Scale Efficiency and its Determinants of Cattle Fattening Enterprise in Borno State, Nigeria

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Abstract
This Study was conducted to examinethe scale efficiency of cattle fattening enterprise in Borno state, Nigeria. Multi-stage sampling technique was use to select the sample respondents. Primary data was used for the study which was collected with the aid of structured questionnaire. The data gathered includes those on socio-economic variables of the cattle fatteners, inputs used and the output (quantity of beef). The data gathered were analysed using the descriptive statistics, Data Envelopment Analysis and Logit regression model.The result of the scale efficiency analysis revealed a mean efficiency score of 0.541. The main sources of inefficiencies were level of education, age, access to credit and extension services. The study therefore recommends that formal credit facilities should be channel to the cattle fatteners to increase their scale of operation and the fatteners should be encourage to form a strong cooperative societies.
Keywords: Cattle fattening, enterprise, scale efficiency

1. Introduction

The livestock sector, which is basic component of the agricultural sector, plays a pivotal role in the nation's economy. The sector contributes about 2.30% to the nation's Gross Domestic Product and 15.3% of the total agricultural sector in 2010 (CBN, 2010). This low sectorial contribution of the livestock sector to the GDP is an indication that more still need to be done to revive the sector (Okoruwa*et al*., 2005).

Cattle fattening is a management strategy employed to increase the quantity and quality of beef per cattle (Okoruwa*et al.*, 2005),hence, cattle fattening enterprise can be considered as an agro-farm through which low value inputs (grass) are transformed into high value output (meat) to make profit (Jean, 1993). In this regard, cattle are regarded as biological machines that convert low quality feed into high quality beef to make profit (Baset*et al*., 2003).Beef which is the end product of cattle fattening is about the best source of animal proteins in the nation.

Nigeria is agrarian society with about 80% of the population engage in agricultural sector. It is characterized by a large number of small-scale farmers with small holdings low capitalization and low output. These with their small farm holdings constitute the engine of economic development of the nation (Ogundari and Ojo, 2007).The role of this small farm enterprise has frequently been undermined. Initially, these small enterprises were believed to impede economic growth by attracting scarce resource from the larger enterprise. However, the recent view is that small enterprise is the key element and driving force in generating employment and realizing economic development (Sarris *et al.,* 2006).

Agricultural policies have a crucial role in increasing rural as well as aggregate national income in Africa, given that the majority of the people are in rural areas and are employed in agriculture (Sarris *et al.,* 2006). Crucial among these policies are those that help increase farm income through improvement in efficiency and profitability of the farm enterprise. It is reported that in a country where majority of the farmers were poor and opportunities for developing and adopting new technologies are absent, empirical investigation of efficiency are extremely important (Islam *et al* 2011). Such studies help to develop the level at which farmers use existing technologies and likely explore the possibility of raising the productivity of farms by increasing the efficiency with which the available resources endowments and technologies were utilised.
The objectives of the study are to determine the scale efficiency and their determinants in cattle fattening enterprise in Borno State, Nigeria and recommends appropriate policy measures.

2. Methodology

Borno state is located between latitudes 10^0 and $14^{0,}$ and longitudes $11^{0,}$3E and $14^0$45'E. It is the largest state in the federation in term of land mass with an area of 69,436sq km. The state has a population of 4,151,193 people (NPC, 2006), which is projected to be 4,708,599 for 2010 base on 3.2 per cent annual population growth. The population density is approximately 60 inhabitants per square kilometres. The state shares borders with the Adamawa to the south, Yobe to the west and Gombe to the south west. It also occupies the greatest part of the Chad Basin and Shares borders with the Republic of Niger to the North, Chad to the North-east and Cameroon to the East (Sulumbe, 2012).

Multi-stage sampling technique was used for this study. The first stage involves a purposive sampling of three Local Government Areas, namely; Bama, Ngala and Maiduguri metropolitan council from the state based on prevalence of fattening enterprise. Secondly, from each of the Local Government Areas, two villages were purposively selected based on the intensity of fattening farmers which include Bama and Banki from Bama, Gamboru and Ngalafrom Ngala, and Bolori and Gwange from Maiduguri metropolitan area council. The third stage involves a random selection of 10% of the cattle fattening farmers from each of the sample district making a sampling size of 98 cattle fattening enterprises.

