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ESTIMATION OF TECHNICAL EFFICIENCY OF ENVIRONMENTALLY CONTROLLED SHED BROILER PRODUCERS IN PUNJAB, PAKISTAN

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ABSTRACT: This study estimated the level of technical efficiency of environmentally controlled (EC) shed broiler farmers in Punjab, Pakistan. Multistage random sampling technique was used for selection of 60 EC broiler producers. Data was collected from sampled producers during the months of January-February, 2014. The analysis of data was done applying stochastic frontier Cobb-Douglas production function. Maximum likelihood estimation technique was utilized for estimation. Results showed that the mean technical efficiency of sampled farmers was 0.999 ranging from 0.934 to 1.00. This implies that, on average, EC shed broiler producers were operating at full technical efficiency level. Based upon these findings it is suggested that government should motivate open shed broiler producers to switch over to EC shed broiler production and also motivate investors to invest in EC shed broiler farming. This will result in higher production of poultry meat and the problem of insufficiency of protein and other nutrients can be easily eradicated. This will also provide employment opportunities to the labor force of the country.

KEYWORDS: Environmentally Controlled Shed Broiler Farms, Technical Efficiency, Cobb-Douglas Production Function, Punjab, Pakistan.

1 INTRODUCTION

Poultry is a sub-sector in the livestock industry constituting a major component in agriculture of developing countries. Poultry sector is one of the sparkling segments of Agriculture Industry in Pakistan.

Although there are a several types of poultry raised and consumed chicken is the most important. There are three main types of chicken in Pakistan; broiler, layer, and breeder.This sector generates income and employment for about 1.5 million people. Its contribution in agriculture growth is 4.81% and in livestock growth 9.84%. Poultry meat contributes 19% of the total meat production in the country. The daily availability of protein quantity per capita in Pakistan amounts to 13.6 gram, deriving from animal source including beef, mutton, poultry and fish. Poultry sector has shown a vigorous growth rate of 7 to 8 percent per annum, which is mirror of its intrinsic potential. Value addition of poultry has increased from Rs. 113465 million in 2011-12 to Rs. 121726 million in 2012-13; illustrate a boost of 7.3 percent than last year [1]. For poultry industrial to express their full potential, some basic rations must be provided; these are like good management, environment, balanced provisions of resources and adequate housing. According to the World Health Organization standards the required daily dietary protein allowance from animal source is 27 grams whereas we have much less than this. Animal protein is crucial for normal physical and mental development of the human being. An adequate consumption of meat is the indication of economic and social welfare. Demand for animal protein is usually elevated in cities than in villages because of the difference in level of education its availability and in income [2]. In Pakistan the consumption of white meat has gradually increased in recent years due to growing health awareness in masses. The cheapest source of animal protein available in Pakistan is broiler meat. Broiler birds are reared in lesser time than any other source of animal protein. The increasing demand of the white meat in the market and short Production has made it a profitable business enterprise. The production of commercial poultry for the last three years is given in Table 1.

Table 1 Production of commercial poultry in Pakistan

Commercial Poultry	Units	2010	2011	2012
Broilers	Million No	542.74	34.82	37.25
Layers	Million No	32.54	44.10	47.00
Breeders	Million No	8.81	597.02	652.72
Day old chicks	Million No	566.89	9.25	9.71
Eggs	Million No	8690.00	623.58	685.94
Chicken meat (Broilers + Layers)	000 tones	662.18	7281.00	9912.00

Source: GoP, 2013.

Poultry Farming in Controlled Environment has brought a great change in poultry industry of Pakistan and is rapidly becoming popular among broiler producers due to its many significant advantages. According to Industry sources there is capacity of 5,000 environmental control houses in Pakistan and currently 2,500 houses are working out of which 75% (1,875) are in Punjab and remaining 25% (625) are in other provinces [3]. In controlled environment farm, inputs including farm equipments like drinkers, feed trays, brooders, and feeders and other items like feed, vaccines & medicines, rice-husk or saw-dust, water, electricity and evaporative cooling system etc are required and they make environment quite conducive for poultry production by getting continuous production. The society expects the livestock sector, poultry included, to continue to meet rising world demand for animal products cheaply, quickly and safely [4]

