



## Estimation of Technical Efficiency of Small Scale Broiler Producers in Khartoum State, Sudan 2015

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### ABSTRACT

The purpose of this paper was to estimate the production technical efficiency small-scale broiler producers in Khartoum state. It determined the factors that may affect productivity and the broiler farms efficiency. A sample of 40 small-scale broiler producers in the State was selected, using a well-structured questionnaire. Stochastic frontier production function was used to calculate technical efficiency scores and to explore the effect of inefficient factors. Results showed that the estimated average of technical efficiency for these farms was 83%, which means these producers in average can increase their output by 17% given the present condition of technology and inputs levels to reach 100% of technical efficiency. This paper recommended that the producers of small scale broiler farms were not technically efficient in use their inputs in broiler production.

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### INTRODUCTION

Broiler is that side of poultry production concern with meat production, special breeds for those purposes which have the ability to convert food to edible muscles i.e. rapid growth breeds (Sharabeen, 1996). Chicken meat topping the list of poultry meat consumed worldwide as it present a more than 70% of the global poultry meat and representing four continents, North America, South America, Asia and European union,

percentage 90% of the production of chicks in the world (ICAS, 2008). Poultry sector in Sudan is considered the most advanced and sophisticated, where the poultry industry has seen great development in Sudan to enter the national and exclusive investments in response to the growing demand for poultry products resulting from increased economic growth and improved standard of living in addition to the expansion of the consumer food

culture (ARPPP, 2010). Khartoum State is considered the largest and most states of Sudan invest in the poultry industry in which invests more than 85% of poultry production projects in Sudan. The reality of poultry production in the state is based on breeding in the traditional open barns (ICAS, 2008). Chicken has become one of the most important meats consumed in the world (Watt, 2012). Its importance in terms of consumption in Africa is becoming significant (Shine, 2006). Given a few information of broiler farms importance in Khartoum as well as Sudan; Khartoum state produce almost 70% of Sudan broiler product (Chamber of Poultry, 2012). In economics, the term economic efficiency refers to the use of resources to maximize the production of goods and services. An economic system is said to be more efficient than another (in relative terms) if it can provide more goods and services for the society without using more resources (Barr, 2004). The objective of resource management is to ensure efficient use of resource and to maximize resource and productivity (Onyebinama, 2002). Efficiency in production is a way to ensure that products of firms are produced in the best and most profitable way. To prevent waste of resources efficiency is of great importance for every sector in the economy, but for the Sudan agricultural sector, the upcoming policies will radically increase the already high need efficiency. There are distinctly two types of efficiency; technical and allocative. Markovits (2008) defined allocative efficiency as type of economic efficiency in which the economy producers produce only that goods and services which are more desirable in the society and in high

demand. Sullivan and Shiffrin (2003) defined technical efficiency as means in which natural resources are transformed into goods and services without waste, that producers are doing the best job possible of combining resources to make goods and services. Technical efficiency is just one component of overall economic efficiency. On other words, find ways of increasing output per unit of input and obtaining desirable inter-firm, intra-firm and inter-sector transfer of production resource in order to provide the means of raising the economic level (Awoke and Okorji, 2003).

The main goal of this paper was to estimate the technical efficiency for small-scale producers in Khartoum State.

## **MATERIALS AND METHODS**

In order to calculate technical efficiency the study depended mainly on primary data while secondary data was also collected. The primary data was collected during May to August, (2015) in Khartoum State. The secondary data was collected from different sources related to the topic of the study. The sampling method used for this research was multistage sampling technique. The first stage, involved a purposive based on population of the broiler small-scale producers, and availability size of the small scale. The second stage involved purposive sample of 40 broiler producers in Khartoum state. Purposive sample of 40 producers representing the small-scale broiler farms (less than 500.000 broilers per year) of Khartoum state was selected. A well-structured questionnaire was designed for this purpose. Different locations of produced areas were visited. The idea behind efficiency studies is to measure a firm's position relative to an

efficient frontier, resulting in an efficiency score of the firm. The efficiency score is bounded between zero and one, where a score of one indicates full efficiency. When using SFAM, estimation via the production, cost or profit function will be possible. The cost and profit functions are both dual to the production function, and thus they can be derived from the estimates. Cost and profit functions have the advantage of following multiple outputs, but if we want to limit the behavioral assumptions, as we do in this study, the production function is probably a better choice (Coelli, 1996). This study also believes that data on inputs have higher quality than price data, making the production function a more suitable choice.

**Stochastic frontier production (SFA)**

**model:** Modern efficiency measurement begins with Farrell (1957) who drew upon the work of Debreu (1951) and Koopmans (1951) to define a simple measure of firm efficiency that could account for multiple inputs. He proposed that the efficiency of a firm consists of two components: Technical efficiency, which reflects the ability of a firm to obtain maximal output from a given set of inputs, allocative efficiency, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices. These two measures are combined to provide a measure of total economic efficiency.