Primary data were used for this study. The data were collected using the interview method with the aid of a structured questionnaire designed to collect information on outputs, inputs and prices. The information gathered includes those on socio-economic variables of the cattle fatteners such as age, educational qualification, years of experience, feeding frequency, access to formal credit facilities, contact with extension services and number of animals fattened in a batch.

Others are data on the output (live weight gained in kg) and inputs used, such as feeds (kg), labour (hours), water (litres), number of animals (head), Veterinary care and medicine (₦), length of fattening period (days) and transportation cost(₦) were collected. Similarly, data on fixed inputs like building and equipment used were collected. The initial and the final weight of the live animal was taken using a measuring instrument known as weight band, which is a tape designed to measure the live weight of animals such as cattle, pig sheep and goats.

3. AnalyticalFramework

Data Envelopment Analysis (DEA) was used to estimate the scale efficiency measures. It is another popular method for estimating the best practice production frontier and provide analytical tool for determining efficient and inefficient behaviour. Some researchers preferred DEA over the stochastic frontier approach due to the fact that it is less data demanding, works with small sample sizes and does not require knowledge of the proper functional form of the frontier, error and inefficient structures. Stochastic models like the stochastic frontier approach (SFA) require large sample size to make a reliable estimation (Coelli*et al.,* 2005).

The Data Envelopment Analysis (DEA) approach use linear programming methods to construct a surface, or frontier around the data. Thus, efficiency is measured relative to this frontier, where all deviations from this frontier are assumed to be inefficiency (Coelli*et al*., 2005).

DEA model was constructed assuming that each cattle fattening enterprise produces a quantity of beef (Y_i) using multiple inputs (X_i). The data for all farms are denoted by the K x N input matrix (X_i) and M x N output matrix (Y_i). Consider n firms producing m different output using h different inputs. Thus, Y is an m*n matrix of outputs and X is an h*n matrix of inputs. Both matrices contain data for all n firms. In order to determine the scale efficiency, both constant return to scale (CRS) and variable return to scale (VRS) models were analyse.

The technical efficiency of cattle fattening enterprise was model in a multiple-input, single-output framework. The quantity of beef produced during the fattening period in 2011 was used to measure the output (kg). Similarly, six inputs were used for the economic efficiency analysis, namely feed (kg), and labour (hours), water (litres), number of cattle (head) cost of veterinary care and medicine (₦) and transport cost (₦)

The TE scores obtained from the CRS DEA can be classified into two components, one due to scale efficiency and one due to “pure” technical inefficiency. This could be done by determining both CRS and a VRS DEA upon the same data. If there is a difference in the two TE scores for a particular DMU, then this indicates that the decision making unit (DMU) has scale inefficiency. The scale inefficiency can be calculated from the difference between the TE_{VRS} and the TE_{CRS} scores (Coelli*et al.,* 1998). The fattening enterprise were classified as scale efficient if the SE = 1, or if the $TE_{VRS} = TE_{CRS.}$

$$Min_{\theta,\lambda}\theta,$$

$$\text{Subject to} \quad -y_i + Y\lambda \geq 0$$

$$\theta\,\text{xi} - X\lambda \geq 0,$$

$$N1\,\lambda \leq 1$$

$$\lambda \geq 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Hence, $SE = CRS_{TEi} - VRS_{TEi}$……………………………………………..(4)

This was used to compute the level of scale efficiency. This was computed using the statistical package LIMDED 7.0 version econometric software

Tobit Regression

This study used the two stages Tobit regression model to identify the determinants of the economic efficiency. In the first stage of analysis, DEA problem was solved involving only the traditional inputs and

output of fattening enterprises. In the second stage, the efficiency scores from the first stage are regressed upon the socio-economic variables (Coelli*et al.,* 2005). The Tobit approach estimating the potential determinants was used because the efficiency estimates had 1 as an upper limit and 0 as a lower limit. A number of previous studies have used the Tobit model (Binam*et al.,* 2004, Chavas*et al.,* 2005 and Ceyhan and Karem, 2010).