The concept of efficiency in the use of farm resources, which goes back to the pioneering work of Farell [5] is concerned with the relative performance of the processes used in transforming given inputs into outputs. There are basically three major types of efficiency, viz, technical, allocative and economic efficiency. Technical efficiency in production is the physical ratio of product output to the factor input, the greater the ratio, the greater the magnitude of technical efficiency. It refers to the ability of firms to employ the best practice in the production process so that not more than the necessary amount of a given set of inputs is used in producing the “best” level of output [6] and it is expressed as the ratio of farmer’s actual output to the technically maximum possible/frontier output, at given level of resources; Technical Efficieny (TE) = Q_i / Q_i^*, Where Qi is the observed output and Qi^* is the frontier output. Allocative efficiency is concerned with choosing optimal sets of inputs. Allocative efficiency refers to the choice of optimum combination of inputs consistent with the relative factor prices. It is expressed as the ratio of the technically maximum output, at the farmer’s level of resources to the output obtainable at the optimum level of resources. On the other hand, Economic efficiency is the ability of a farm to maximize profit or it is obtained in the presence of both the technical and allocative efficiency.

The crucial role of efficiency in increasing agricultural output has been widely recognized by researchers and policy makers alike. Efficiency is an important factor of productivity growth especially in developing agriculture where resources are meager [7]. Technical efficiency is a a mean of fostering production in agriculture [8]. Analysis of technical efficiency in agriculture has received particular attention in developing countries because of the importance of productivity growth in agriculture for overall economic development. For example in Nigeria considerable effort has been devoted to analysis of farm level efficiency by both academician and policy analysts in the country for more than a decade [9].Technical efficiency is the main ingredient for enhanced performance of the agricultural industry [10]. Ellis suggested that the producers’ performance should be estimated only in terms of technical efficiency. This according to him is because measures of technical efficiency rely less heavily on assumptions of perfect knowledge, perfectly competitive markets and the profit maximization objective [11].

The core problem in agriculture in developing countries is how to increase output per unit input. One way of addressing the problem of increasing production is to analyze how efficiently farmers are utilizing their available resources and existing technology. If resources are not efficiently utilized, output can be increased by optimal and efficient adjustment factors of production. In case resources are efficiently utilized, then output can be increased by innovation and adoption of inputs technology of production[12].

Previously no research work has been carried out to estimate technical efficiency of EC shed broiler farmers in Pakistan. Therefore, this study is an attempt to estimate technical efficiency of EC shed broiler farmers in the study. The findings of this study will be helpful for EC shed broiler farmers to identify factors that affect wheat farmer’s technical efficiency and determining the opportunity for increasing output. Similarly policy makers will also benefited from these findings to form sound programs or legislations related to expand national food production potential more effectively.

2 DATA AND METHODOLOGY

2.1 UNIVERSE, SAMPLING TECHNIQUE AND SAMPLE SIZE OF THE STUDY

This study was designed to examine technical efficiency of EC shed broiler farms in Rawalpindi Division of Punjab, Pakistan. Multistage sampling technique was employed for selection of sample size. Rawalpindi Division was purposively selected, in first stage. In second stage, four districts were randomly selected through simple random sampling technique. In stage third, eight villages were randomly selected, from each district. In stage four 60 EC shed broiler farms were randomly selected using proportional allocation sampling technique [13]

$N_i \quad = \quad n^{*} (N_i/N) \qquad (1)$

Where;

n_i = Number of sampled broiler farms in ith district.

n = Total sample size.

N_i = Total number of broiler farms in ith district.

N = Total number of broiler farms in the study area.

2.2 DATA COLLECTION

For collection of required data from EC shed broiler farmers a comprehensive interview schedule was prepared and pretested in the field. Interview schedule was corrected according to the feedback from the field survey. Sampled farmers were interviewed either at their farms. Farmers were first taken in to confidence that the required was needed purely for research purpose, to get correct and accurate data for reliable estimates. For collection of secondary data different government and official sources e.g. Punjab Poultry Research Institute (PPRI) Rawalpindi, Economic Survey of Pakistan and Agriculture Statistics of Pakistan were used [14].