The computer program, FRONTIER program, used to obtain maximum likelihood estimates of a subset of the stochastic frontier production and cost function. Since the stochastic production frontier Meeusen and Van den Broeck (1977) first and nearly simultaneously published model and Aigner *et al.*,

(1977), there has been considerable research to extend the model and explore exogenous influences on producer performance. Early empirical contributions investigating the role of exogenous variables in explaining inefficiency effect adopted a two-stage formulation, which suffered from serious econometric problem. In the 1990, Kumbhakar *et al.*, (1991), Reifschneider and Stevenson (1991), Huang, and Lui (1994) proposed stochastic models that simultaneously estimate the parameters of both the stochastic frontier and the inefficiency functions. While the formulated models differ somewhat in the specification of the second error component, they all used cross-section data. Battese and Coelli (1995) formulated a stochastic frontier production model similar to that of Huang and Liu and specified for panel data. In this study, we adopt the Coelli but specified cross-section data context (Coelli, 1996). The original specification involved a production function specified for cross-sectional data, which had an error term of two components, one to account for random effects and another to account for technical inefficiency.

The model of SFA can be written as a:

$$Q_i = \alpha + \beta_m x_{mi}$$

$$\ln Q_i = \ln \alpha_0 + \beta_1 \ln x_{1i} + \beta_2 \ln x_{2i} + \dots + \beta_j \ln x_{ji} + \ln \alpha_1 + \alpha_2 \ln z_{1i} + \alpha_3 \ln z_{2i} + \dots + \alpha_j \ln z_{ji} + U_i - V_i$$

Whereas:

$Q_i$ : the broiler production (or logarithm of the production).

$\alpha$ : intercept

$\beta_m$ : parameters

$x_m$ : independent variables

$x_1$ : total costs /kg

$x_2$ : bird stock /number

$x_3$ : ration / ton

$x_4$ : labour /number

$z_m$ : inefficiency parameters:  
 $z_1$ : Age / year  
 $z_2$ : Education level  
 $z_3$ : Number of family  
 $z_4$ : Number of family working in the farm  
 $z_5$ : Experience /year  
 $z_6$ : Information source  
 $z_7$ : mortality rate / percentage  
 $U_i$ : non-negative random variables  
 $V_i$ : random variables  
 $Y_i = x_i\beta + (V_i - U_i)$   
 $i = 1, \dots, N$   
 Whereas:  
 $Y_i$ : the broiler production (or logarithm of the production) of the  $i$ -th firm.  
 $x_i$ : is input quantities of the  $i$ -th firm.  
 $\beta$ : unknown parameters.  
 $V_i$ : random variables Which are assumed to be,  $N(0, \sigma^2)$ .  
 $U_i$ : non-negative random variables which are assumed to account for

technical inefficiency in production and are often assumed to be  $N(0, \sigma^2)$ .

## RESULTS AND DISCUSSION

Technical inputs efficiency scores were estimated for one product cycle of small-scale broiler producers in Khartoum state, using the stochastic frontier approach (SFAM). Table (1), shows the maximum likelihood (ML) estimates of the stochastic frontier trans-log production parameters for the broiler small-scale farms producers. The Sigma-squared ( $\sigma^2 = 0.41$ ) and the gamma ( $\gamma = 0.90$ ) are quite high and highly statistically significant at 1% level. The high and significant values of the sigma-square ( $\sigma^2$ ) indicate the goodness of fit correctness of the specified assumption of the composite error terms distribution. The gamma ( $\gamma = 0.90$ ) depicts that 90% of the total variation in broiler output is due to the technical inefficiency.

**Table 1:** Maximum Likelihood Estimates (MLE) of the stochastic production frontier function of small-scale broiler farms in Khartoum state, 2015

Production Factors	Parameter	Coefficient	Standard-Error	t-ratio
Intercept	$\beta_0$	5.7	0.62	9.1***
Total cost	$\beta_1$	-0.17	0.52	-3.4***
Bird stock	$\beta_2$	0.18	0.59	1.9*
Ration	$\beta_3$	0.17	0.98	7.2***
Labour	$\beta_4$	-0.11	0.83	-1.4
Technical inefficiency:				
Intercept	$\alpha_0$	1.7	4.7	2.5***
Age	$\alpha_1$	-0.14	0.62	-0.24
Education level	$\alpha_2$	-7.8	1.6	4.6***
Member of family	$\alpha_3$	-0.94	0.57	-1.6
Member of family working in the farm	$\alpha_4$	0.50	0.82	0.61
Experience	$\alpha_5$	0.51	0.35	1.4
Information source	$\alpha_6$	-0.66	0.83	-0.79
Mortality rate	$\alpha_7$	-0.42	0.54	-0.76
Variance parameters:				
Sigma-squared	$\sigma^2$		0.41	5.8***
Gamma	$\gamma$		0.90	20.6***
ML			-4.37	
LR			32.42	

\*\*\*significant at level 1%

\*\*significant at level 5%

\*significant at level 10%.