Tobit Model Specification

The general formulation of the model with a limited dependent variable as proposed by Greene (2003) and applied by Ceyhan and Karem, 2010)isdefined as:

$$Y_{i^*} = \beta_o + \sum_{i=1}^{n} \beta_i X_{ij} + \mu_i, \qquad \mu_i \sim IN\ (0, \delta^2) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where: Y_i*= Latent (dependent) variable representing the efficiency score of enterprise j;
β_i= Vector of unknown parameters to be estimated;
X_i= Vector of explanatory variables m (m =1, .k) for enterprises j which is known constant and hypothesized as determinant of efficiency.

U_i= an error term that is independently and normally distributed with a mean zero and a constant variance (δ^2)

$$Y_i = \beta_o + \sum_{1=0}^{n} \beta_i\ X_{ij} + u_i\ ; if\ u_i > \beta_o + \sum_{i=0}^{n} \beta_i X_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$Y_i = 0;\ if\ u_i \leq \beta_o + \sum_{i=0}^{n} \beta_i X_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

LIMDEP econometric software version 7.0 was used to solve the two-stage regression analysis.
The Tobit regression model for the cattle fatteners was empirically specified as:

$Y_i = \beta_o + \beta_1 x_1 + \beta_2 X_2 + \beta_3 X_3 + {}_4X_4 + {}_5X_5 + {}_6X_6 + V_i + U_i$ ……(8)

Where: Y_{ij}= Measure of scale efficiency for the i-th fattening enterprise, X_1= Age of the fattener (years), X_2=Number of years of schooling, X_3 = Size of Household, X_4= Main Occupation, X_5=Number of cattle fattened (head), X_6 =Feeding frequency (Number per day), X_7=Length of fattening (days), X_8 = Management record Kept, X_9=Extension contact per month, X_{10}= Access to formal credit facilities (₦), = Parameters of the model to be estimated, U = Random error term.V_{ij} =Explanatory variables that influences the economic efficiencies of the farms

These variables were included in the Tobit model to indicate their possible influence on the scale efficiency of the fattening enterprise.This model was computed using the LIMDEP econometric software version 7.0.

4. Result and Discussions

4.1. Scale Efficiency of Cattle fattening Enterprise in Borna State

The table 1 revealed the scale efficiency scores of the sampled cattle fattening enterprise in the study area. The result revealed that the scale efficiency of the cattle fattening enterprise in the study area ranges from 0.166 to 1, with a mean value of 0.541. This implies that, on the average inefficient fattening enterprises would have to increase their scale of operation by 46% to attain full scale efficiency. This indicates that majority of the cattle fattening enterprise were small holder which operate at a low level. This could be attributed to the liquidity constraint faced by the fatteners which limit their ability to expand the scale of their operation. This equally implies that the cattle fattening enterprise in the study area lack access to formal credit facility.

4.2. Frequency Distribution of the Scale Efficiency of the Fattening Enterprise

Table 2 shows the frequency distribution of the scale efficiency of the sampled cattle fattening enterprise in the study area. The result revealed that the mean scale efficiency was 0.541, with 1.000 for the most scale efficient fattener and 0.166 for the least scale efficient fattener. This implies that cattle fattening in the study area need to increase their scale of operation by input fell by 46 % to attain full scale efficiency and enjoy the economics of scale in production. The majority (64%) of the fatteners possess scale efficiency scores less than 0.70. This implies that most cattle fatteners in the study area are operating at small scale. The result also indicate that for the average fattener in the sample to achieve scale efficiency of his most efficient counterpart, he would have to increase his scale of operation by 46 per cent (1-0.541/100) to reach the level of scale efficiency. While the least efficient fattener would have to increase the scale of his operation by 84 per cent (1-0.166/100) to achieve the level of scale efficiency of his most scale efficient counterpart. This findings agrees with that of Rios and Shively (2005) who reported that large farms are more efficient (technically and allocatively) than the smaller farm.