2.3 ANALYTICAL FRAMEWORK

2.3.1 CONCEPTUAL MODEL

Efficiency concepts were first introduced Koopmans [15] and Debreu [16]. Technical efficiency was defined by Koopmans [15] while Debreu [16] introduced its measurement as the 'coefficient of resource utilization'. Based upon the work done by Koopmans [15] and Debreu [16], Farrell [5] was the first to measure economic efficiency. He decomposed economic efficiency in to technical and allocative efficiency. According to Farrell [5] technical efficiency is the ability of a firm/farm to produce maximum possible level of output from available inputs. Allocative efficiency is the allocation of inputs in best optimal proportions, given their relative prices and available technology. Economic efficiency is measured as the product of technical efficiency and allocative efficiency. The most efficient farmer/s operates on the frontier/isoquant.

Literature unveils that efficiency of firms/farms were estimated by different studies using i) nonparametric and ii) parametric approaches. Nonparametric approach makes use of linear programming (LP) which is known as Data Envelopment Approach (DEA) and free disposal hull (FDH) [17]. DEA method was initiated by Farrell [5] and transformed into estimation techniques by Charnes [18] while FDH approach was developed by Deprins, *et al*. [19]. DEA approach makes no assumption about the distribution of error term and no functional form. This method is limited because; i) it has no proper statistical procedure for testing of hypothesis, ii) error term is not incorporated; this means that every variation in output from the frontier erect firm's inefficiency and iii) measurement is very sensitive to outliers [17].

Parametric approach is based on econometric theories in which error terms are taken in to account. Error term is further decomposed in to natural error term (v_i) and farm and/or farmer specific error term (u_i). v_i is symmetric; its value ranges between $-\infty$ and ∞ and accounts for variations in Q_i in response to statistical errors in measurements, breakdowns, weather conditions and natural disasters etc. v_i is beyond the control of farmers and is assumed to be independently and identically distributed as iid $N \sim (0, \sigma^2_{vi})$ [18][19]. u_i is a non negative random variable; related to farm and/or farmer specific factors which can be controlled by farmers. u_i is associated with technical inefficiency of the EC shed broiler farm; independently and identically distributed as iid $N \sim (0, \sigma^2_u)$ i.e. half normal distribution having value between 0 and 1. v_i and u_i are assumed to be independent of each other [18]. The stochastic frontier function was independently proposed by Aigner *et al*. [18] and Meeusen and van den Broeck [20].

Stochastic frontier approach makes it possible to estimate a frontier function that simultaneously takes into account the random error and inefficiency factors specific to every farm/farmer as follows:

$\ln Q_i = X_i \beta_i + \epsilon_i$ (2)

Where Q_i is production obtained by ith farmer, X_i are inputs applied by ith farmer, β_i are unknown parameters to be estimated and ϵ_i is composite error term consisting of v_i and u_i

2.3.2 EMPIRICAL MODEL FOR ESTIMATION OF TECHNICAL EFFICIENCY OF EC SHED BROILER FARMERS

The farm specific technical efficiency is ratio of observed output (Q_i) to the corresponding frontier output (Q_i^*) using the available resource and technology. Hence technical efficiency of EC shed broiler farmers is given as follows:

$$TE_i = \exp(-\mu_i)$$
$$= Q_i / Q_i^* \quad (3)$$
$$= [f(X_i, \beta_i) + v_i + u_i] / [f(X_i, \beta_i) + v_i;\ u_i = 0]$$

Where;

Q_i = Observed output of ith farm.

Q_i^* = Highest predicted/frontier output for ith farm.

TE_i = Technical efficiency of ith farm that ranges between 0 and 1.

Technical efficiency takes values ranging from zero to one, where 1 stands for fully efficient farm and 0 indicates for inefficient.Production technology of EC shed farmers is assumed to be specified by stochastic production function representing Cobb-Douglas production technology [21]:

$$\ln Q_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \epsilon_i \quad (4)$$

Where;

Q_i = Production of broilers obtained by ith broiler farmer in kilograms per EC shed.

X_{1i} = No of day old chicks per shed

X_{2i} = Feed intake in kilograms per shed

X_{3i} = Number of labors in man days per shed X_{4i} = Number of vaccinations per shed

X_{5i} = Capacity of shed (Number of broilers)

β_0 = Intercept

β_i = Unknown parameters to be estimated.

ϵ_i = Composite error term.

ϵ_i = $v_i + u_i$

v_i = Natural error term.

u_i = Farm and/or farmer specific error term.

Ln = Natural logarithm.

i = 1, 2, 3, ………, n.

Q_i = Production of broilers obtained by ith broiler farmer in kilograms per EC shed.

X_{1i} = No of day old chicks per EC shed.

