Research Article

Allocative Efficiency of Broiler Farms in District Charsadda, Khyber Pakhtunkhwa: Stochastic Frontier Analysis

Irfan Ullah, Shahid Ali*, Muhammad Fayaz and Abbas Ullah Jan

Department of Agricultural & Applied Economics, The University of Agriculture, Peshawar, Pakistan.

Abstract | This study estimated and examined allocative efficiency of broiler farms in district Charsadda, Khyber Pakhtunkhwa, Pakistan. Data from 120 respondents was collected through multistage random sampling technique. Stochastic frontier cost function of Cobb- Douglas type was used for the estimation of allocative efficiency. The function was estimated using Maximum Likelihood estimation technique. Results revealed that the mean allocative efficiency of broiler farms was 0.84; implies that an average farm could have used 16% less inputs for given level of output if inputs were allocated efficiently. The estimated coefficient of output in the stochastic cost frontier was -0.159 and statistically significant at 5% significant level which implies that output level need to be increased which ultimately leads to decrease inefficiency of resources allocation. In allocative inefficiency effect model, estimates of education and experience were negative and statistically significant which implies that educated and experienced broiler farmers efficiently allocated resources on their farms. Therefore, the policy makers needs to provide education and training facilities to the farmers which are appropriate to rearing of broiler in open shed farms for the efficient utilization of resources and enhancing productivity of broilers.

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***Correspondence** | Shahid Ali, Department of Agricultural & Applied Economics, The University of Agriculture, Peshawar, Pakistan; **Email:** drshahid@aup.edu.pk
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Introduction

Poultry can be defined as birds which provide meat and eggs. To bridge the gap between the increasing demand and low supply of poultry products it requires the use of fast growing birds that can convert feed to meat quickly in order to get market weight while egg production requires good laying birds to produce eggs (Ogunlade and Adebayo, 2009). Chickens originated from Jungle Fowl in South Eastern Asia around 3200 BC (Farran, 2009). Chickens were domesticated and spread to China, India, Africa, Pacific Island, and Europe. The main use of chickens has never changed. They were primarily raised for human food while in some societies chickens were used in cock fighting as a source of entertainment. Moreover their feathers were used for making cushions and their litter for fertilizers (Ali et al., 2014).

Poultry provide an enormous supply of food to meet the increasing demand of the poultry all over the world. In 2007 world poultry production was 3 percent higher than last year which was 86.77million tons. In Asia poultry production increased from 10 to 30.90 million tons from 1990-2007 (Barbara and Hans-Wilhelm, 2011). According to latest statistics, more than 50 billion chickens are produced on annual basis. In the list of egg production United Kingdom top the list by producing about 29 million eggs on daily basis. In top ten producing countries of chicken United States comes first with the production of 17,961.00 ('000' MT) followed by China with production of 13,110.00 ('000' MT) (USDA, 2015).

The contribution of Asia in poultry meat consumption is 40% in which China and India are contribute37% of the total consumption in Asia (Global Poultry Trends, 2015). Hong Kong, United State and Israel are also the major consumers of broiler meat with the per capita consumption of 67.20, 49.40 and 43.80 kilograms, respectively (USDA, 2015).

The importance of poultry sector to the national economy cannot be ignored, as it has large contribution towards earning foreign exchange. Major exporter of broiler are Brazil, United State, Europe Union, Thailand and China with the export stock of 3,665.00, 3,030.00, 1,150.00, 570.00 and 430.00 ('000' MT) respectively (USDA, 2015). While in the race of import Japan is leading followed by Saudi Arabia, Mexico and Iraq with the import of 895.00, 790.00, 760.00 ('000' MT) respectively (USDA, 2015).

Poultry farming in Pakistan on commercial scale was initiated in 1963 when the first modern hatchery was built by Pakistan International Airlines (PIA) at Karachi with the cooperation of Canadian firm "shaver" (Mohsin et al., 2008).The poultry sector of Pakistan producing more than 530.00 million birds annually and stands 2nd Largest Industry of the country (FAO, 2014). The value added of this sector has increased from Rs121.70 billion (2012-13) to 130.70 billion (2013-14) showing an increase of 7.4% as compared to previous year (GoP, 2014). There are approximately 25,000 poultry farms in Pakistan with the production capacity that is ranged from 5,000 to 500,000 broilers. The poultry sector of Pakistan on annual basis produced 1,220 million kilo grams chicken meat, while the annual per capita consumption of meat and eggs are 6.50 kilo grams and 65-70 eggs respectively. Moreover in developed nation this trend is completely different with the per capita consumption of meat and eggs are 40 kilo grams and 300 eggs respectively (Pakistan Poultry Association (PPA), 2014).