Table 1: Frequency Distribution of the Scale Efficiency of Fattening Enterprise

Efficiency	Frequency	Percentage
0.10 – 0.49	11	11.2.
0.50 – 0.59	49	50.0
0.60 – 0.69	19	3.1
0.70 – 0.79	3	6.1
0.80 – 0.89	6	3.1
0.90 – 0.99	3	6.2
1.000	6	
Mean	**0.541**	
Std. Dev.	**0.120**	
Min	**0.166**	
Max	**1.000**	

4.3. Determinants of Scale Efficiency of Cattle Fattening Enterprise

Tobit model regression analyses identify the source of scaleefficiency of the sampled cattle fattening enterprise in the study area. The result revealed that the coefficient of age was positive and significant at 5% ($p<0.05$) for the scale efficiency. This implies that older fatteners were more efficient in their scale of operation. This can be attributed to the fact that older people in the study area tend to believe in landed property which could be easily dispose-off to finance the operation of the cattle fattening enterprise whenever they so desire. The coefficient of educational qualification is also positive and significant at 5% ($p< 0.05$) for scale efficiency. The influence of education on the scale efficiency could be attributed to the ability of more educated farmers to procure loan from the formal financial institutions and expand the scale of their operation. Likewise the more educated fatteners were better-off than the less educated counterpart in term of personal income (wage). Therefore, they could be able to save enough from their high wages to finance the expansion of their enterprise. However, the coefficient of family size is negative and at significant at 1 % level ($p< 0.01$), implying that fatteners with larger family size were scale inefficient. One plausible explanation could be that fatteners with large family size would be financially constraint by the need to feed large number of people which consequently their impaired ability to expand the scope of their operation.

In the category of farm characteristics, the coefficient of farm size is negative and significant at 1% level ($p< 0.01$) for scale efficiency, implying that the enterprise with large number of cattle were efficient than those with lower number of cattle. The coefficient of length of fattening (duration) period is negative and significant at 5% ($p<0.05$), implying that fatteners with longer duration of fattening were scale inefficiency. The coefficients of feeding frequency and management records were positive but not significant, implying that they have little or no influence on the scale efficiency of the sample cattle fattening enterprise.

All variables belonging to the institutional category positively influence the scale efficiency of the fattening enterprises. The coefficient of extension contacts was positive and significant at 10% ($p< 0.10$) for scale efficiency. The possible explanation is that extension worker enlightens the fatteners and creates awareness on the sources of cheap farm credits. This tends to reduce the liquidity constraint being face by the small fatteners in the study area. Similarly, the coefficient of credit use was positively and significant at 1% ($p< 0.01$) scale efficiency, implying that credit enhanced the level of scale efficiency of the sampled cattle fattening enterprises. This could be attributed to the fact that credit would remove liquidity constrained which limits the capacity of the fatteners to operate on a larger scale. This is also supported by the finding of Ceyhan and Karem (2010) who reported that credit use increases scale efficiency.

Table 2: Result of Tobit Analysis: Determinants of Scale Efficiency

Variable	Coefficient	S E	P[Z / >z]	Mean of X
Personal Characteristic				
Age of the fattener (years)	0.017**	0.002	0.051	5.236
Level of Education (years)	0.403**	0.210	0.002	9.214
Family size (no. of persons)	-0.214***	0.015	0.001	6.310
Main occupation	0.091**	0.043	0.005	12.233
Farm Characteristics				
Number of Cattle (heads)	0.074***	0.023	0.000	8.351
Length of fattening(days)	-0.062**	0.032	0.005	3.672
Feeding frequency	-0.324	0.241	0.005	7.231
Management record	0.121	0.113	0.024	14.412
Access to institutions				
Extension Contact	0.502***	0.021	0.022	0.678
Credit Use	0.652***	0.213	0.001	13.643
Likelihood ratio test	**59.34**			

***P<0.01, **P<0.05,*P<0.10

5. Conclusion and Recommendations

From the findings of the study, cattle-fattening enterprises could be describes as very profitable farm enterprise with a high net farm income. Similarly, the fattening enterprises exhibit high efficiencies scores. Also, the credit supply had a positive impact on improving the economic efficiency of the fattening farm. However, there is scope for increasing the output level using the same level of inputs used. Hence, it is recommended that there is the needs for the government to create a special credit package for the small-scale cattle fatteners to enable them increase their herd size. This loan should be paid in two or three different instalments to avoid being diverted to another purpose and the cattle fatteners should be provided with a subsidy on inputs used particularly concentrate feed in order to enable them increase their efficiency.

