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DETERMINANTS OF TECHNICAL EFFICIENCY IN CATTLE FATTENING ENTERPRISE IN BORNO STATE, NIGERIA: STOCHASTIC FRONTIER ANALYSIS APPROACH

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ABSTRACT

The study estimates the technical efficiency of cattle fattening farms in Borno State, Nigeria, using stochastic frontier analysis approach. Multi-stage sampling technique was used to select 98 respondents. Primary data were used for the study which was collected using the interview method with the aid of structured questionnaire. Stochastic frontier production function was used to analyse the data collected. The results revealed mean technical efficiency score of 0.735, implying there is scope for improving technical efficiency by about 26 % in the study area. The main sources of efficiencies were level of education, management record, herd size, access to credit and extension services. The study therefore recommends that formal credit facilities should be channelled to the cattle fatteners, there is the need to train the cattle fatteners on keeping simple farm records and the fatteners should be encouraged to form strong cooperative societies.

Keywords: Cattle; Fattening; Technical Efficiency; Stochastic frontier

INTRODUCTION

The Nigerian livestock sector especially cattle enterprise is a vital part of the nation's agricultural sector contributing about 5.8% of the total 24.16% of agricultural contribution to the nation's Gross domestic product (GDP) in 2016 (CBN, 2016). In addition to providing the farmer with additional revenue, cattle serve as a form of interest accruing equity (Ouma *et al.,* 2007). In many sub-Saharan African countries including Nigeria, ownership of cattle serves the same functions as holding monetary resource. They are used as informal bank meant for cushioning difficulties during periods of economic hardships. Cattle enterprise Form the basis for a multi-billion dollar industry with over $30 billion been exchanged in beef trade annually in many parts of the world (Topcu and Uzundumlu, 2009).

Cattle fattening is the preparation of the animal for marketing. It is a management strategy employed to prepare the animal for marketing through improved quantity and quality of beef per cattle by subjecting the animals to intensive feeding regime and management technique (Okoruwa *et. al*., 2005; Umar *et al.* 2014).

Cattle fattening is gaining prominence as an important livestock business in many parts of the world. It provides and sustains employment and income of millions of Nigerian. Millions of people earn their livelihood from the fattening industry as producers, marketers and transporters as well as from processing of cattle products, feed milling and veterinary services. The common breeds of cattle used in fattening programme in Borno State include Bunaji, Rahaji, Wadara, Kuri, and White Fulani. They have a body characterized by great depth and they are bred primarily for the production of meat (Umar, 2007).

The Nigerian livestock sector is relatively neglected part of agriculture with a great deal of untapped potentials. This neglect is reflected by it consistently decreasing contribution to the GDP of the nation in the ranges of 2.81%, 2.02%, 2.63% and 4.8% in 1981, 1991, 2006 and 2012 respectively (CBN, 2012). To address this, the federal government of Nigeria introduced the National Livestock project small holder fattening scheme since 1979 with the aim of promoting livestock production in the country. However the desired effect is yet to be realised in the sector. Perhaps, this might be the reason behind the consistent massive importation of cattle into the country from the neighbouring republics of Cameroun, Niger and Chad.

The scarcity of the beef has imposed serious constraints on the ability of the people to consume the important source of protein (meat). Studies (Okoruwa *et al.*, 2005; Yusuf and Molomo, 2007; Adepoju, 2008; Ike and Udeh, 2011; Oguniyi, *et al* 2012) have indicated that diet of most Nigerian are low in animal protein below the average of 35 g/ caput / day recommended by FAO.

The shortage of animal protein in the nation leads to the search for alternative means of boasting the supply of the production I n the nation. Cattle fattening has been recognized as one of the quickest ways for a rapid increase in protein supply in the nation. Several studies have recognized the potential importance of efficiency as a means of improving productivity and supply of the animal protein in the nation (Oluwatayo *et al.*, 2003; Maurice, 2004; Ogundari and Ojo, 2006) and the State (Umar, 2007; Umar *et al.* 2013).