Poultry is rear mainly with two different ways of farming i.e open shed house and Environmentally Controlled houses. In Pakistan the number of environmentally controlled poultry sheds is increasing rapidly because in controlled shed houses the incentive for profit is more as compared to open shed houses (The Express Tribune, 2014). The chicken inherent potential is 8.00 million in the country across the provinces with the contribution of Punjab 68% followed by KPK with 30% and then comes Sindh and Baluchistan with the percentage contribution of 2% and -% respectively (PPA, 2012).

Charsadda is one of the important district of Khyber Pakhtunkhwa regarding to the industries and it place the sixth largest District (Appendix VII) based on poultry farming in Khyber Pakhtunkhwa (Govt. of Khyber Pakhtunkhwa, 2006). Government provides support to the poultry industry by offering various program to increase production and bridge the gap between the increasing demand and the low supply of poultry products, especially chicken. In this sense the role of commercial and development banks cannot be ignored which provide loans to the farmers for expanding their production (FAO, 2006). However, there is no empirical evidence to justify whether the broiler farmers are allocatively efficient or not since the cost of input is increasing day by day. In developing countries measurement of efficiency of agricultural production is main issue and also before this study no research has been carried out on allocative efficiency of broiler forms in the Study area. There is, therefore, a dire need to conduct a systematic study to estimate and examine allocative efficiency of broiler farms in District Charsadda, Khyber Pakhtunkhwa, Pakistan. The main objectives of this research study were to estimate allocative efficiency and to identify factors that are responsible for allocative inefficiency, if any, across the broiler farms in district Charsadda.

Materials and Methods

Universe of the study

The present study was conducted in district Charsadda, Khyber Pakhtunkhwa Province. Charsadda lies between 34-03' and 34-38' north latitudes and 71-28' and 71-53' east longitudes. Charsadda is located in the west of the Khyber Pakhtunkhwa and is bounded by Malakand district to the north, Mardan district to the east, Nowshera and Peshawar districts to the south and the Mohmand Agency of the Federally Administered Tribal Areas to the west.

Population size, sample size and sampling technique

For the selection of respondents multi-stage sampling technique was employed. In this technique the respondents were chosen through a process of defined stages (Ali et al., 2014; Miraj and Ali, 2014; Wahid, et al., 2017). In the first stage district Charsadda was purposively selected by taking into consideration the prevalence of commercial broiler production in that districts. In second stage three tehsil namely Charsadda, Tangi and Shabqadar were purposively selected by taking into consideration the prevalence of commercial broiler production in these tehsils. Thirdly, the population of broiler farms (530 farms) in district were identified out of which 235 farms are operated in tehsil Charsadda, 160 farms are operated in tehsil Tangi, and the remaining 135 farms are operated in tehsil Shabqadar (Directorate of Livestock, district Charsadda, 2016). Fourth stage involved the selection of the 120 farms from the mentioned tehsils by using proportional allocation random sampling technique. The following formula was employed for the selection of farms from each tehsil in district Charsadda (Cochran, 1977).

$$ni = n *(Ni/N)............(1)$$

Where;
ni = Number of sampled broiler farms in ith tehsil.
n = Total sample size.
Ni = Total number of broiler farms in ith tehsil.
N = Total number of broiler farms in the study area.

Table 1: *Population and sample size of broiler farms in each Tehsil area*

District	Tehsil	Number of broiler farms	Sample size
Charsadda	Charsadda	235	53
	Tangi	160	36
	Shabqadar	135	31
Total		**530**	**120**

Source: Directorate of Livestock in district Charsadda, 2016.

Conceptual framework of the model

For efficiency measurement two approaches are used that is classical and the frontier approaches. According to Oji and Chukwuma (2007), the classical approach measures the ratio of output to a particular input. Classical approach was not used in this study because it does not take into account other environmental/exogenous factors that affect the production cost and efficiency of the broiler farms.

The frontier approach uses residuals to measures the difference between the inefficient units and the frontier. The essence of frontier analysis is to construct a best practice frontier against which to elaborate the performance of individual producers (Lovell, 2008). The frontier approach takes into account other environmental/exogenous factors that influence the cost of production and efficiency of the farmers.

