, labour and flock size have positive significant effect on the output of poultry farms in vertically integrated poultry farms and non-integrated poultry farms. This indicates that the output of poultry farms increases with the increase in the number of bags of feed consumed, number of workers and the flock size.

The efficiency analysis reveals that vertical integration increases efficiency in poultry farms. However, the efficiency depends on the extent of integration. Vertical integration therefore, if practiced fully, it will enhance the technical efficiency in the poultry industry. The determinants of technical efficiency in the poultry industry are age of the poultry farmer or the decision maker, educational status, feedtype, and vertical integration.

References

Aigner, D.C., A. Lovell and P. Schmidt, 1977. Formulation and Estimation of Stochastic Frontier Production Function Models. J. Economet., 6: 21-37.

Aihonsu, J.O.Y., 1999. Optimal Laying Period for Profitable and Sustainable egg production. Ife J. Agri., 20: 67-80.

Ajibefun, I.A. and A.G. Daramola, 2000. Measurement and Sources of Technical Inefficiency in Poultry Egg Production in Ondo State, Nigeria. J. Rural Eco.,10: 85-93.

Araji, A.A., 1976. The Effect of Vertical Integration on the Production Efficiency of Beef Cattle Operations. Am. J. Agri. Eco., 50: 101-104.

Battese, G.E. and T. Coelli, 1995. A Model of Technical Inefficiency Effect in a Stochastic Frontier Production for Panel Data. Empirical Eco., 20: 325-332.

Coelli, T.J., 1994. A Guide to FRONTIER Version 4.1: A computer Program for Stochastic Frontier Production and Cost Function Estimation. Mimeo, Department of Econometrics, University of New England, Armidale, Australia.

Kelly, P.D., 1977. A frontier Production Function Approach of Measuring Technical Efficiency in the New South Wales Egg Industry. Quarterly Review of Agri. Eco., 30: July 1977.

Mputela and Kraft, 1994. Women Farmer's Role in Managing Cassava Production in Bandundu, Zaire. J. Farm. Sys. Res. Ext., 4: 2-12.

Singh, J.P., 1975. Resource use Efficiency and Returns to scale in a Backward Agriculture. Ind. J. Agri. Eco., 30: 33-46.

Tshibaka, B.T., 1994. Prospect of Increasing Agricultural Labour Productivity under the Current Resource Biased Technology In: Division and Allocation of Labour in Rural Household Economy and the Implication for the Productivity of Agricultural Labour. IFFPRI. Washington D. C.