Borno State is one of the leading cattle producing State in the nation. The State alone responsible for about 40% of the total domestic production of beef in the country. Also it serves as the major route through cattle is imported into the country from the neighbouring countries of Chad, Niger and Cameroun Republics (Umar, 2007). There are few studies conducted on cattle fattening farming in the State. The few studies conducted on cattle fattening farming focused mainly on the profitability of the enterprises (Gabdo *et al.*, 2005, Oni, 2005, Umar, 2007; Umar *et al.* 2008; Omolehin *et al.*, 2009 and Umar *et al.* 2014). Therefore, there is the need to examine the technical efficiency of the cattle fattening farm in Borno State. Identifying the main factors causing inefficiency is a sure way of improving the productivity and of the cattle fatteners in the study area. It is believed that the findings of the study could be useful to those involved in decision-making process at the farm level, state and the national level by identifying the factors contributing to efficiency or inefficiencies. It was against this background that this study was undertaken to provide empirical information on technical efficiency and the source technical inefficiency of cattle fattening farms in Borno State.

MATERIALS AND METHODS

The Study Area

Borno State is located between latitudes 10^0 30'N to 14^0'30'N and longitudes 11^0'3E to $14^0$45'E. It has a land mass of 69,436sq km with population density of approximately 60 inhabitants per square kilometre. The state has a population of 4,151,193 people (NPC, 2006), which is projected to be 5, 870, 155 for 2017 based on 3.2 per cent annual population growth. The State shares borders with Adamawa State to the South, Yobe State to the West and Gombe State to the Southwest. It also shares international borders with Niger Republic to the North, Chad to the Northeast and Cameroun to the East (Borno State Official Diary, 2013).

The climate of the State is semi-arid type, characterised by low and highly variable rainfall. The annual rainfall ranges from 500 mm to 700 mm, usually starting from May to June and last from October to November. The minimum temperature ranges from 15 – 20 ^{0} C and maximum range from 37 – 45 ^{0} C (Ibrahim, 2012).

Farming is the main occupation of the people, with major crops grown comprising of maize, millet, wheat, rice, groundnut, cowpea and vegetables like carrot, tomato, onion, cabbage, watermelon and cucumber. Livestock reared include cattle, sheep, goat in addition to poultry (Ibrahim, 2012).

Sampling Procedure and Data Collection

This study uses multi-stage sampling technique to obtain the respondents. The first stage involves a purposive selection of nine wards and villages across the State namely; Bama, Banki in Bama local government area, Ngala and Gambaru in Ngala local government area and Kasuwan Shanu, Bolori, Shuwari, Gwange and Bayan quarters in Maiduguri Metropolis based on concentration of fattening farms. In the second stage, 10% of the cattle fattening farms were randomly selected from each of the sample wards and villages which gave a sampling size of 98 cattle fattening farms.

Table: 1 Distribution of cattle fatteners in the study area

Local Govt. Area	Villages	No. of Fatteners	Number Selected
Bama	Bama	132	13
	Banki	83	08
Ngala	Ngala	63	06
	Gamboru	72	08
Maiduguri	Kasuwan Shanu	188	19
Metropolis	Maiduguri	136	14
	Bolori	73	07
	Shuwari	84	08
	Gwange	93	09
	Bayan quarters	63	06
Total		958	98

Primary data were used for this study. The data were collected using the interview method. The data gathered included those on socio-economic variables of the cattle

fatteners such as age, years of experience, family size, farm size, educational qualification, access to extension services, access to formal credit and membership of associations. Others are information on inputs used (feed, labour, veterinary services and equipment and the output (weight gained in kg). The initial and final weights of the cattle were taken using an instrument known as weight band, which is an instrument designed to measure live weight of animals.

Data Analysis

A stochastic frontier production function that incorporates inefficiency factors was estimated using maximum livelihood estimation (MLE) techniques to obtain farm specific technical efficiency and its determinants.

Model Specification

Following Aigner, *et al.* (1977) Meeusen and Van de Broeck (1977), which was later, improved and used by Battese and Coelli (1995), the stochastic frontier production function model is specified as follows.