X_{2i} = Feed intake in kilograms per EC shed.

X_{3i} = Number of labors employed in man days per EC shed.

X_{4i} = Number of vaccinations per EC shed.

X_{5i} = Capacity of EC shed (Number of broilers).

B_0 = Intercept.

β_i = Unknown parameters to be estimated.

ϵ_i = Composite error term.

ϵ_i = $v_i + u_i$

v_i = Natural error term.

u_i = Farm and/or farmer specific error term.

ln = Natural logarithm.

i = 1, 2, 3, ………, n.

β_0 and β_i are the parameters to be estimated.

2.3.3 DETERMINATION OF TECHNICAL INEFFICIENCY OF BROILER FARMERS

In order to determine factors contributing to the observed technical inefficiency, the following model was formulated and estimated jointly with the stochastic frontier model in a single stage maximum likelihood estimation procedure [22]. The model is given as fallows:

μ_i = $g\,(Z_i : \delta_i)$ (5)

μ = $\delta_o + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 D_{1i} + \delta_5 D_{2i} + \omega_i$ (6)

Where;

μ_i = Technical inefficiency.

Z_{2i} = Age of the poultry farmers in years.

Z_{2i} = Farming experience of the poultry farmers in years.

Z_{3i} = Education of the poultry farmers in years.

D_{1i} = Dummy variable for access to credit; D_{1i} =1, if farmers have access to credit, D_{1i} = otherwise.

D_{2i} = Dummy variable for membership with poultry association/cooperatives,

D_{2i} = 1, if farmers have membership with poultry association/cooperatives, D_{2i} = 1, otherwise.

ω_i = Stochastic error term.

δ_o = Intercept.

δ_i = Parameters to be estimated.

2.4 DIAGNOSTICS TESTS

Following diagnostic tests were applied to test the robustness of the estimates of the stochastic frontier Cobb-Douglass production model.

2.4.1 NORMALITY TESTS

For testing normality of residuals/error terms the following tests were performed.

I. Jarque Bera (JB) test

The estimated p-value (0.8387) for JB statistic was found to be statistically insignificant; implies that we accept the null hypothesis of normal distribution of residuals/error terms.

II. p-p plot test

p-p plot shows departure of residuals from regression line. Residuals obtained from our data depicts that residuals are not far from regression line, suggesting normal distribution of residuals.

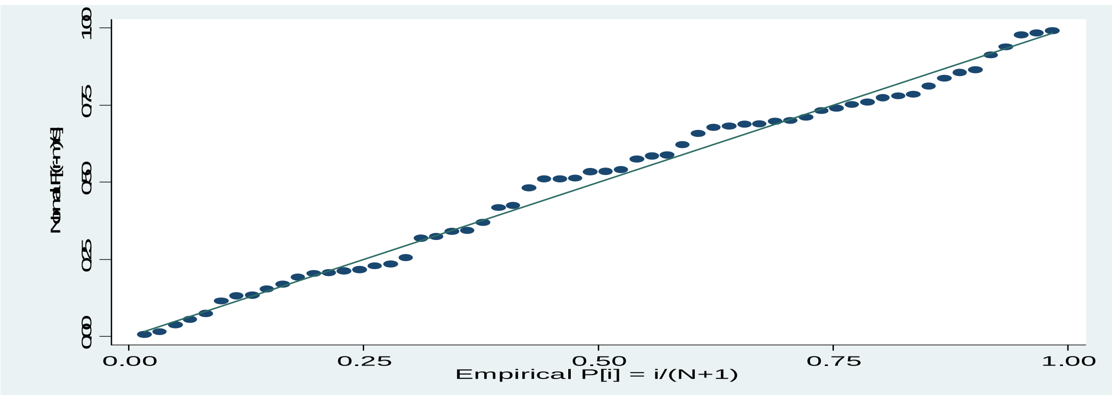

Figure 1 p-p plot

2.4.2 HETEROSCEDASTICITY TESTS

When the assumption of homoscedasticity (equal variances) is violated then we face the problem of heteroscedasticity (unequal variances). In presence of heteroscedasticity problem still we have unbiased estimates but no longer efficient. The results of the variances which may be small or large, leading to type I or type II error in the presence of heteroscedasticity which means that OLS is no not BLUE (Best Linear Unbiased Estimator). Heteroscedasticity is mainly present in cross sectional data as ours, than time series data [19].

