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Technical Efficiency of Broiler Contract Growers in Chegutu District of Zimbabwe: A Stochastic Frontier Analysis

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Abstract **Original Research Article**

Zimbabwe has witnessed a steady growth in broiler contract farming post the land reform programme which has brought in new players for which little is known about their level of productivity when compared to traditional commercial broiler producers. The purpose of this study was to determine the technical efficiency of broiler contract growers in Chegutu district of Zimbabwe. Specific objectives for the study were to establish socio-economic characteristics of boiler contract growers, estimate their technical efficiency and establish the determinants of technical efficiency. A population of 54 growers under one contract farming arrangement was studied. Cross sectional data was collected using a structured questionnaire and the stochastic frontier analysis was used to analyse the technical efficiencies and the determinants of technical efficiency. Broiler contract farming is dominated by male growers who constitute 72% of the contracted farmers. Significant factors influencing output were found to be batch size, feed quantity and transport cost. The broiler contract growers were found to be highly efficient with a mean technical efficiency of 97.1% ranging from 88.9%-99.6%. Grower residence on the farm and grower management of daily operations were found to significantly reduce technical inefficiency while technical inefficiency increases with grower age and key employee experience. The study recommends that there is need to expand broiler contract farming as it is highly efficient. The government must also put in place measures that encourage young smallholder farmers to venture into broiler contract farming as they are more efficient when compared to older farmers. Measures should also be put in place to encourage more female farmers to venture into broiler contract farming.
Keywords: Broiler contract growers, Technical efficiency, Stochastic frontier analysis, Zimbabwe.

INTRODUCTION

The Zimbabwe's agriculture sector is a vital component in the country's economic architecture. The agriculture sector contributes 11% of the country's gross domestic product (GDP) with the livestock sector contributing 22% of the agricultural GDP (LMAC, 2016). It is also an important source of livelihood for 70% of the rural population which is reliant on it. Traders, agro processors also derive livelihood from agricultural activities (World Bank, 2010). The Zimbabwe livestock sector remains an important facet of the Zimbabwean economy with poultry continuing to steadily lead growth in the sector (LMAC, 2015). Poultry farming is also the most vibrant of the livestock sector accounting for approximately 5% of agricultural GDP (World Bank, 2010).

Poultry farming in Zimbabwe has restructured and is now dominated by small diverse production units as a result of new small scale players joining the commercial poultry industry (Figure 1). This transformation is the driving force behind the new poultry industry (Scoones, 2014). The smallholder sector has contributed largely to the growth in the broiler industry. This growth was complemented by the entry of four new hatcheries and growth in the feed sector (Sukume, 2016). The entry of new players included new contracting entities and the introduction of variant contracting models.

Sukume (2011) classified broiler production in Zimbabwe by the level of integration into four basic categories - large scale fully integrated and large scale semi-integrated constituting 35%; and medium scale and small scale constituting 65% of the broiler industry. This shows the dominance of smallholder growers.

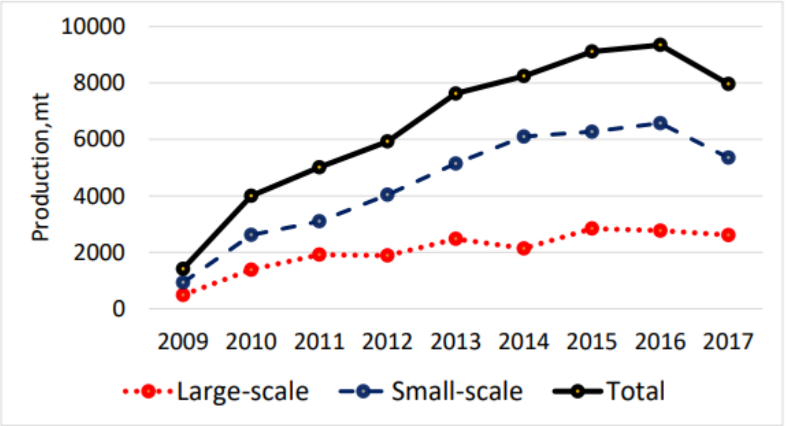

Figure 1: Large Scale (Actual) and Small Scale (Estimated) broiler meat production, 2009 to March 2017 (Source: ZPA, 2017)

Broiler contract production is increasing with the transformation of the poultry industry. Sustainability of the growth may better be understood through appreciating growers' technical efficiencies. Broiler contract farming is one potential option for inclusion of the smallholder sector into the mainstream broiler meat value chain. The mushrooming of smaller abattoirs in the country presents such opportunities to this farming subsector. However, although small scale poultry producers have contributed significantly to the meat market, documented information to guide policy makers is limited (Gororo and Kashangura, 2016). Not much is known with regards to technical efficiency of broiler producers in Zimbabwe. More empiric evidence would add to knowledge of broiler contract production. Value chain competitiveness is attained by having technically efficient farmers and good understanding of how to manage inefficiency.

