IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 14, Issue 1 Ser. III (January 2021), PP 06-14
www.iosrjournals.org

Determinants of Profit efficiency in smallholder broiler production in Kabwe district, Zambia

Emmanuel Chibanda Musaba[1], Cletus Chibalani[2]
[1] *Department of Agriculture, School of Agriculture and Natural Resources, Mulungushi University, P.O Box 80415, Kabwe, Zambia.*
[2]*Zambia Correctional Service, HQ, P.O. Box 80926, Kabwe, Zambia.*
***Corresponding Author:** Emmanuel C. Musaba,*

Abstract:
Poultry in particular broiler production is an important source of income and animal protein for small-scale broiler farmers in Zambia. Profitability of broiler production is affected by high prices of chicken feed and other inputs and low bird selling prices. This study was initiated with the objective of examining profit efficiency and its determinants in small-scale broiler production in Zambia. Data collected from 120 smallholder broiler farmers in Kabwe district in Central province of Zambia was analyzed using descriptive statistics and Cobb-Douglas stochastic profit frontier model. The result indicated that smallholder broiler farmers were not operating at full profit efficiency level. The profit efficiency ranged from 2% to 77% with a mean of 38%. This implies that profit efficiency for an average broiler farmer in the study area could be increased by 62% by improving technical and allocative efficiencies of available resources adopting the management practices of the best-performing farmer.
The cost of chicks ($p<0.01$) and cost of labour ($p<0.10$) have positive significant effects on farm profit, while feed cost (($p<0.01$) has a negative significant effect on broiler farm profit. The profit inefficiency model showed that being a male has significant positive effect on profit efficiency, while farming experience, flock size and extension contact have significant negative effects on profit efficiency. In order to improve profit efficiency among the small-scale farmers, the study recommends that policy measures should focus on significant factors found in this study namely, gender, farming experience, extension access, and flock size.
***Key Words:** Stochastic profit frontier, Profit efficiency, broiler production, smallholder, Zambia*

Date of Submission: 07-01-2021 Date of Acceptance: 23-01-2021

I. Introduction

In Zambia, poultry farming (i.e. broiler meat and eggs) is a major component of livestock production and accounts for 48% of livestock output (IAPRI, 2018) [1]. Livestock and fisheries together accounts for 35% of agricultural GDP and agriculture contributes about 9% of gross domestic product (GDP), employs 52% of the labor force, and generates 9% of export earnings (World Bank, 2017) [2]. Since 2000, the poultry industry has grown rapidly at annual rates of 8% and 10% for broilers and layers, respectively (Poultry Association of Zambia, 2014) [3]. This rapid growth in poultry production has been in response to high demand for poultry products resulting from rapid human population growth, urbanization, and rising disposable income, and higher taste for chicken meat among Zambians. The growth in supply has been supported by the introduction of advanced technology in poultry breeding, production and processing. In particular there has been stable supply of day-old-chicks and point of lay birds, quality feeds and readily availability of veterinary drugs and services and poultry equipment in the country.

In Zambia, poultry production is concentrated along the line of rail Livingstone-Lusaka-Kitwe and around urban centers. Poultry producers can be categorized into three classes: (i) subsistence farmers, who rear mainly indigenous or local chickens under the low-input free range system; (ii) small-scale and medium-scale commercial producers of broilers and eggs; and, (iii) large-scale commercial firms. The poultry industry anchors on the small and medium enterprises that operate 60% of poultry production farms (Poultry Association of Zambia, 2014) [3]. These include growing numbers of urban dwellers who engage in backyard poultry production as a means of generating additional income to cope with the rising cost of living. The large commercial broiler farms dominate the formal market which handles about 65% of the broilers and eggs sold. The large firms supply into the formal market dressed chickens and packaged /graded eggs through chain stores, supermarkets, hotels, lodges and fast foods (Agriprofocus, 2015) [4]. Most of the live sales occur at informal markets countrywide. Suppliers of live birds on the market are mainly the small- to medium-scale producers, including households or individuals producing in their backyards (Samboko et al. 2018) [5].

The potential of small-scale poultry producers to contribute to employment creation, income generation, poverty reduction and food security, is adversely affected by low profitability of broiler farm enterprise resulting from high prices of chicken feed, veterinary drugs, utilities; high interest rates and low chicken prices (due to stiff competition). In addition poultry farming is constrained by lack of improved poultry farming skills and technology; inadequate input use, small flock sizes, and outbreak of diseases. The effect of these factors is reduced production, low productivity, high operation costs and low profitability of smallholder broiler enterprises. Despite all these challenges, broiler farming is still considered an important investment opportunity among smallholder farmers and individual households operating in backyards. Thus, finding ways to improve profit efficiency of poultry farming is relevant. In this regard undertaking efficiency studies is useful in that they help in identifying ways to improve output and profits through efficient utilization of existing farm resources and technology. Profit efficiency, is defined as the ability of a farm to achieve highest possible profit given the prices and levels of fixed factors of that farm and profit inefficiency is the loss of profit from not operating on the frontier (Ali and Flinn, 1989) [15].