The assumption of the homoscedasticity of the classical linear regression model is that the variance of each disturbance term μi for the chosen values of the dependent variables is a constant number equal to σ^2. Symbolically it can be written as:

$$E(\mu_i^2) = \sigma^2 \qquad i = 1,2,\ldots..,n$$

If the aforementioned assumption is violated then it will lead to a problem of heteroscedasticity, which means that variance of the error term will no more remain constant. The consequence of heteroscedasticity is an unbiased but inefficient estimate of the coefficients. The results of the variances which may be small or large, leading to type I or type II error in the presence of heteroscedasticity which means that OLS is no not BLUE (Best Linear Unbiased Estimator). Heteroscedasticity is mainly present in cross sectional data as ours, than time series data (Gujarati and Porter, 2009).

i. Breusch-Pagan test

Breusch-Pagan test for heteroscedasticity also follows χ^2 distributions. The estimated value of Breusch-Pagan statistic was statistically insignificant (p-value = 0.2715) at all levels of significance. So we can not reject the null hypothesis of homoscedasticity.

ii. White's general test

White's general test proposed by White does not rely on normality assumption and is easy to implement. Heteroscedasticity follows χ^2 distributions. The estimated value was found to be insignificant (p-value = 0.1371) at all levels of significance, suggesting that the model may not be plagued with problem of heteroscedasticity. This result reinforces our hypothesis of homoscedasticity.

2.4.3 MODEL SPECIFICATION TESTS

When one or more relevant variables are excluded from the model or one or more irrelevant variables are incorporated in the model, then model specification error can occur. Estimates of regression are substantially affected by model specification errors [19]. Ramsey's RESET test was applied for detection of model specification errors as follows:

i. Ramsey's RESET test

Ramsey's RESET test performs a regression specification error test (RESET) for omitted variables. Ramsey RESET test follows F distribution [19].

As our F calculated (1.68) is less than F tabulated ($F_{0.05\ (5,\ 55)}$ = 2.53), therefore, we can conclude that there is no specification error in the estimated model.

3 RESULTS AND DISCUSSION

3.1 MAXIMUM LIKELIHOOD ESTIMATES OF THE STOCHASTIC FRONTIER PRODUCTION FUNCTION OF EC SHED BROILER FARMERS

Table 2 shows estimates of stochastic frontier Cobb-Douglas production function for EC shed broiler farms. The estimated coefficient of day old chicks was found to be 1.4519 and statistically significant at 1 percent level of significance. This means a one increase in day old chicks brings about 1.4519 percent increases in broiler production of EC shed farms. These results are in conformity with the findings of Ohajaniya *et al*. [23] and Effiong [24] .

The estimated coefficient of feed was 0.0963 and statistically significant at 5 percent level of significance. This implies that a one percent increase in feed increases broiler output by 0.0963 percent. Similar results were found in earlier studies by Oleki and Islinka [25] while in contrast to the results of Alwris and Francis [26], Ike [27] and Areet *et al*.[28].

The estimated coefficient of labor was -0.060 and was statistically significant at 5 percent level of significance. This implies a one percent increase in labor decreases broiler production by 0.060 percent.

Source: Survey data, January-February, 2014.

The results is in accordance with the results of Ezeh, *et al*. [29] and Areet, *et al*. [28] while opposes the results of Ike [27]. One of the possible explanations of negative coefficient of labor is that broiler farmers of EC shed in the study area were either misallocating or over utilizing labor.

The estimated coefficient of vaccination cost was found to be negative and statistically insignificant. This means that vaccination has no significant effect on broiler production because all the broiler farmers in study area were applying approximately the same number of vaccination to their broilers. These results corroborate to the results of Oleke and Isinnika [26] and Ezeh *et al*. [29] while in contrast to the results of Ike [26] and Ohajaniya *et al*. [23].

The coefficient of capacity of shed was found to be - 0.0163 and statistically insignificant at 5 percent level of significance. This implies that capacity of shed has no significant effect on broiler production. This result opposes the findings of Ike [27] who found statistically significant effect of capacity of shed on broiler production.