$Y= F (X; \beta) e_i$

Where: Y = value of output (kg)
X_i = Quantity of input used (kg)
B = Vector of parameter
e_i = error term
$e_i = V_i – U_i$ = composite error term

The V_is are random variable which account for random variation in output due to factors outside the fattening control such as weather, disease and measurement error in production. It is assumed to be independently and identically distributed N ($O\sigma^2V$) and independent of U_i. The U_is are random variable that accounts for technical inefficiency of the farm, which are assumed to be non-negative truncation of the half-normal distribution N ($U\ \sigma^2$).

$TE; = Y_1/Y_i^*$
$=f (X_i; \beta) \exp (V_i – U_i)/f(X; \beta) \exp V_i – \exp (-U_i)$

Where; Y_i is the observed output and Y_1 is the frontier's output. The technical efficiency ranges between 0 and 1.

Empirical Frontier Model for Cattle Fattening Farms in Borno State

The stochastic frontier production was specified by Cobb-Douglas production function as follows:

$\text{In } Y_i = \beta o + \beta_1 \text{In } X_1 + \beta_2 \text{In} X_2 + \beta_3 \text{In}_3 + \beta_2 \text{In} X_4 + \beta_5 \text{In}_5 + \beta_6 \text{In} X_6 + (V_i – U_i)$

Where:

Y_i = Weight gain (kg/ cattle)
βo = Intercept
$\beta_1 - \beta_6$ = Estimated scalar parameters
X_1 = Total feed used (kg)

X_2 = Number of Labour (in Man days)
X_3 = Farm size (number of cattle per farm)
X_4 = Water (litres)
X_5 = Veterinary Services (₦)
X_6 = Potash/salt (kg)
U_i = Random error
V_i = Technical inefficiency effects
Ln = Natural logarithm

Technical Inefficiency Model

It is assumed that the technical inefficiency effects are independently distributed and U_{ij} arises by truncation (at zero) of the normal distribution with mean U_{ij} and variance, $ð^2$. The technical inefficiency effects (U_{ij}) is defined by:

$U_i = \delta_0 + \delta_1 In\ Z_i + \delta_2\ Z_{2i} + \delta_3\ Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5+}\ \ \delta_6 Z_6$

Where:

U_i	=	Represents the technical inefficiency of the i-th fattener
Z_1	=	Fattening experience (years)
Z_2	=	Educational qualification (Number of years of schooling)
Z_3	=	Herd size (number of cattle fattened/batch)
Z_4	=	Management record (yes or no)
Z_5	=	Access to extension services (yes or no)
Z_6	=	Access to formal credit facilities (yes or no)

These variables are included in the model to indicate their possible influence on the technical efficiencies of the fatteners. The δ_1- δ_7 are scalar parameters to be estimated.

The variances of the random errors, $\delta^2 v$ and that of the technical inefficiency effects $\delta^2 V$ and overall variance of the model δ^2 are related thus; $\delta^2 = \delta^2 v + \delta^2 u$ and the ratio $y = \delta^2 v / \delta^2$, measures the total variation of output from the frontier which can be attributed to technical inefficiency (Battesse and Corra, 1997). The parameters of the frontier model are estimated such that the variance parameters are defined as;

$\delta^2_5 = \delta^2_{vi} + \delta^2_{Ui}$ and $Y - \delta^2 / \delta_{7;}$ where the x has a value between 0 and 1.

This stochastic frontier functions and inefficiency effects were estimated using the computer programme, FRONTIER VERSION 4.0 developed by Coelli (1996).

RESULTS AND DISCUSSION

Technical Efficiency of Cattle Fattening Farms

Table 1 revealed the estimates of the parameters for the frontier production function and the variance parameters of the model. The variance parameters Sigma (δ^2) was 0.126 and was statistically significant ($P<0.01$). This indicates a good fit and correctness of the distributional form assumed for the composite error term. The gamma (γ) which is the proportion of deviation from frontier that is due to inefficiency estimate was 0.891 and is statistically significant ($P<0.01$), indicating the amount of variation resulting from the technical inefficiency of cattle fatteners. This means that more than 89% of the variation in farmers output is due to the difference their technical efficiencies.