Prior to this paper there was no recent study in Zambia which had examined profit efficiency in the Zambian poultry or livestock farming. The existing studies on efficiency of Zambian agriculture, focused on technical and allocative efficiency of crops and excluded livestock or poultry. These studies include: Kabwe (2012) [6] on cotton, Chiona et al. (2014) [7] on maize and Musaba et al. (2014) [8] on maize. For poultry, one exception is a study on cost efficiency of poultry farming in Zambia conducted by Musaba and Mseteka (2014) [9]. As regards profit efficiency, there is only a study by Chikobola (2016)[10] on profit efficiency of groundnut production in Eastern province of Zambia.

Many studies have been conducted in other African countries and beyond on profit efficiency of poultry farming, and these include: Dziwornu and Sarpong (2014)[11], Tuffour and Oppong (2014) [12], and Oladimeji et al. (2017) [13]. Most studies have used the stochastic profit frontier model and concluded that there was scope for increasing profitability of broiler farming through improved efficiency of resources use and adopting appropriate management practices. In Ghana, Dziwornu et al. (2014) [11] applied the stochastic profit frontier model and showed that the mean profit efficiency of small-scale commercial broiler producers in the Greater Accra Region of Ghana was 69 percent. In addition, age of producer, extension contact, market age of broiler and credit access were found to significantly influence economic efficiency in broiler production. While, Tuffour and Oppong (2014) [12] revealed that broiler producers were able to realize 54% of their frontier profit on the average and that number of years of experience in broiler production was found to reduce inefficiency whilst farms owned by sole proprietors were less economically efficient. In Nigeria, Oladimeji et al. (2017) [13] found that the mean profit efficiency was 74% with a range of 30-98% and showed that age, household size and cooperative membership were the socio-economic variables responsible for the variation in profit efficiency of the broiler producers in Kwara State.

In view of the lack of studies on profit efficiency of broiler farming in Zambia, and the prevailing low profitability and high cost of production, the need to fill this information gap exists. Therefore, this study was initiated to fill the information gap with respect to issues affecting profit efficiency of the small-scale broiler producers in Zambia. This study helps by understanding the levels of profit efficiency or inefficiency and identifies the associated socio-economic factors and management practices that can be addressed to improve profit efficiency among broiler farmers under study. The major objective of this study is to assess the profit efficiency of broiler production and its determinants among smallholder farmers by applying the stochastic frontier approach to data from small-scale broiler farmers in Kabwe District of Central Province of Zambia.

Efficiency is concerned with relative performance of the processes used in transforming given input into output. Economic efficiency comprises two components – technical and allocative efficiency. Technical efficiency relates to the degree to which a farmer produces the maximum feasible output from a given bundle of inputs (an output oriented measure), or uses the minimum feasible level of inputs to produce a given level of output (an input oriented measure). Allocative efficiency relates to the degree to which a farmer utilizes inputs in optimal proportions, given the observed input prices (Coelli et al., 2005) [14]. While, economic efficiency is defined as the capacity of a firm to produce a predetermined quantity of output at minimum cost for a given level of technology. Another concept is that of profit efficiency, is which refers to the ability of a farm to achieve highest possible profit given the prices and levels of fixed factors of that farm and profit inefficiency is the loss of profit from not operating on the frontier (Ali and Flinn, 1989) [15].

There are three approaches to measurement of productive efficiency: parametric (deterministic and stochastic), non-parametric based on Data Envelopment Analysis (DEA), and productivity indices based on growth accounting and index theory principles (Coelli et a., 1996) [16]. Stochastic Frontier Analysis (SFA) and DEA are the most commonly used methods. Both methods estimate the efficiency frontier and calculate the firm's technical, cost and profit efficiency relative to it. The frontier shows the best performance observed among the firms and it is considered as the efficient frontier. The SFA approach requires that a functional form be specified for the frontier production function while DEA uses linear programming to construct a piece-wise frontier that envelops the observations of all firms. An advantage of the DEA method is that multiple inputs and output can be considered simultaneously, and inputs and outputs can be quantified using different units of measurement. Being non-stochastic, the DEA approach does not differentiate data noise and inefficiency (Coelli, 1996) [16]. On the other hand, SFA takes into account measurement errors and other noise in the data. SFA is important for studies of farm level data that usually include measurement errors.

The profit function approach combines the concepts of technical and allocative efficiency in the profit relationship and any errors in the production decision are assumed to be translated into lower profits or revenue for the producer. The common approach of measuring profit (economic) efficiency involves use of the stochastic profit frontier function (Ali and Flinn, 1989) [15]; Kumbhakhar and Battacharya, 1992) [17]; Wang et al., 1996; Rahman, 2003) [19].