Reference

Binam, J.N. Tonye, J. Wandji, N.Nyambi, G. and Akoa, M. (2003).Factors Affecting the Technical Efficiency among Smallholder Farmers in the Slash and Burn agricultural Zone of Cameroon. *Food policy*,29: 531-545.

Bravo-ureta, B.E. and Rieger, L. (1991). Dairy Farm Efficiency Measurement using Stochastic Frontiers and Neoclassical duality.*American Journal of Agricultural Economics,* 73: 421 – 428.

Ceyhan, V. and Karem, H. (2010).Economic efficiency of Cattle fattening Frams in Amasya province, Turkey.*Journal of Animal and Veterinary Advances*, 9 (1): 60-69.

CBN (2010).Statistical Bulletin, vol. 21*Annual Reports and Statement of Accounts*, Abuja, Nigeria.CBN Publications.

Charnes, A. Cooper, W. and Rhodes, E. (1978). Measuring Efficiency of Decision making units.*European journal of operation Research,* 2: 429-444.

Chavas, J.P. Petrie, J. and Roth, M. (2005). Farm Household Production Efficiency: Evidence from the Gambia. *American Journal of Agricultural Economics,* 87:160-170.

Coelli, T.J. (1996). A guide to DEAP version 2.1 computer programme for Data envelopment analysis, CEPA working paper 96/67 Centre for Efficiency and production Analysis, University of New England, Armidale, NSW, Australia.

Coelli, T. Rahman, S. and Thirtle, C. (2002).Technical, Allocative Cost and Scale Efficiencies in Bangladesh Rice Cultivation: A Non-parametric Approach. *Journal of Agricultural Economics,*53: 607 – 626.

Farrell, M.J. (1957). The Measurement of Productive Efficiency.*Journal of the Royal Statistics Society,* 129: 253 – 281.

Greene, W. (2003).*Econometric Analysis.*5th Edition Pretence Hall, New Jersey, USA.

Ibrahim, H.Y.Saingbe, L. and Ibrahim, H.I. (2011).An Evaluation of Groundnut Processingby Rural Women in a Rural Areas of North central Nigeria.*Journal of Agricultural Science,*2(1): 206-212.

Janansson, L. (1996). Mathematical Programme for Sector Analysis – Some Applications, Evaluations and Methodological Proposals. Ph. D. Dissertations.Swedish University of Agricultural Science, Sweden.

National Population Commission (2006).NPCPopulation Census of the Federal Republic of Nigeria.Census Report. National Population Commission, Abuja.

Ogundari, K.Ojo, S.O. and Bernhard, B. (2006). Productivity Potential and Technology Efficiency of Agricultural Production in Alleviating Poverty: Empirical Evidence from Nigeria. .*Journal of fisheries International,* Med-well online.

Ogundari, K. and Ojo, S.O. (2007).An Examination of Technical, Economic and AllocativeEfficiency of Small Farms: The Case Study of Cassava Farmers in Osun State of Nigeria. *Journal of Central European Agriculture,* 7(3): 432 – 432.

Okoruwa, V.O.Obadaki, F.O. and Ibrahim, G. (2005).Profitability of Beef Cattle Fattening in the Cosmopolitan City of Ibadan, Oyo State.*Moor Journal of Agricultural Research,* 6(4): 45 – 51.

Sarris, A. Savasfano, S. and Christiaensen, L. (2006). The Role of Agriculture in Reducing Poverty in Tanzania: A Household Perspective from Rural Kilimanjaro andRuvena. Paper presented at the International Association of Agricultural Economists Conference Gold Coast, Australia, August, 12 –18.

Sulumbe, I.M. (2012). Analysis of Economic Efficiency of Urban Agricultural Enterprises ofBorno State, Nigeria.Unpublished Ph.D. Thesis. University of Maiduguri, Nigeria.

Rios, A. and Shively, G.E. (2005). Farm Size and Non-parametric Efficiency Measurements for Coffee farms in Vietnam. A Paper Presented at the American Agricultural Associations Annual meeting, Providence, Rhode Island.