The mean technical efficiency of the farmers was 0.831, implying that on the average, the cattle fatteners were able to obtain about 83% output from a given quantity of inputs. This that there exist the scope of increasing beef output by about 17%, by adopting the practices and production techniques of his most efficient cattle fattener in the study area. The result revealed that the coefficient for feed (0.572) was positive and statistically significant (P<0.01). This implies that 1% increase in the quantity of feed will lead to 0.572% increase in beef output. A plausible is that feed constitutes the most important input in the fattening farms. The quality and the quantity of feed influence the performance of the animals.

The coefficient of labour (0.236) was positive and statistically significant (P<0.01). This implies that 1% increase in labour use will result in 0.234 % increase in beef output. This is probably due to the fact that cattle require prompt attention in terms of refreshing their water, feed supply and cleaning of their environment. The availability of labour implies that these services are promptly provided to the animals as and when due which will in turn improves their efficiency. However, the coefficient of farm size (0.354) was negative and statistically significant (P<0.01). A plausible explanation could be large number of cattle being kept in the same farm could encourage steep competition for feeds, and other resources among the animals. Similarly, the coefficient of water (0.025) was positive and statistically significant (P<0.10). This implies that quantity of water taking by the animal had little influence on the level of beef output. The coefficient of veterinary services and vaccine (0.372) was positive and statistically significant (P<0.01). The quality of veterinary services not only improves the efficiency of the animal in terms of feed conversion, but also reduce rate of mortality in the farm. The coefficient of potash/salt lick (0.163) was positive and statistically significant (P<0.10). These findings also support that of Ceyhan and Karem (2010) which reported similar findings for cattle-fattening farms in Turkey and Mlote *et al*. (2013) in study of technical efficiency of small scale beef cattle fattening enterprise in the Lake zone in Tanzania.

Table 1: Estimates of technical efficiency of cattle fattening farms in Borno State

Variables	Parameter	Coefficient	Standard Error	t-ratio
Constant	β_0	2.431	0.471	5.163
Feed	β_1	0.572	0.1564	3.652***
Labour	β_2	0.236	0.098	2.407**
Herd size	β_3	-0.354	0.1213	2.931***
Water	β_4	0.025	0.0176	1.420
Veterinary services	β_5	0.372	0.1587	2.343**
Potash/salt	β_6	0.165	0.0952	1.732*
Variance parameter				
Sigma	δ^2	4.253		
Gamma	γ	0.891		
Log likelihood		36.33		
Mean efficiency		0.831		

Source: Field survey 2013, *** Significant at 1%, ** Significant at 5%, *Significant at 10%

Frequency Distribution of Technical Efficiency of Cattle Fatteners

The result revealed that the mean technical efficiency was 0.831. The implication here is that for the average fattener in the sample to achieve efficiency level of his most efficient counterpart, he could reduce his inputs level by about 17 per cent (1 – 96.4/98) x 100) and still produce same quantity of beef. Similarly, the least efficiency fattener in the sample could reduce his inputs usage by 49 per cent (1 – 0.42/98) x 100) and produce same quantity of inputs. The greater proportion (68%) of cattle fatteners had technical efficiency scores exceeding 70%, indicating that cattle fatteners in the study area exhibit high technical efficiency.