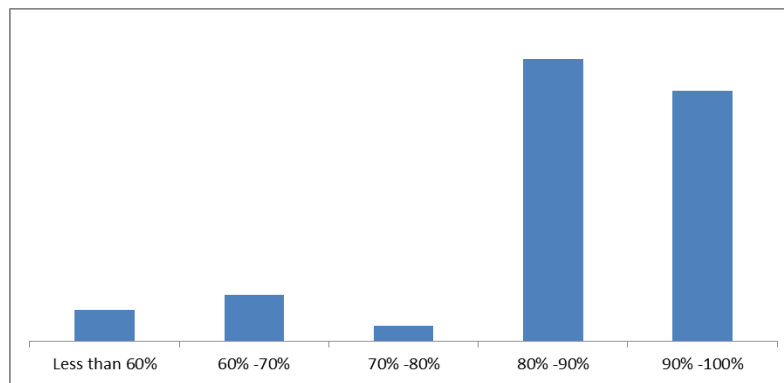
The coefficient of the total costs was negatively correlated with high level of significance (1%). This indicates that the negative relationship between total costs and production and one percent increase in total costs, broiler production decreases by 17%.

The coefficient of the stock bird was positive and significant at the 1% level of significance. One increase in day-old chicks brings about 18% increases in broiler production. This means that farms can still increase their broiler production substantially by increasing their stock.

Ration was positive and highly significant at the production 1% level of significance. This implies that ration are important in broiler production, also indicates if this variable increase output will increase, because feed was a highest challenge faced small-scale broiler producers.

The estimated coefficient of labour was -0.11 and insignificant, this means that labor had no significant effect on broiler production. This is due to the availability of cheap labour in broiler production.

**Technical efficiency:** Results of technical efficiency percentage distribution are presented in Figure (1). Estimated technical efficiency measures revealed the existence of substantial technical inefficiencies of broiler farms. The computed average technical efficiency was 83%, similar result were obtained by (Aldai, 2014, and Elwali, 2015). Given the present state of technology and input level. This suggests that farms in the sample are producing on average at 83% for their potential. These results make inquiries about heterogeneity and the possibility that these producing farms in average can increase their output by 17% given the present state of technology and input levels.



**Figure 1:** Percentage distribution of technical efficiency of the stochastic production frontier function of the broiler small-scale producers' farms in Khartoum State, 2015

**Determinants of technical efficiency:** Stochastic frontier and the inefficiency models are presented in Table (1). A negative inefficiency coefficient implies a positive relationship with technical efficiency and vice versa.

Age has negative effect but insignificant on the technical inefficiency of broiler producers, which means increase in age, decreases the inefficiency that the older ones are more efficient than the younger ones. This could be attributed to the fact

that older people are more experience in broiler production, while as younger willing to adopt new ideas of doing things.

Education level of farmers has a negative sign and it was highly significant (1% level of significance).

The effect of technical inefficiency, indicating that the higher the education level of farmers will reduce the level of technical inefficiency reached by farmers. This is because education helps in the adoption and use of improved technological innovations. This result also shows that farmers spent many years in education to be more efficient in broiler production. Nachare, (2007) obtained similar results.

The coefficient of number of family members had a negative sign and insignificant effect on the level of technical inefficiency, but family labour is a good way of providing labour for the farm activities.

The coefficient of Source of information and mortality rate were negative signs but were insignificance. This implies that source of information and mortality rate are not major determinants of technical efficiency among the small-scale broiler producers' farms.

No significant relationship was found between technical efficiency and number of family members working in farm and producers' experience.

## CONCLUSION

In the Sudan, poultry industry plays a major role in contributing towards addressing key national development goals and improving the standard of living of people through poverty alleviation and creating employment opportunities. For all these reasons studies focus on the broiler small scale farms producers'. Specifically, the study

looks at the socio-economic characteristics of the producers and production factors that affect technical efficiency of farmers.

Finally it could be concluded that the main challenge facing the broiler producers is to enhance their cost minimizing skills. Showed the education level of the producer was the major socioeconomic variable. Level of education can be manipulated within the framework of an agricultural policy in order to improve the technical efficiency of small scale broiler producers. Actually, all policy measures that build the capacities of farmers will lead to a substantial reduction of technical inefficiency.

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