Table 2 Maximum likelihood estimates of the stochastic frontier production function of EC shed broiler farmers

Dependent variable = log output of broilers

Variables	**Parameters**	**Coefficients**	**Standard error**	**T- ratios**
Constant	β_0	-4.9068	0.1760	-27.88*
Day old chicks	β_1	1.4519	0.0734	19.76*
Feed	β_2	0.0963	0.0508	1.90**
Labor	β_3	-0.0600	0.0286	-2.10**
Vaccin	β_4	-0.0179	0.0144	-1.24
Capacity	β_5	-0.0163	0.0187	-0.87
Technical inefficiency effects model				
Constant	δ_0	-43.1047	30.2251	-1.43
Age	δ_1	-1.0390	1.3821	-0.75
Experience	δ_2	1.5302	1.6217	0.94
Education	δ_3	3.3174	2.8516	1.16
Credit access	σ_4	-0.2253	2.4177	-0.09
Membership	δ_5	-2.9315	3.3403	-0.88
Sigma u^2	σ_u^2	0.00199		
Sigma v^2	σ_v^2	0.00124		
Sigma^2	σ^2	0.00324		
Gamma	γ	0.61753		
Mean TE	X_{mean}	0.999		
Minimum TE	X_{min}	0.934		
Maximum TE	X_{max}	1.000		

* and ** indicates significance at 0.01 and 0.05 probability, respectively.
Source: Estimated from survey data, 2014.

3.2 FREQUENCY DISTRIBUTION OF TECHNICAL EFFICIENCY OF OPEN SHED FARMS

Table 3 shows the estimated technical efficiency's frequency distribution of broiler farmer of open shed. The minimum and maximum values for estimated technical efficiencies are 0.440 and 0.985 with a mean efficiency of 0.880, which shows that majority of the farmers that is about 55 percent of the sample respondent in the study area, have technical efficiency of above 0.90.

Table 3 Frequency distribution of technical efficiency of open shed farms

TE class interval	Frequency	%
0.9–1.00	60	100
Sample size	60	100
Minimum TE	0.440	-
Maximum TE	0.985	-
Mean TE	0.880	-

Source: Estimated from survey data, 2014.

4 CONCLUSION AND RECOMMENDATIONS

This paper estimated the level of technical efficiency of EC shed broiler farmers in Rawalpindi division, Punjab. For selection of sampled respondents, multistage sampling technique was used. A total of 60 farmers of EC shed boilers farms were interviewed. An interview schedule was used for collection of required data. For the estimation of technical efficiency of broiler production, stochastic production frontier function was used. Data was analyzed using Stata (version 12) computer program.

Maximum likelihood estimates of the stochastic frontier Cobb-Douglas production function revealed that number of day old chicks and feed were statistically significant with positive coefficients and labor was significant with negative sign for EC shed farms. The average technical efficiency of EC shed farmers was found to be 0.999 ranging from 0.8392 to 1.00. This implies that EC shed farmers were efficiently utilizing their resources in broiler production. The estimated value of gamma was 0.40 but statistically insignificant.

Based upon these findings it is suggested that government should motivate open shed broiler producers to switch over to EC shed broiler production and also motivate investors to invest in EC shed broiler farming. This will result in higher production of poultry meat and the problem of insufficiency of protein and other nutrients can be easily eradicated. This will also provide employment opportunities to the labor force of the country.

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REFERENCES

[1] GoP. 2013. Economics Survey of Pakistan, 2012-13. Economic advisory Wing. Finance Division, Islamabad, Pakistan.
[2] Ikeme, A. I. 1990. Meat science and technologyin Africa. Federal Publishers Ltd Ibadan. Pp. 112- 113.
[3] GoP. 2009. Economics Survey of Pakistan, 2008-09. Economic advisory Wing. Finance Division, Islamabad, Pakistan.
[4] FAO. 2009. FAOSTAT. www.fao.org
[5] Farrell, M. J. 1957. The Measurement of Productive Efficiency. Journal of the Royal Statistical Society. 120, pt.3, 253-281.
[6] Carlson, B.1972. The measurement of efficiency in production: An application to Swedish manufacturing industries. Swedish Journal of Economics. 72(2): 468-485.

[7] Adedeji, A., K. O. Adelalu, S. I. Ogunjimi and A. O. Otekunrin. 2013. Estimation of technical efficiency of Poultry egg production in Ogbomoso Metropolis of Oyo State,Nigeria. World Journal of Agricultural Research.1(6): 119-123.