In addition, according to Chirwa (2002), the efficiency measurement through frontier can be classified into non-parametric frontiers and parametric frontiers. Data Envelopment Analysis (DEA), is the commonly used non- parametric frontiers approach, which apply linear programming techniques to build an efficient cost/production frontier. The main point of weakness in non-parametric frontiers approach such as DEA is that all the variation from the frontier is considered to be the result of the firm's inefficiency. DEA is also criticized for not permitting hypothesis testing (since non-parametric frontiers do not impose a functional form on the cost frontiers and do not make assumptions about the error terms).

Contrary to non-parametric approach, parametric approach entangle modeling cost/production frontier using various econometric techniques. The underlying principle behind the parametric approaches such as Stochastic frontier approach is that it accounts for random error (factors outside the scope of the farmers which affect production cost) and separate the inefficiency component from it and make credible statistical inferences and also the parametric approach has not received any valid criticism since its introduction. Therefore the parametric approach was chosen in this study.

According to Kumbhakar and Lovell (2000), implicit stochastic cost frontier can be written as follows:

$$C = f(w, y, \alpha) \,.\, e^{vi+ui} \quad .... (2)$$

Where;
C = Cost of production in Rs. / shed
w = Cost of inputs in Rs. / shed
y = Output of broiler in kilograms / shed
α = Parameters to be estimated
Allocative efficiency in farming is defined as the ratio of the predicted minimum cost (Ci*) to the observed or actual cost (Ci).

$$AEi = Ci^*/Ci \,......... (3)$$

$$AEi = [h(w, y, \alpha)\, exp(v){:}\ \mu = 0] \,/\, [\, h(w, y, \alpha)\, exp(v+\mu)]$$

The allocative efficiency scores index for each farm ranges between 0 and 1. If AE = 1, then farmer are allocatively efficient. And if AE = 0, then farmer are allocatively inefficient.

Determinants of allocative inefficiency: To find the factors which are contributing to the observed allocative inefficiency, the following model was estimated jointly with the stochastic frontier cost model in a single stage using maximum likelihood estimation procedure with stata 12 and frontier version 4.1 software (Coelli, 1996).

$$\mu_i = \beta_0 + \Sigma \beta_i Z_i + \varepsilon_i \text{ ....(4)}$$

Where;
μ_i = Allocative inefficiency error term of the i-th farm
Z_i = Farm/Farmer specific inefficiency factors
β_0 = Constant
β_i = Estimated parameters
ε_i = Error term of the model

The Empirical Model: For estimating empirical model, cost of broiler production and economic profit (Net Return) were estimated as follows (Debertin, 1985; Varian, 1992):

$$Net\ Return = Total\ Return - Total\ Cost \text{ .... (5)}$$

Where
Total Return= $PY_i * Y_i$
Total Cost= $\Sigma PX_i * Xi$
Net Return = Net Return from broiler reared in shed (Rs per shed)
Total Return = Total return from broiler reared in shed (Rs per shed)
Total Cost = Total cost of broiler production in shed (Rs per shed)
PY_i= Price of broiler (Rs per kg)
Y_i= Output of broilers (kgsper shed)
Xi = Inputs applied (units per shed)
PX_i= Prices of inputs (Rs per unit)

Cost of production of broilers was estimated as the sum total of day old chicks, cost of feed intake, cost of vaccines, labor cost, electricity cost per shed, cost of litters and cost of transportation and fixed costs. Cost of transportation includes transport of day old chicks to farm, transport of feed and transport of broilers to market sale. Fixed cost composed of rent of building and cost of equipments used in one production period. All these cost items were estimated on per shed per production period basis. Prevailing market prices of inputs and output were taken into account for cost estimation and net return from broiler.

After estimation of cost of broiler production and output of broilers, Cobb-Douglas cost model was used for the estimation of allocative efficiency as follows:

$$lnc = \alpha_0 + \alpha_1 lndocc + \alpha_2 lncof + \alpha_3 lncov + \alpha_4 lnlabcost + \alpha_5 lnfc + \alpha_6 lny + v_i + u_i \text{ ....(6)}$$

Where c is cost of production of broilers per production period (PRs), docc is day old chicks cost (PRs), cof is cost of feed (PRs), cov is cost of vaccines (PRs), lab cost is labor cost (PRs), fc is fixed cost (PRs), y is output of broilers (kilograms/shed), $\alpha_0$is constant, α_i are the parameters to be estimated, v_i is error due to natural shocks and $u_i$is effect of inefficiency factors.