In light of the above, in order to estimate the profit efficiency and determine the farm-specific factors affecting profit efficiency among small-scale broiler farmers of Kabwe district in Central province, Zambia, the stochastic profit frontier analysis was applied.

II. Material And Methods

Study area

The study was conducted in Kabwe district which located 130 km north of Lusaka, the capital of Zambia. It has a total land area of 1,572 Km^2 with a population of 221,077, (CSO, 2010) [37]. It is in agro-ecological Region II that receives annual rainfall in the range of 850mm to 900mm. The urban settlement is surrounded by farms and the major crop products include maize, cotton, tobacco, groundnuts and vegetables. While livestock activities include: cattle, goats, dairy, and poultry. In then urban area, some households engaged in backyard raising of broilers and layers.

Sources and type of Data

Data were collected from primary and secondary sources. A structured questionnaire was used in collection primary data from respondents captured data on captured information for the most recent production cycle regarding broiler output, amounts of variable inputs used, prices or cost of inputs and prices of products, revenue, and socio-economic variables. The survey was conducted during February and March 2018. Out of 120 questionnaires administered to farmers, 110 questionnaires were suitable for analysis.

Sampling technique and sample size

Purposive and multi-stage sampling procedureswere used in selecting respondents for the study. Kabwe district in Central province was purposively selected for the study. The district is the capital of Central province and a major urban area in the province where backyard broiler farming is commonly practiced. Within the district, six residential areas (communities) namely: Mukobeko, Makululu, Kawama, Railways, Katondo, and Chowa were purposively selected and within each community, 20 broiler farmers were selected using the snowballing method. A total of 120 smallholder broiler farmers were interviewed.The sample size was determined using Yamane's formula, assuming a target population of (N=500) smallholder broiler farmers in Kabwe urban areas and allowable error of precision at e=8%.

Sample size $n= N/(1 +Ne^2) = 500/[(1+500*(0.08)*(0.08)] = 119.05$

Therefore a sample size was set at 120 and data was collected from 120 farmers.

Data Analysis

Descriptive statistics namely means and percentages were used to summarize the key characteristics of the smallholder broiler farmers in Kabwe District. The estimation of the profit efficiency and its determinants was achieved using the stochastic frontier approach.

Analytical framework: The Stochastic Profit Frontier Approach

Production efficiency is usually analyzed by its two components –technical and allocative efficiency. Recent developments combine both measures into one system, which enables more efficient estimates to be obtained by simultaneous estimation of the system (Wang, Cramer and Wailes, 1996) [19]. The popular approach to measure efficiency – the technical efficiency component – is the use of frontier production function (Tzouvelekas et al., 2001 [20]; Wadud and White, 2000 [21]). However, it has been argued that a production function approach to measure efficiency may not be appropriate when farmers face different prices and have different factor endowments (Ali and Flinn, 1989) [15]. This led to the application of stochastic profit function models to estimate farm specific efficiency directly (Wang et al., 1996).

Profit efficiency, as alluded to earlier refers to the ability of a farm to achieve highest possible profit given the prices and levels of fixed factors of that farm and profit inefficiency is the loss of profit from not operating on the frontier (Ali and Flinn, 1989) [15]. The profit function approach combines the concepts of technical and allocative efficiency in the profit relationship and any errors in the production decision are assumed to be translated into lower profits or revenue for the producer (Ali et al., 1994) [37].

Battese and Coelli (1996) [16]extended the stochastic production frontier model by suggesting that the inefficiency effects can be expressed as a linear function of explanatory variables, reflecting farm-specific characteristics. The advantage of this model is that it allows the estimation of farm specific efficiency scores and the factors explaining the efficiency differentials among farmers in a single stage estimation procedure. Following Rahman (2003), this study adapts the Battese and Coelli (1995) [22] model by postulating a profit function, which is assumed to behave in a manner consistent with the stochastic frontier concept. Following the approach of Rahman (2003), the stochastic profit function is defined as:

$$\pi_i = f(P_i, Z_j).\exp(e_i) \quad (1)$$

where πi is the normalized profit of the ith farm defined as gross revenue less total variable cost, divided by farm specific output price; $P_i$is the price of variable inputs faced by the ith farm divided firm specific output price; $Z_j$is the level of the fixed factor on the ith farm; and $e_i$is an error term; and i = 1,.., n, is the number of farms in the sample.

The error term $\varepsilon_i$is assumed to behave in a way consistent with the frontier concept (Ali and Flinn 1989; Rahman 2003) [15, 18], i.e.,

$$e_i = V_i - U_i \quad (2)$$

$V_i$is a symmetric error term and is assumed to be independently and identically distributed (V_i~iid N(0, σ^2_v)) two-sided error term, representing the random effects, measurement errors, omitted explanatory variables and statistical noise. $U_i$is the one-sided error term, and the U_i's are assumed to have a half normal non-negative distribution N(0, σ^2_u) and represent profit inefficiency of the farm (Abdulai and Huffman 1998) [23]. Thus, it represents the shortfall from its maximum possible value that will be given by the stochastic profit frontier.