The purpose of this study was therefore to determine the technical efficiency of broiler contract growers in Chegutu district of Zimbabwe. Technical efficiency is an imperative in farmer performance and a fundamental in competitiveness of value chains in the context of contract farming. Understanding the technical efficiency of diverse groups of broiler contract farmers is essential for the formulation of appropriate policies that guide the development of sustainable contract farming models. The specific objectives of this study were to (i) establish the socio-economic characteristics of broiler contract growers in Chegutu district; (ii) estimate the technical efficiencies of the broiler contract growers in Chegutu district; and (iii) establish the determinants of technical inefficiencies of broiler contract growers in Chegutu district.

METHODOLOGY

This study was conducted in Chegutu district in the Mashonaland West province of Zimbabwe. Chegutu district is an area where one of the largest broiler contract production is conducted in Zimbabwe. Cross-sectional data was collected using a structured pretested questionnaire from a population of 54 active broiler contract growers who operate varying batch sizes and are all contracted by one contractor.

Descriptive statistical analysis was used to establish the socio-economic characteristics of the contract growers. The stochastic frontier model was used to estimate the production function, the technical efficiencies and the determinants of the technical inefficiencies for the farmers.

The estimated stochastic production function was specified as follows:

$$\ln Q=\beta_0+\beta_1\ln X_1+\beta_2\ln X_2+\beta_3\ln X_3+\beta_4\ln X_4+\beta_5\ln X_5+\beta_6\ln X_6+\beta_7\ln X_7+\beta_8 \mathrm{Ln} X_8+\beta_9\ln X_9+(V_i-U_i)$$

Where β_1 to β_9 are the production function model parameters and ln denotes the natural logarithm (base e). The variable definitions are presented in Table 1.

The determinants of the technical inefficiency function were estimated using the following model:

$$E=\alpha_0+\alpha_1Z_1+\alpha_2Z_2+\alpha_3Z_3+\alpha_4Z_4+\alpha_5Z_5+\alpha_6Z_6+\alpha_7Z_7+\alpha_8Z_8+\alpha_9Z_9+\alpha_{10}Z_{10}+\alpha_{11}Z_{11}+U_i$$

Where E is the technical inefficiency and αs are inefficiency model parameters. The variable definitions are presented in Table 1**.** The *a priori* or hypothesized impact of the independent variables on the dependent variable are also shown. A (+) means the independent variable is expected to have a positive impact on the dependent variable while a (-) means the independent variable is expected to have a negative impact on the dependent variable.

Table 1: Variables for the Stochastic Frontier Production Model and inefficiency function

Variable	Description	Measurement	Hypothesis
Production Function			
Dependent Variable			
Q	Total live mass sold of broilers	kg	
Explanatory Variables			
X_1	Batch size/stock size	Number of chicks	+
X_2	Labour cost	$	+
X_3	Feed quantity	Kg	+
X_4	Vaccines and medication costs	$	+
X_5	Heating costs	$	+
X_6	Bedding costs	$	+
X_7	Other costs	$	+
X_8	Transport costs	$	+
X_9	Disinfectant costs	$	+
Inefficiency function			
Dependent Variable			
E	Technical inefficiency		
Explanatory Variables			
Z_1	Gender of grower	Dummy; Female = 1; 0 = Male	+/-
Z_2	Grower experience	Number of batches	-
Z_3	Extension visits	Number of visits	-
Z_4	Residence of grower	Dummy: 1=non-resident on farm; 0=resident	+
Z_5	Manager of daily activities	Dummy: 1 = Owner; 0 = Key employee	+
Z_6	Watering technology	Dummy: 1 = automated; 0 = manual	-
Z_7	Experience of key employee	Number of years	-
Z_8	Grower's years of education	Number of years	-
Z_9	Slaughter age of birds	Number of days	-
Z_{10}	Employee turnover	Number	+
Z_{11}	Grower age	Number of years	+/-

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Broiler Contract Growers

72% of the contract growers in Chegutu district were male. The mean age for the growers was found to be 49.24 years (Table 2). The youngest grower was 22 years and the oldest grower was 85 years. The average experience in commercial broiler production was 3.25 years and the average number of batches done per grower was 8.17. 58% of the contract growers were resident full-time on their farms. The growers are quite educated with average years spent in school being 16.16 years.