Allocative inefficiency determinants: To determine the factors that affect allocative inefficiency, the following model was estimated using stochastic frontier model with maximum likelihood estimation technique as follows:

$$u_i = \beta_0 + \beta_1 Af + \beta_2 Educa + \beta_3 Expe + \beta_4 Crdt + \beta_5 Lab + \beta_6 Occu + \varepsilon_i \text{ ....(7)}$$

Where;
Af = Age of farmer in years
Educa= Education level of Farmers in years
Expe= Farming experience in years
Crdt = Farmers having access to credit (PRs.)
Lab = Type of labor used (Hired labor/Family labor)
Occu = Farmer specific occupation (poultry farming/other)
β_0 = Constant
β_i = Parameters to be estimated
ε_i = Error term of the stochastic model

Results and Discussion

Cost of production and return of broiler farms

Cost of production of broiler farms: Table 2 shows average cost of production across the broiler farms during the production period. Finding showed that the average day old chick and feed cost were Rs 89,949.65 and Rs 428,890.40, respectively while the average vaccine cost, labor cost and fixed cost were Rs 27,736.44, Rs 23,390.00 and Rs 20,849.78 respectively. The result further demonstrated that the average total cost incurred across the broiler forms was Rs 611,468.70. Highest cost item in broiler production was feed (70.14%) followed by day old chicks (14.71%), vaccines (4.53%) and labor (3.82%). These four cost items collectively constitute 93.20% of the total cost of broiler production.

Table 2: *Cost of production of broiler farms*

Variables	Units	Quantity	Cost/ Unit (Rs)	Total Cost (Rs)	% in total Cost
Day old chicks	No.	3,996.67	22.21	89,949.65	14.71
Feed intake	Kg	10,890.79	39.55	428,890.4	70.14
Vaccines	Ml	14,332.36	1.97	27,736.44	4.53
Labor	Days	70.00	343.02	23390.00	3.82
Electric-ity	Month	1.50	6882. 20	10323.30	1.70
Litter	Trolley	1.50	5398.7	8098.08	1.32
Trans-portation	Rs			2231.08	0.36
TVC	Rs			590619.00	96.59
Rent	Rs			12394.75	2.03
Equip-ment's	Rs			8455.025	1.38
TFC	Rs			20849.78	3.41
TC	Rs			611468.70	100

Source: Survey data estimates, 2016

Net return from broiler farms: Table 3 demonstrates that on average 6,686.40 kg output (broiler in kg) was produce and sold @ of 126.51 Rs/kg having the total value of 768,249.4 rupees. The by-product was sold at the rate of 3.37 Rs/Sqft with the average value of Rs. 13,482.52. On average, total return from broiler farm was Rs. 781,731.90 with the net return of Rs. 170,263.20.

Table 3: *Net return from broiler farms*

Particular	Units	Quantity	Price/ unit (Rs)	Total value (Rs)
Broiler Meat	Kg	6,686.40	126.51	768,249.40
Manure	Sqft	3,996.70	3.37	13,482.52
Gross Revenue	Rs			781,731.90
Total Cost	Rs			611,468.70
Net Revenue	Rs			170,263.20

Source: Survey data estimates, 2016

Descriptive statistics of the variables used in SFA Cobb-Douglas type cost function

Table 4 shows the descriptive statistics of variables used in SFA Cobb-Douglas type cost function. The finding shows that the minimum and maximum cost incurred on the broiler production in the study area was Rs 356,290.00 and Rs 1,082,525.00 respectively with the mean value of Rs 611,468.73 and standard deviation of 20,0514.61. The table further revealed that the minimum and maximum cost incurred on DOC was Rs 34,500.00 and Rs 193,725.00 respectively with the mean cost of Rs 89,949.65 and standard deviation of 42,602.76. The minimum and maximum cost incurred on feed during the production period was found to be Rs 237,500.00 and Rs 826,460.00 respectively with the mean value of Rs 428,890.40 having the standard deviation of 157,160.23.The minimum, maximum and mean cost of vaccine during the broiler production was found to be Rs 15,120.00, Rs 46,580.00 and Rs 27736.44 respectively with the standard deviation of 6,536.64. The minimum, maximum and mean labour cost incurred during the production of broiler farm in the study area was found to be Rs 11,000.00, Rs 41,700.00 and Rs 23390.00 with the standard deviation of 6,421.59. The minimum, maximum and mean fixed cost during the production period was found to be Rs 13,820.00, Rs 29,435.00 and Rs 20,849.78 respectively having the standard deviation of 3,788.15. The table further demonstrates that the minimum maximum and mean output during the production process was found to be 3,380.00 Kg, 10,670 Kg and 6,686.41 Kg respectively with the standard deviation of 2,407.26.