In the inefficiency effects model, the ui terms in equation 2 are assumed to be non-negative random variables, associated with inefficiency of the farm. They are assumed to be independently distributed, such that efficiency measures are obtained by truncation of the normal distribution with mean, $\mu = \delta_0 + \Sigma_d \delta_d W_{di}$ and variance σ^2_u ($|N(\mu, \sigma^2_u|$), where W_{di} is the dth explanatory variable associated with inefficiencies on farm i and δ_0 and δ_d are the unknown parameters.

The profit efficiency of the farm i in the context of the stochastic frontier profit function is defined as

$$EFF_i = E[\exp(-u_i)\,|e_i] = E[\exp(-\delta_0 - \Sigma_d \delta_d W_{di})|e_i] \quad (3)$$

Where, E is the expectation operator. The method of maximum likelihood is used to estimate the unknown parameters, with the stochastic frontier and the inefficiency effects functions estimated simultaneously. The likelihood function is expressed in terms of the variance parameters, $\sigma^2 = \sigma^2_v + \sigma^2_u$ and $\gamma = \sigma^2_u/\sigma^2$ (Battese and Coelli, 1995) [22].

Empirical Models: Stochastic profit frontier and inefficiency models

Following Rahman (2003) [29], this study specifies a Cobb-Douglas stochastic frontier function with behaviour inefficiency components as expressed below. The explicit Cobb-Douglas functional form for the smallholder broiler farmers in Kabwe district in Central Province, Zambia, is expressed as:

$$In\pi = \beta_0 + \beta_1 InP_{1i} + \beta_2 InP_{2i} + \beta_3 InP_{3i} + \beta_4 InP_{4i} + \beta_5 InP_{5i} + \beta_6 InX_{1i} + (V_i - U_i) \quad (4)$$

Where:

π = normalized profit computed for jth farm which is defined as gross revenue less variable costs divided by farm specific broiler output price P_y; ln = Natural log; P_i = Price of variable inputs normalized by price of output. P_1= Costs of labour normalized by unit price of broiler output (P_y); P_2 = Cost of chicks normalized by unit price of broiler output (P_y); P_3 = Cost of feed normalized by unit price of broiler output (P_y); P_4 = Cost of medications normalized by unit price of broiler output (P_y); P_5 = Other costs normalized by unit price of broiler output (P_y); X_i = Quantity of fixed inputs (i = 1, 2); X_1= Area chicken house for each farm jth; β_0 = Constant parameter, and β_i (i=1,…,6) are coefficients of parameters to be estimated.

To facilitate examining the effect of the possible determinants of profit inefficiency, the following inefficiency (Ui) model was estimated:

$$U_i = \delta_0 + \delta_1 W_{1i} + \delta_2 W_{2i} + \delta_3 W_{3i} + \delta_4 W_{4i} + \delta_5 W_{5i} + \delta_6 W_{6i} + \delta_7 W_{7i} + \vartheta \quad (5)$$

Where; W_1, W_2, W_3, W_4, W_5 and W_6 represents W_1= age, W_2=gender, W_3=educational level, W_4=farming experience, W_5=poultry training and W_6=extension service, and W_7=flock size. These socio-economic variables were included in the model to assess their possible effect on profit efficiencies of the broiler farmers. All parameters of the stochastic frontier profit function and the inefficiency model were estimated together using the program STATA version 13.

III. Result and Discussion

Summary statistics of sample households

The age of respondents ranged from 23 to 55 with mean of 35.16 years. Majority of respondents were male (76%) and 24% were female (Table 1). The average level of education attained by the respondents was 3.41 which was equivalent to secondary school education. On average farmers have 5.26 years of broiler farming experience with a minimum of

Table 1: Summary statistics of characteristics of sample broiler farmers in Kabwe district

Variable	Minimum	Maximum	Mean	Std. Deviation
Gender (1=Male, 0=Female)	0.00	1.00	0.76	0.43
Age (years)	23.00	55.00	35.16	7.32
Education level	1.00	4.00	3.41	0.61
Training (1=yes, 0=No)	0.00	1.00	0.56	0.50
Experience (years)	1.00	20.00	5.26	3.74
Extension visits (number)	0.00	7.00	1.53	1.18
Used Credit (1=Yes, 0=No)	0.00	1.00	0.52	0.50
Used Savings (1=Yes, 0=No)	0.00	1.00	0.77	0.42
Record keeping (1=Yes, 0=No)	0.00	1.00	0.75	0.43

one year and a maximum of 20 years. The average of 5 years farming experience indicate that most farmers in the study area are new to poultry farming and would require technical advice to farm profitably. More than half (56%) of respondents have attended training in the poultry management and 75% of respondents practice record keeping. The main sources of capital used to start the broiler business were personal savings (72%) and credit (56%). The mean frequency of extension contact was 1.5 times in a production cycle. This reveals that there is low frequency of extension contact between farmers and extension workers.