Table 2: Socioeconomic Characteristics of broiler contract growers of Chegutu District (N=54)

Category	Characteristic	Mean
Grower	Grower Gender	72
	Grower age	49.24
	Grower education	16.16
	Broiler commercial experience	3.23
	Grower residence	58
Employees	Managed by key employee	61.1
	Period with key employee	4.59
	Number of employees	4.54
	Key employees with secondary education	80.6
	Gender of key employee	86.1
Performance	Food conversion ratio (FCR)	1.81
	Bird weight at slaughter	1.9
	Slaughter age	37.07
	Mortality	0.03
Scale	Batches done	8.17

Category	Characteristic	Mean
	Batch size at time of study	11146.24
	Batch size at joining contract production	5731.38
Extension	Extension visits per production cycle	8.06
Production technology	Manual feeders	100
	Electricity	100
	Solar power electricity	63.9
	Automated drinking system	80.6
	Charcoal based heating system	97.2

The broiler contract growers employ an average of 4.5 employees. All the growers have a key employee in charge of broiler production activities and 61.1% growers' sites were managed by the key employee. The key employees have average broiler experience including time prior to joining the growers of 4.5 years. 80.6% of the key employees have at most secondary level education with 86.1% being male. This suggests that the key employees are relatively experienced and educated given the nature of their work and responsibilities.

The growers started off with an average batch capacity of 5731.48 birds and this has since grown 94.47% to a current mean capacity of 11146.24 birds (Table 2). The mean food conversion ratio (FCR) for the growers was 1.81 with an average bird weight of 1.90kg suggesting very good performance from the growers. The growers mean batch mortality rate is 0.03% which is quite low. The slaughter age of the chicks is 37.1 days and the mean slaughter weight is 1.9 kgs.

The growers generally use similar production technologies. All the growers use manual feeders and all growers have electricity with 63.9% of the growers using solar energy. 80.6% of the growers have automated automated drinking systems and 97.2% used charcoal based heating systems (Table 2). The growers receive on average 8.06 extension visits per production cycle.

Technical Efficiency of the Broiler Contract Growers

The contract growers are highly efficient with a mean technical efficiency of 97.1% (Table 3). The minimum technical efficiency was 88.9% and the maximum technical efficiency was 99.6% with 96.3% of the growers having technical efficiencies above 90%.

Table 3: Percentage distribution of broiler contract production technical efficiency (N=54)

Technical Efficiency Category	Percentage
0.96 – 0.90	3.7
0.91 – 0.95	22.2
0.96 – 1.00	74.1
Mean technical efficiency	97.1
Minimum technical efficiency	88.9
Maximum technical efficiency	99.6

The technical efficiencies of the study growers are comparable to those found by other studies. Pakage *et al.,* (2015) found a technical efficiency of 92.9% with a range of 73% to 98%. Ezeh *et al.,* (2012) obtained an average technical efficiency of 75% with a range of 8% to 90%. Alrwis and Francis (2003) measured technical efficiency of both small and large farms and found that the mean technical efficiency of small farms was 83% with a range of 45% to 99% while that for large farms was 82% with a range of 57% to 99%. In Thailand, Todsadee *et al.,* (2012), estimated the technical efficiency of broiler producers with more than 5000 batch sizes and found a mean technical efficiency of 79% with a range of 11% to 100%.

Determinants of Technical Inefficiencies of the Broiler Contract Growers

The results of the estimated stochastic production function and the determinants of technical inefficiency for the contract growers are presented in Table 4. The Wald statistic of 13235.57 is highly significant at 1% level and this indicates the model fit is good. Three of estimated variables (batch size (X_1), feed quantity (X_3) transport costs (X_8)) were found to be significant inputs in broiler contract production and they are all significant at 1% level of significance.

Table 4: Stochastic Frontier estimates for total live mass sold

Variable	**Coef.**	**Std error**	**Z**	**P > |z|**
Total live mass sold				
Batch Size (X_1)	0.2975215	0.0736178	3.91	0.000
Labour cost (X_2)	0.017462	0.0222574	0.78	0.433
Feed quantity (X_3)	0.6864883	0.065706	10.45	0.000
Vaccines and medication costs (X_4)	-0.0017096	0.013	-0.13	0.895
Heating costs (X_5)	-0.0025527	0.0089077	-0.29	0.774
Bedding costs (X_6)	-0.0059359	0.0145665	-0.41	0.684
Other costs (X_7)	-0.002162	0.0023343	-0.93	0.354
Transport costs (X_8)	0.0290933	0.008001	3.64	0.000
Disinfectant costs (X_9)	-0.0030641	0.004626	-0.66	0.508
Cons	-0.0098947	0.0725707	-0.14	0.892
Insig2v_cons	-9.545597	0.7027371	-13.58	0.000
Insig2u				
Gender of growers (Z_1)	-0.2312036	0.5460444	-0.42	0.672
Growers experience (Z_2)	-1.309412	0.9963321	-1.31	0.189
Extension visits (Z_3)	1.827105	1.946578	0.94	0.348
Residence of growers (Z_4)	1.596149	0.8207213	1.94	0.052
Manager of daily activities (Z_5)	-2.153205	0.895584	-2.40	0.016
Watering technology (Z_6)	0.4739052	0.4727957	1.00	0.316
Experience of key employee (Z_7)	2.32271	0.8066184	2.88	0.004
Growers years of education (Z_8)	0.4337157	3.843783	0.11	0.910
Slaughter age of birds (Z_9)	-16.98315	14.17278	-1.20	0.231
Employee turnover (Z_{10})	-0.0323706	1.294024	-0.03	0.980
Growers age (Z_{11})	5.357591	2.538643	2.11	0.035
Cons	8.700281	22.31405	0.39	0.697
Sigma_v	0.0084567	0.0029714		
Log likelihood	134.73392			
Number of obs	54			
Wald chi2(9)	13235.57			
Prob>chi2	0.000			