MLE estimates of parameter of stochastic cost Frontier

Table 5 shows the Maximum–likelihood estimates of parameters of stochastic cost frontier. The result implies that 1% increase in price of day-old chick, feed, disease treatment and prevention, capital assets will lead to approximately 0.06%, 0.31%, 0.016%, and 0.09% increases in total production cost respectively. The finding further shows that 1% increase in output and the price of labour will lead to an approximate decrease of 0.15% and 0.16% in the total cost of production, respectively. The result further shows that those farms which are labour intensive have a decrease in their production cost which indicates that the cost incurred on labour have direct contribution towards increasing the output which in turn decrease the production cost.The estimate of day old chick cost, feed cost and vaccine cost are in accordance with the finding of Pakag et al. (2015), Etuah and Seth (2014) , Akhter and Rashid (2008).The finding of labor cost are matching with previous study of Pakag et al. (2015)

Table 4: *Descriptive statistics of the variables used in SFA Cobb-Douglas type cost model*

Variables	Units	Minimum	Maximum	Mean	Std. Dev.
Total cost	Rs	356,290.00	1,082,525.00	611,468.73	200,514.61
Day old chick cost	Rs	34,500.00	193,725.00	89,949.65	42,602.76
Cost of feed	Rs	237,500.00	826,460.00	428,890.40	157,160.23
Cost of vaccine	Rs	15,120.00	46,580.00	27,736.44	6,536.64
Labor cost	Rs	11,000.00	41,700.00	23,390.00	6,421.59
Fixed cost	Rs	13,820.00	29,435.00	20,849.78	3,788.15
Output	Kg	3,380.00	10,670.00	6,686.41	2,407.26
Age	Years	23.00	56.00	35.40	6.99
Education	Years	0.00	16.00	8.04	4.37
Experience	Years	0.00	11.00	4.62	3.007
Loan/Credit	Dummy	0.00	1.00	0.48	0.501
Occupation	Dummy	0.00	1.00	0.59	0.493
labor used	Dummy	0.00	1.00	0.55	0.499

Source: Survey data estimates, 2016

Table 5: *MLE estimates of parameter of stochastic cost Frontier*

Variable	Parameters	Coefficients	t-ratio
Constant	α_0	3.79	4.08**
ln docc	α_1	0.063	2.01**
ln cost of feed	α_2	0.312	2.91**
ln cost of vaccine	α_3	0.016	0.320
ln labor cost	α_4	-0.160	-1.73*
ln fixed cost	α_5	0.099	2.15**
ln y	α_6	-0.159	-1.79*

Source: Survey data estimates, 2016 (significant at 5% ** sig at 1%)*

and Ashagidigbi et al. (2011) and was in contrast with the estimates of Etuah and Seth (2014) and Akhter and Rashid (2008).

Similarly the estimate of fixed cost is in line with the results of Eze et al. (2013), Etuah and Seth (2014), and Arerrat et al. (2012) and contradicts the finding of Omar (2014). The finding of output is in contrast with the previous study of Etuah and Seth (2014), Akhter and Rashid (2008), and Pakag et al. (2015).

Allocative inefficiency effect model

Table 6 shows the estimates of allocative inefficiency effect model. The findings show that the estimates of experience and education of the farmers were negative and statistically significant which implies that educated and experienced farmers in broiler production are more cost efficient than those farmers who do not fall into this category. The negative coefficient for credit is an indication that credit less farmers are more cost efficient than those farmers who take credit. The coefficient obtained from the allocative inefficiency model of this study was compared with the previous studies the results show that the estimates and significance of age and experience are in line with the findings of Akhter and Rashid (2008) and Ashagidigbi et al. (2011). Similarly the estimate of age confirmed the finding of Akhter and Rashid (2008). The finding further showed that the estimate and significance of credit was matched with the result of Ashagidigbi et al. (2011). Sigma-square (σ^2) which shows overall variation from the frontier model has a value of 0.025 which is significant statistically at 5% indicating that the variation from the frontier is very important and cannot be ignored. The estimate of gamma (Υ) in the model is 0.72 which is statistically significant at 1% and 5% level. The value of gamma implies that about 72% of the variation in the total production cost among the broiler farms in the study area was due to differences in their cost efficiencies.