The descriptive statistics for farm variables are presented in Table 2. The mean size of the poultry house was 28.75 square meters. The farmers operated a deep litter system with manual feeding of birds. On average 200 day-old chicks were purchased per production cycle and 192 mature birds reached the marketing stage after 5-6 weeks. The average production costs for feed, day-old chicks and veterinary drugs were ZMW 3567, ZMW 1126, and ZMW 316, respectively. Feed cost and cost of day-old chicks were the major expense items contributing 56.3% and 17.8% of the variable costs, respectively. The average number of workers employed per farm was 1.32 workers and the average cost of labour was ZMW328 per month. The farmer produced an average of 6 batches per year and the average broiler price was ZMW 41.50 per bird during 2018. The mean total variable cost was ZMW 6333.7 and the average gross margin was ZMW 2550. Based on a stock of 200 birds, the average variable cost per bird would be ZMW 31.00.

Table 2: Descriptive statistics of broiler output and input usage in Kabwe district

Variable	Minimum	Maximum	Mean	Std. Deviation
Batches per year (number)	4.00	9.00	6.03	0.95
Poultry house size (m^2)	6.00	280.00	28.76	26.55
Flock size (day-old chicks)	70.00	500.00	201.86	93.95
Total broilers	62.00	485.00	192.19	92.98
Selling age (weeks)	5.00	6.00	5.49	0.50
Labour men	1.00	3.00	1.32	0.52

Labour cost (ZMW)	200.00	900.00	328.73	137.00
Cost of chicks (ZMW)	406.00	2750.00	1126.15	533.99
Feed cost (ZMW)	1346.00	9470.00	3567.67	1746.63
Vet. Drug cost (ZMW)	148.00	5254.00	316.39	480.03
Gross margin per farm (ZMW)	-47681.00	15290.00	2550.34	5509.83
Broiler price (ZMW/bird)	40.00	50.00	41.95	2.54
Total Variable cost (ZMW)	2328	55721	6333.74	5419.51

Source: Survey, 2018

Maximum likelihood estimates of the profit frontier

Table 3 presents the maximum likelihood estimates for parameters of the Cobb-Douglas stochastic profit frontier model for small-scale broiler farmers in Kabwe district. The results show statistically significant coefficient for sigma squared (σ^2), indicating that the model has a good fit and correctly specified distributional assumption of the error term. The value of gamma (γ) is estimated to be 0.82 and this means that 82% of the variation in actual profit from maximum frontier profit among broiler farmers was due to farmers inefficiency and the rest (28%) is caused by external factors or random shocks outside the farmer's control. The result is consistent with the findings of Tuffor and Oppong (2014) [12] who found that about 89% variation in gross profit from the frontier profit among broiler producers in Greater Accra in Ghana was due to economic inefficiency effects whilst 11% was due to pure noise. Thus, profit variability was largely determined by inefficiency effects rather than random distribution of the deviations from the frontier profit.

Among the estimated coefficients of the parameters of the Cobb- Douglas frontier profit function in Table 3, cost of chicks and cost of labour were positive and significant at 1% and 10% level of probability. While the cost of feed was negative and statistically significant at 1% level. These results showed that cost of feed, cost of chicks and labour are

Table 3: Maximum likelihood Estimates of the Parameters of the Stochastic Profit Function

Variables	**Coefficients**	**Std. Err.**	**t-value**	**Sig.**
LNzCOSTCHICK	3.677***	0.569	6.460	0.000
LNzFEEDCOST	-2.051***	0.659	-3.110	0.002
LNzCOSTLAB~R	0.761*	0.463	1.640	0.100
LNzVETCOST	-0.216	0.351	-0.620	0.538
LNarea	0.345	0.324	1.070	0.287
Constant	-1.926	1.274	-1.510	0.130
Variance parameters				
sigma_v	0.807	0.195		
sigma_u	1.723	0.329		
Sigma-square	3.619	0.907		
lambda	2.135	0.498		
Gamma	0.820			
Log likelihood	-183.8758			

***Significant at 1% level, **significant at 5% level, *significant at 10% level.

significant determinants of profitability of broiler farming in the study area. A one percent increase in expenditure on day old chicks results in 3.67 percent increase in profits, other factors holding constant. A one percent increase in labour results in 0.76 percent increase in broiler profitability. Application of feed had negative effect on broiler profitability implying that a percentage increase in feed cost results in 3.67 percent decrease in the profit from broiler production. The negative coefficient of feed cost implies that the marginal value contribution of feed was lower than its price and as a result additional cost to use more feed reduced profit. The result of a negative coefficient of feed cost contrasts the finding of Oladimeji et al. (2018) [13] on broiler farming in Kwara State, Nigeria but concurs with that of Jabbar et al. (2005) [36] who found that the price of feed reduces profit in broiler production.