[8] Thiam, A., B. E. Bravo-Ureta and T. Rivas. 2001. Technical efficiency in developing country agriculture: A meta-analysis. Agricultural Economics. 25: 235-243.

[9] Kolawole, O. 2009. A meta-analysis of technical efficiency in Nigerian agriculture. Contributed Paper prepared for presentation at the International Association of Agricultural Economists Conference,Beijing China, August 16-22.

[10] Bansah, A., S. Dawson, A. Nyamike, E.Colecraft and G.S. Marquis. 2012. Enhancing backyard poultry enterprise performance in the Techiman area: a value chain analysis. African Scholarly Science Communications Trust.12(1).

[11] Ellis, F. 1988. Peasant Economics: Farm households and Agrarian Development. Cambridge University Press, Cambridge. 257-259.

[12] Sing, J. P., 1975. Resource Use Efficiency and Returns to Scale in a Background Agriculture. Ind.J.Agri Eco 30: 33-46.

[13] Debreu, G. 1951. The coefficient of resource utilisation. Econometrica, 19: 273–92.

[14] Koopsman, T. C. 1951. An analysis of production as an efficient combination of activities. Cowles Commission for Research in Economics. Monograph No. 13, Wiley, New York.

[15] Nchare, A. 2007. Analysis of factors affecting the technical efficiency of Arabica coffee producers in Camroon. African Economic Research Consortium, Nairobi. 163: 1-46.

[16] Charnes, A., W. W. Cooper and E. Rhodes. 1978. Measuring the inefficiency of decision making unit. European Journal of Operational Research, 2: 429–44.

[17] Deprins, D., L. Simar and H. Tulkens. 1984. Measuring labor efficiency in post offices. In M. Marchand, P. Pestieau and H. Tulkens, eds., The Performance of Public Enterprises: Concepts and Measurements, pp. 243–67. Amsterdam: North-Holland

[18] Aigner, D. J., C. A. K. Lovell and P. Schmidt. 1977. Formulation and Estimation of Stochastic Production Frontier Function Models. Journal of econometrics, 6: 21-37.

[19] Gujarati, D. N. and D. C. Porter. 2009. Basic Econometrics, 5th Edition. McGraw Hill Inc., New York.

[20] Meeusen, W. and van den Breock. 1977. Efficiency estimation from Cobb-Douglas production functions with composed error. International Economic Review, 18(2): 435–444.

[21] Henderson, J. M., and R.E. Quant. 1971. Microeconomic Theory; A Mathematical Approach. McGraw Hill Inc., New York.

[22] Coelli, T J. and Battese. 1996. Identification of Factors which Influence the technical inefficiency of Indian farmers. American Journal of Agriculture Economics. 40: 103-128.

[23] Ohajianya, D. O., J. U. Mgbada, P. N. Onu, A. Enyia, N.G. Henri-Ukoha, Be-chendo and C. C. Godson-Ibeji. 2013. Technical and Economic Efficiencies in poultry Production in Imo State, Nigeria. American Journal of Experimental Agriculture. 3(4): 927-938.

[24] Effiong, E. O. 2005. Efficiency of production in selected livestock Enterprises in Akwa-Ibom State, Nigeria. PhD. Thesis, Dept. of Agricultural Economics, Michael Okpara University of Agriculture, Umudike.

[25] Oleke, J. M. and A. C. Isinika. 2011. Assessing the Technical Efficiency of Commercial Egg Production in Tanzania for improved livelihoods. Journal of Development and Agricultural Economics. 3(8): 343-352.

[26] Alwris, K. N. and E. Francis. 2003. Technical efficiency of broiler farms in the Central Region of Saudi Arabia: Stochastic frontier approach (pp. 5-34). Agricultural research center, King Saudi Arabia University.

[27] Ike, P. C. 2011. Resource use and technical efficiency of small scale poultry farmers in Enugu State, Nigeria. International Journal of Poultry Science. 10 (11): 895-898.

[28] Areet, T, A., H. Kameyama, K. Ngamsomsuk and K. Yamauchi. 2012. Production efficiency of broiler farms in Thailand. Jourrnal of Agriculture Sciences. 4(12): 221-231.

[29] Ezeh, I., C. O. Anyiro and J. A. Chukwu. 2012. Technicaal Efficiency in Poultry Broiler Production in Umuahia Capital Territory of Abia State, Nigeria. Greener Journal of Agricultural Sciences. 2 (1): 001-007.