It also suggests that the inefficiency component contribute 72% in the composite error term. Or in other word it also suggests that about 28% of the variation was due to uncertainty or random shocks beyond the farmers control.

Frequency distribution of broiler farms on the basis of allocative efficiency

The result in Table 7 implies that the cost efficiency level of the broiler farms ranged from 0.69 to 1.03 with the mean value of 0.84. The average allocative efficiency (0.84) implies that there seems to be 16 percent allocative inefficiency in the broiler production cost or it demonstrates that with the given resources, farmers could have minimized input utilization by 16% for the given level of output.

Table 6: *Allocative inefficiency effect model*

Variables	Parameters	Coefficient	t-ratios
Intercept	β_0	-0.313	-1.65*
Age	β_1	-0.012	-0.867
Education	β_2	- 0.030	-2.74**
Experience	β_3	-0.031	-2.42**
Credit	β_4	-0.053	-1.05
Occupation	β_5	0.089	1.46
Labor used	β_6	0.162	1.73*
Variance Parameters	σ^2	0.025	8.28**
	Υ	0.720	2.12**

Source: Survey data estimates, 2016 (significant at 5% ** sig at 1%)*

Table 7: *Distribution of broiler farms on the basis of allocative efficiency*

Allocative Efficiency	Percentage	Frequency
<0.80	30.00	36
0.80-0.90	42.50	51
0.91-1.00	19.17	23
>1.00	8.33	10
Max	1.03	-
Min	0.69	-
Mean	0.84	-
Efficiency Gap	0.34	-

Source: Survey data estimates, 2016

Table 5 further shows that among the sampled broiler forms in the study area 8.33% are incurring costs that are above the minimum defined by the frontier. These estimates are in line with the findings of Pakag et al. (2015) and Etuah and Seth (2014).

Conclusion And Recommendations

Results show that the allocative efficiency is relatively high in the study area. The mean allocative efficiency was 0.84, it implies that there seems to be 16 percent allocative inefficiency in the broiler production cost in the study area or it demonstrates that for the given level of resources, the farmers could produce 16% more of output or could have utilized 16% less cost to get a similar level of output.

The estimated coefficient of output in the stochastic cost frontier was -0.159 and statistically significant at 5% significance level which implies that output level need to be increased which ultimately leads to increase the cost efficiency of the broiler farms in the study area. In allocative inefficiency effect model, the estimates of experience and education were turn out to be negative and statistically significant therefore the policy makers needs to provide education and training facilities to the farmers which are appropriate for raising of broiler in open shed farms for the efficient utilization of resources and enhancing productivity and efficiency. The main issues which are barrier in this business were abrupt price fluctuations, distance of inputs and output market and extreme weather conditions. Therefore it is recommended that government needs to establish a regulatory body to suggest policies for price stability of broiler inputs and output and other issues related to broiler farming.

Author's Contribution

Irfan Ullah conducted the study and wrote first draft of the manuscript. Shahid Ali supervised and helped in modeling specification and statistical analysis of the manuscript. Muhammad Fayaz and Abbas Ullah Jan helped in technical writing and editing of the manuscript.

References

Akhter, S. and M. H. A. Rashid. 2008. Comparative efficiency analysis of broiler farming under aftab bahumukhi farm limited supervision and farmers' own management. Progress. Agric. 19(2): 195-204.

Ali, S. S Ali and B, Riaz. 2014. Estimation of technical efficiency of open shed broiler farmers: A Stochastic Frontier Analysis. J. Econ. Sustain. Develop. 5(7): 79-88.

Areerat, T., K. Hiroshi, N. Kamol and Y. Kohen. 2012. Economic Efficiency of Broiler Farms in Thailand: Data Envelopment Analysis Approach. British J. Econ. Financ. Manag. Sci. 5(1): 33-43.