Profit efficiency scores

The distribution of profit efficiency scores is presented in Table 4. The results of the efficiency analysis showed that profit efficiency scores for the sample farms varied from 0.70% to 79% and the mean score was 38.1% (see Table 4). This indicates presence of high level of profit inefficiency in broiler farming among sample farms. The profit efficiency of 38 % implies that about 61.9 percent of the profit is lost to inefficiency of management. Thus, in the short run, there is scope for increasing profit from backyard broiler farming by 61.9% through adoption of the technology and techniques used by the best–practicing broiler farmers in the study area.
The wide range of profit efficiency values indicates large variations in performance across sample farms. The result show that 22.7 percent of farms have profit efficiency scores below 20 %, about third (31.8 percent) of farms their efficiency scores is from 21 to 40 %, for 28 percent of farms their efficiency scores were in the range of 41 to 60%, and only 17% farms have their efficiency above 60%. The mean profit efficiency score was 38.1%

Table 4: Profit efficiency distribution of broiler farmers in Kabwe district, Zambia

Efficiency Range	Frequency	Percent
0-20	25	22.7
21-40	35	31.8
41-60	31	28.2
61-80	19	17.3
>80%	0	0.0
TOTAL	110	100.0
Mean		38.07
Min		0.018
Max		0.784

Determinants of profit inefficiency

Since there were wide differences in the profit efficiency levels among surveyed broiler farmers, it was necessary to investigate further why some farmers achieved higher efficiency scores than others. The inefficiency function is known to provide some explanations for variations in efficiency levels. The results of the inefficiency effects model are presented in Table 5. A negative coefficient indicates that the variable causes inefficiency to decrease, while a positive coefficient indicates an increase of inefficiency. The farmer specific characteristics included in the inefficiency model were gender of the farmer, age of the farmer, education, training, poultry farming experience, access to extension services, and flock size (farm size).

The results in Table 5 shows that the coefficient of gender is negative and significantly ($p<0.10$) associated with profit inefficiency. It means that gender (male farmer) has a significant positive influence on profit efficiency of smallholder broiler farmers. This result suggests that male broiler farmers were more profit efficient than female broiler farmers in the study area. This result is consistent with the previous studies (Yiadom-Boakye et al., (2013) [24] and Otieno et al., (2012)) [25]. The differences in efficiency between male and female farmers can be attributed to differential access to inputs (Bahta and Baker, 2015) [26]

Table 5: Estimates of the determinants of profit inefficiency for small-scale broiler farmers

Variable	Coefficient	SE	t-ratio	p-value
GENDER	-1.29	0.78	-1.67*	0.096
AGEHHH	-0.11	0.08	-1.47	0.141
EDULEVEL	1.03	0.77	1.33	0.183
TRAINING	-0.86	0.68	-1.28	0.201
EXPERIENCE	0.22	0.13	1.74*	0.083
EXTENSIONVISITS	0.89	0.47	1.91*	0.057
BIRDSNOW (FLOCKSIZE)	0.01	0.00	1.78*	0.076
Constant	-3.29	4.71	-0.70	0.485

SE, standard error. ***Significant at 1% level, **significant at 5% level, *significant at 10% level.

The estimated coefficient for poultry farming experience was positive and statistically significant at 10% probability level. This result is unexpected but it indicates that as farming experience increases, the profit inefficiency of the farmer increases. This result contrasts the findings of Ogundari (2006) [27], Kolawole (2006) [28] and Rahman (2002) [29] and Nganga et al. (2010) [39] but is consistent with that of Akinyemi et al. (2015) [35], who found that the more experienced the farmer the more inefficient he becomes.

Participation in extension programs is expected to improve profit efficiency of a farmer. In this study, the coefficient associated with extension was found to be positive and significant. This implies that farmers who have access to extension services would perform poorly operating at higher level of inefficiency. This result is contrary to findings of Bocher and Simtowe (2017) [30], Saysay (2016) [31] and Binam et al., (2003) [32] who reported a positive relationship between access to extension delivery programs and profit efficiency. The negative effect of extension contact on profit efficiency, could be probably because the extension services were not directly for the purposes of using the knowledge for poultry farming.

The coefficient for flock size is found to have a positive effect on profit inefficiency, indicating that profit efficiency decreases with an increase in the number of birds produced. This finding confirmed the findings of Ike and Ugwumba (2011) [33] that as more birds are bought, mortality rate could become high particularly with poor management, using low quality feed, and inadequate feeding of birds, which in turn reduces output and increases profit losses.