Table 2: Frequency distribution of technical efficiency of cattle fattening farms

Efficiency	Frequency	Percentage
0.10 – 0.49	04	4.1
0.50 – 0.59	09	9.2
0.60 – 0.69	18	18.4
0.70 – 0.79	24	24.5
0.80 – 0.89	38	38.8
0.90 – 0.99	05	5.1
Total	120	100

Source: Field survey, 2013

Determinants of Technical Efficiency of Cattle Fattening Farms

The maximum likelihood estimates for the sources of technical inefficiency was revealed by table 3. The result revealed that coefficient of years of experience (-0.0130) was negative and significant (P<0.01), implying that as the years of experience of the fattener increase, his inefficiency decreases. This is expected as fatteners do same thing for many years, they will become more efficient. Similarly coefficient of educational qualification (-0.0431) was negative and significant (P<0.05), implying that as fattener's level of education increases, he tend to be more technically efficient. The influence of education is usually attributed to the ability of more educated farmers to understand and adopt modern production practices that could enhance productivity (Islam *et al.*, 2011). This finding collaborate with that of Latruffe *et al.* (2005) which reported low educational attainment as source of inefficient practice of Polish dairy farms. The educated farmers are more likely to be efficient than their less educated counterparts because of their better skills, access to information and good farm planning (Begun *et al.*, 2009). However, the coefficient of farm size (-0.0180) was negative and significant (P<0.01). Large herd size minimise wastage of feed which is the most important input used in cattle fattening This finding collaborate with that of Kumbhakar *et al.* (1991) and Gillespie *et al.* (1997) which reported that large dairy farms were relatively efficient technically than smaller farms.

The coefficient of management record (-0.0401) was negative and significant (P<0.05), indicating that enterprise with management records were more efficient than enterprise without written record. This might be possibly due to the fact that farm record tends to indicate strengths and weakness of particular agricultural enterprises, thus enabling the farmer to improve on his deficiencies. Also, the coefficient of access to extension services (-0.0351) was negative but not significant, implying that it have little or no

influence on the technical efficiency of the fattening farmers. This could possibly due to the fact that extension services were inefficient in most of the underdeveloped nations of the world. Frequent contact with extension workers allows easy access to modern techniques and innovations of farming which greatly enhance the efficiency of the cattle fatteners. However, greater proportion of the cattle fatteners in the study area had little or no contact with the extension worker. These findings also agree those of Ceyhan and Karem (2010) and Mlote *et al*. (2013) which reported similar findings for cattle-fattening farms in Turkey. The coefficient of access to credit (-0.0580) was negative and significant (P<0.01), implying that credit enhanced the level of technical efficiency of the sampled cattle fattening farms in the study area. This could be attributed to the fact that when there is timely disbursement of credit, it would enable the fatteners to purchase inputs at the appropriate time. Similarly, financial constraints decrease technical efficiency due to the fact that the quantity and timing of inputs usage positively influence farms efficiency. Consequently, the farm that faces financial constraints may not be able to arrange production at the best (right) time (Liu, 2006).This also supports the finding of Ceyhan and Karem (2010) who reported that credit use increased technical efficiency of cattle fattening farms in Turkey.

Table 3: M L E of technical inefficiency effects in cattle fattening farms

Variables	Parameter	Coefficient	Standard Error	t- ratio
Inefficient Model				
Constant	δ_0	0.0521	6.0990	5.263***
Experience	δ_1	-0.0130	3.5420	3. 671***
Educational qualification	δ_2	-0.0431	0.0166	2.530**
Farm size	δ_3	-0.0180	0.0103	5.231***
Management record	δ_4	-0.0401	0.0680	2.340**
Extension service	δ_5	-0.0351	0.0181	1.823**
Access to credit	δ_6	-0.0580	5.4041	4.256***

Source: Field survey 2013, ***, ** and * implies significant at 1%, 5%, and 10% respectively

CONCLUSION

The cattle-fattening farms exhibited high efficiencies scores. However, there is need for improving the level of efficiency by using the same quantity of inputs. To achieve this, the following recommendations are made; there is the need for the government to provide formal education to the cattle fatteners to improve their literary skills, Also, there is the need to train the fatteners on the acts of keeping simple farm records so that they could keep track of the expenditure and income. Similarly, the cattle fatteners should be mobilized to form cooperative societies to enable them procure inputs for their members at cheaper rates. Further, the policy makers should focus on enhancing the farmer's access to formal credit to enable them expand their scale of production and hence enjoy the economies of scale.

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