Ashagidigbi, W. M., S. A. Sulaiman and A. Adesiyan. 2011. Technical and Allocative efficiency of Poultry Egg Producers in Nigeria. Agric. Journal. 6(4): 124-130. https://doi.org/10.3923/aj.2011.124.130

Barbara, G. and W. Hans-Wilhelm. 2011. Changing dynamics in global poultry production. World

Poult. 25 (08): 1-2.
Chirwa, E. W. 2002. Sources of technical efficiency among smallholders maize farmers in South Malawi. A research report presented at the biannual research workshop of the African Economic Research Consortium, Nairobi, Kenya.
Cochran, W. G. 1977. Sampling technique third edition. John wiley and sons, inc. 471 (16240): 77-728.
Coelli, T. J. 1996. A guide to FRONTIER version 4.1: A computer program forstochastic frontier production and cost function estimation. Center for Efficiency and Productivity Analysis (CEPA) Working Paper 96/07. University of New England, Armidale, Australia.
Debertin, D.L. 2012. Agriculture Production Economics, 2nd Edition. Macmillan publishing company, New York.
Directorate of Livestock in district Charsadda on Mardan road near Muslim Public High School and College, 2016.
Etuah and Seth. 2014. Cost efficiency and economies of scale in broiler production in Ghana. Unpulished Thesis Submitted to the Department of Agricultural Economics, Agribusiness and Extension, Kwame Nkrumah University of science and Technology.
Eze, C. C, J.C. Okere, A.I. Maduike and G.N. Ben-Chendo., 2013. Allocative Efficiency and Returns to Scale among Fadama II Broiler Farmers in Imo State, Nigeria. Developing Country Studies www.iiste.org 3(10): 1270-1276.
FAO. 2014. Food and Agriculture Organization. www.fao.org
Farren, M. 2009. Design and development of low cost semi-automated poultry vaccination machine. Personal communication, 2009.
Food and Agriculture Organisation. 2006. Animal production and emergency centre for trans boundary animal diseases socio economics, production and biodiversity unit.
Global Poultry Trends. 2015. An International Organization Report, 2014.
Govt. of Khyber Pakhtunkhwa, 2006. Livestock Census. Development Statistics of Khyber Pakhtunkhwa. Bureau of Statistics, Khyber Pakhtunkhwa.
Knox Lovell, C. A. 2008. Frontier analysis in health care. University of Georgia, Athens GA 30602, USA.
Kumbhakar, S. C. and C.A. Lovell. 2000. Stochastic frontier analysis. Cambridge University Press, Cambridge. https ://doi.org/10.1017/CBO9781139174411
Mohsin, A. Q., R. Riaz, S. Asad and A. Mushtaq. 2008. Profitability analysis of broiler production in Rawalpindi district. Pak. J. Agri. Sci. 45(4): 514-519.
Miraj, N. and S. Ali. 2014. Estimation of technical efficiency of garlic farms in district peshawar, Pakistan: A stochastic frontier analysis. Int. J. Innovat. Scient. Res. 9(1): 140-149.
Ogunlade, I. and S. A. Adebayo. 2009. Socio-economic status of women in rural poultry production in selected areas of Kwara State, Nigeria. Int. J. Poult. Sci. 8(1):55-59. https://doi.org/10.3923/ijps.2009.55.59
Oji, U. O. and A. A. Chukwuma. 2007. Technical efficiency of small scale poultry-egg production in Nigeria: Empirical study of poultry farmers in Imo State, Nigeria. Res. J. Poult. Sci. 1 (3-4): 16-21.
Omar, M.A.E. 2014. Technical and economic efficiency for broiler farms in Egypt: Application of data envelopment analysis (DEA). Global Vet.12 (5): 588-593.
Pakage, S., B. Hartono, Z. Fanani and B. A. Nugroho. 2015. Analysis of technical, allocative and economic efficiency of broiler production using closed house system in Malang District of East Java Indonesia, Faculty of Animal Husbandry University of Brawijaya Malang East Java Indonesia.
PPA, 2012. Pakistan Poultry Association, 2011-12.
PPA, 2014. Pakistan Poultry Association, 2013-14. The Express Tribune, 2014. The Daily Express Tribune. 5th September, 2014.
The Express Tribune, 2014. The Daily Express Tribune. 5th September, 2014.
USDA. 2015. Department of Agriculture United States, 2015.
Varian H. R. 1992. Microeconomic Analysis, 3rd edition. W. W. Norton and Company Inc., New York. N. Y. 10110.
Wahid, U., S. Ali and N.A. Hadi. 2017. On the estimation of technical efficiency of tomato growers in Malakand, Pakistan. Sarhad J. Agric. 33(3): 357-365. http://dx.doi.org/10.17582/journal.sja/2017/33.3.357.365