IV. Conclusion and Recommendation

The present study estimated profit efficiency of broiler farms using the stochastic Cobb-Douglas profit frontier model. The results shows that cost of feed, cost of chicks and labour are significant determinants of profitability of broiler production. The cost of feed was negatively related to profit but cost of chicks and cost of labour had positive effects on profitability of broiler framing in the study area. The mean profit efficiency of farms was found to be 38%, implying that there is room to improve profits by 62% among the sample farms through improving technical and allocative efficiency of available resources in the study area.

The profit inefficiency model revealed that farmer's experience in broiler farming, extension access and farm size (sizeof flock) influenced profit inefficiency positively. While gender (male farmer) negatively influenced profit inefficiency. This implies that profit efficiencywould be higher among male than female farmers, and that increase of farmer's experience in broiler farming,extension access and size of farm size (flock size) would reduce profit efficiency.Policy measures aimed at improving profit efficiency in smallholder broiler production in the study area should consider the significant factors identified in this study.

References

[1]. Indaba Agricultural Policy Research Institute (IAPRI), (2018) Zambia Agriculture Status Report 2017. Indaba Agricultural Policy Research Institute, Lusaka, Zambia.

[2]. World Bank (2017) World Bank Open Data. 2017. Available online: https://data.worldbank.org/ (accessed on July 2018)

[3]. Poultry Association of Zambia (2014). Annual Report, Lusaka, Zambia

[4]. Agriprofocus (2015) Investors Guide: Poultry in Zambia.

[5]. Samboko, P.C., Olipa Zulu-Mbata, O. and Chapoto A. (2018). Analysis of the animal feed to poultry value chain in Zambia. Development Southern Africa 35 (3): 351-368. 2018.

[6]. Kabwe, M. (2012). Assessing Technical, Allocative and Economic Efficiency of Smallholder Maize Producers Using the Stochastic Frontier Approach in Chongwe District, Zambia. Master of Science Dissertation, University of Pretoria, Pretoria, South Africa.

[7]. Chiona, S. (2011).Technical and Allocative Efficiency of Smallholder Maize Farmers in Zambia. Master of Science Thesis. University of Zambia, Lusaka. http://dspace.unza.zm:8080/xmlui/handle/123456789/1813?show=full

[8]. Musaba E. C and I. Bwacha, 2014: Technical Efficiency of Small Scale Maize Production in Masaiti District, Zambia: A Stochastic Frontier Approach: Journal of Economics and Sustainable Development: Vol.5, No.4, 2014.

[9]. Musaba E.C. and Mseteka, M. (2014). Cost efficiency of small-scale commercial broiler production in Zambia: A stochastic cost frontier approach. Developing Country Studies 4 (5): 98-105.

[10]. Chikobola, M.M (2016). Profit Efficiency of Groundnut Production: Evidence from Eastern Province of Zambia. Journal of Economics and Sustainable Development, 7 (8):38-53.

[11]. Dziwornu, Raymond K., and Daniel B. Sarpong. 2014. "Application of the Stochastic Profit Frontier Model to Estimate Economic Efficiency in Small-Scale Broiler Production in the Greater Accra Region of Ghana." Review of Agricultural and Applied Economics 17 (02): 10–16.

[12]. Tuffour, M. and Oppong, B.A. (2014). Profit Efficiency in Broiler Production: Evidence from Greater Accra Region of Ghana. International Journal of Food and Agricultural Economics 2 (1): 23-32.

[13]. Oladimeji Y. U, Abdulsalam Z., Ajao A. M., Abdulrahman S. and. Abdulazeez R. O. (2017). Profit Efficiency of Broiler Production among Public Servant Household Heads in Kwara State, Nigeria: A Coping Strategy. Asian Journal of Economics, Business and Accounting 2 (2): 1-8.

[14]. Coelli, T. J., PrasadaRao, D. S., O'Donnel, C. J. and Battesse, G. E. (2005). An Introduction to Efficiency and Productivity Analysis. (Second Edition), Springer Science and Business Media, Inc., New York. 331pp.

[15]. Ali, M., and Flinn, J.C. (1989). Profit Efficiency among Basmati Rice Producers in Pakistan Punjab. American Journal of Agricultural Economics, 71, 303 – 310

[16]. Coelli, T.J. and Battese, G.E. (1996). Identification of Factors which Influence Technical inefficiency of Indian Farmers. Australian Journal of Agricultural Economics 40(2): 103-128.

[17]. Kumbhakar, S.C. and A. Bhattacharyya, (1992). Price Distortions and Resource Use Efficiency in Indian Agriculture: A Restricted Profit Function Approach. Review of Economics and Statistics 74: 231 – 239.

[18]. Rahman, S. (2003). Profit Efficiency among Bangladeshi Rice Farmers. Food Policy 28: 487-503.