A unit increase in batch size results in a 0.30 units increase in total live mass sold. This finding is consistent with the findings of Oluwatayo *et al*., (2016), Pakage *et al*., (2015), Emokaro and Emokpae (2014), Ezeh *et al*., (2012), Todsadee *et al*., (2012) and Alrwis and Francis (2003).

Feed is the most important factor in broiler production constituting between 60-70% of production costs (Aviagen, 2011). A unit increase in feed quantity consumed results in 0.69 units increase in total live mass sold and this result is consistent with the findings of Oluwatayo *et al*., (2016), Pakage *et al*., (2015), Emokaro and Emokpae (2014), Ezeh *et al*., (2012), Todsadee *et al*., (2012) and Alrwis and Crespi (2003).

Transport costs also positively and significantly influence the total live mass sold. A unit increase in transport cost results in 0.03 units increase in total mass sold. Transport is critical in delivering broilers to slaughter facilities for broiler contract growers. Transport costs are charged based on distance to market and not weight of output delivered and therefore growers are forced to deliver more output to the market in order to cover the higher transport costs.

Significant factors influencing technical inefficiencies for the contract growers were found to be grower residence (Z_4), daily management responsibility (Z_5), key employee experience (Z_7) and grower age (Z_{12}).

Grower residence significantly influences technical efficiency and the result is significant at 10% level of significance. Growers who do not reside on their farms full time are 1.60 more technically inefficient when compared to those growers that a resident on their farms. This finding supports the observation made by Bhatt and Bhat (2014). Growers who manages the daily operations of their farms are more efficient when compared to those growers who delegates the daily management responsibilities to their key employees. Owner managed production units are 2.15 less inefficient when compared to key employee managed units and the result is significant at 5% level of significance. Thus more grower involvement in management of daily production activities results in improved technical efficiency. This may be because when a grower manages activities directly, inefficiencies are reduced as a result of the tendency to ensure optimisation of productivity and minimisation of losses. Kahan (2008) also notes that good farm management ensures efficient use of farm resources enabling reduction of risks and income losses.

Key employee experience was found to positively contribute to inefficiencies and the result is significant at 1% level of significance. A unit increase in key employee experience results increases technical inefficiency by 2.32. This was inconsistent with a priori expectations. This may be because the key employee prior experience in broiler production may not be very relevant to broiler contract farming systems. An employee may have experience in other models of poultry production which may not necessarily conform to the standard operation procedures and approaches used under contract farming. Alvarez *et al.*, (2003) found that efficiency is positively linked to employee experience.

Technical inefficiency was also found to increase with grower age. A unit increase in grower age results in 5.36 units increase in technical inefficiency and the result is significant at 5% level of significance. This result is supported by Oluwatayo *et al.*, (2016) and Ezeh *et al*., (2012).

CONCLUSION AND RECOMMENDATIONS

The purpose of this study was to estimate the technical efficiencies of broiler contract growers in Chegutu district of Zimbabwe and to establish the determinants of technical efficiency for the contract growers. The contract broiler farming is dominated by male farmers who constitute 72% of the contract farmers. A majority of the key employees for these contract growers are male. The study established that broiler contract growers were highly efficient with a mean technical efficiency of 97.1. Batch size, feed quantity and transport costs were found to be significant inputs in broiler contract production.

Grower residence on the farm and grower management of daily operations were found to significantly reduce technical inefficiency while technical inefficiency increases with grower age and key employee experience.

The study recommends that there is need to expand broiler contract farming as it is highly efficient. The government must also put in place measures that encourage young smallholder farmers to venture into contract broiler farming as they are more efficient when compared to older farmers. Female farmers must also be encouraged to venture into contract broiler farming.

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