[19]. Wang, J., Cramer, G.L. and Wailes, E.J. (1996). Production efficiency of Chinese agriculture: Evidence from rural household survey data. Agricultural Economics15:17-28.
[20]. Tzouvelekas, V., C.J. Pantzios and C. Fotopoulos, (2001). Technical Efficiency of Alternative Farming Systems: The Case of Greek Organic and Conventional Olive-Growing Farms. Food Policy, 26: 549-569.
[21]. Wadud, A.- White, B. 2000. Farm Household efficiency in Bangladesh: A Comparison of stochastic frontier and DEA methods. Applied Economics 32:1665-1673.
[22]. Battese, G. and Coelli, T. (1995). A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data, Empirical Economics, 20, 325-332.
[23]. Abdulai, A. and Huffman, W. E. (1998). An Examination of Profit Inefficiency of Rice Farmers in Northern Ghana. Economic Staff Paper Series. 298. Department of Economics, Iowa State University, Ames.
[24]. Yiadom-Boakye, E., Owusu- Sekyerer, E., Nkegbe, P.K., and Ohene-Yankyera, K. (2013). Gender, Resource Use and Technical Efficiency among Rice Farmers in the Ashanti Region, Ghana. Journal Agricultural Economics and Development 2(3): 102-110.
[25]. Otieno D.J, Hubbard L., and Ruto E. (2012). Dterminants of technical efficiency in beef cattle production in Kenya. Paper presented at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguacu, Brazil, August.
[26]. Bahta, S. and Baker, D. 2015. Determinants of Profit Efficiency among Smallholder Beef Producers in Botswana. International Food and Agribusiness Management Review 18(3):107-130.
[27]. Ogundari, K. (2006). Determinants of profit efficiency among small scale rice farmers in Nigeria: A profit function approach. Research Jounal of Applied Science, 1(1-4): 116-122.
[28]. Kolawole, O. (2006). Determinants of profit efficiency among small scale rice farmers in Nigeria: A profit function approach. Poster paper for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18.
[29]. Rahman, S. (2002). Profit Efficiency among Bangladesh Rice Farmers Manchester. Discussion Paper No. 203. School of Economic Studies, University of Manchester. 29pp
[30]. Bocher, T.F. and Simtowe, F. (2017). Profit efficiency analysis among groundnut farmers from Malawi. Journal of Development and Agricultural Economics .9 (10): 278-288.
[31]. Saysay, J. L., Gabagambi, D. M., & Mlay, G. I. (2016). Profit Efficiency among Smallholder Rice Farmers in Central Liberia. Journal of Economics and Sustainable Development 7(14): 94-103.
[32]. Binam (2003) BinamJ.N., Tonye J., Wandji N., Nyambi G. and Akoa, M. (2004). Factors Affecting the Technical Efficiency among Smallholder Farmers in the Slash and Burn Agriculture Zone of Cameron. Food Policy, 29(4): 531- 545.
[33]. Ike, P.C., and. Ugwumba C.O.A. (2011). Profitability of Small Scale Broiler Production in Onitsha North Local Government Area of Anambra State, Nigeria. International Journal of Poultry Science 10 (2): 106-109.
[34]. Nganga, S.K., Kungu, J., de Ridder, N., and Herrero, M. (2010). Profit efficiency among Kenyan smallholders milk producers: A case study of Meru-South district, Kenya. African Journal of Agricultural Research, 5(4), 332-337.
[35]. Akinyemi, M., Okuneye, P.A. and Hosu, S.Y. (2015). Profit efficiency of poultry egg production system in Ogun State, Nigeria. Scholarly Journal of Business Administration, Vol. 5(1) pp.8-12
[36]. Jabbar, M.A, Islam, S.M.F, Delgado, C., Ehui,S., Akanada, M.A.I, Khan, M.I., Kamruzzman, M. (2005). Policy and Scale factors Influencing Efficiency in Dairy and Poultry Production in Bangladesh. Nairobi, Kenya: Addis Ababa, Ethiopia; Salana, Gazipur, Bangladesh.: Systemwise Livestock Programme (SLP): International Livestock Research Institute (ILRI): BSMRAU).
[37]. CSO (2010). Census Report 2010. Central Statistics Office (CSO), Government of Republic of Zambia, Lusaka, Zambia.
[38]. Ali, F, Parikh, A., and Shah, M.K. (1994). Measurement of Profit efficiency Using Behavioral Frontier approaches. Applied Economics, 26, 181-188.
[39]. Nganga, S.K., Kungu, J., de Ridder, N., and Herrero, M. (2010). Profit efficiency among Kenyan smallholders milk producers: A case study of Meru-South district, Kenya.*African Journal of Agricultural Research,* 5(4), 332-337

Emmanuel C. Musaba,, et. al. “Determinants of Profit efficiency in smallholder broiler production in Kabwe district, Zambia.” *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 14(1), 2021, pp. 06-14.