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Full Length Research Paper

An assessment of the technical efficiency of beef cattle fattening in Yobe State, Nigeria: A stochastic frontier model approach

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The study assessed the technical efficiency of Beef cattle fattening production in Nigeria. Randomized sampling technique was used to select 100 respondents from the study area. The data were collected through well structure questionnaire. The analytical tools employed were descriptive statistics and Stochastic Frontier production function. The result showed that 70% of the respondents fall within the productive age of 31 - 50 years. 88% 0f farmers were men and 80% had no formal education. The estimated technical efficiency of the beef cattle fatteners ranged from 51% to 79% with a mean technical efficiency of 64%. The variation in the level of technical efficiency indicates that more opportunities exist for beef cattle fatteners to increase cattle production and income through improvements in their technical efficiency. Determinants of technical efficiency of beef cattle fatteners were found to be feeder cattle herd size, labour, feeds/supplement, veterinary services and capital, since all these variables were found to be positive and significantly related to technical efficiency. The study recommended the establishments of micro-credit schemes and increased local firms for processing feeds.

Key words: Beef cattle fattening, technical efficiency, stochastic frontier model.

INTRODUCTION

The livestock sub-sector (LSS) has always been an important component of Nigeria's economy. It contributes to the Gross Domestic Products (GDP) of the country and substantially also to the supply of animal protein (FDLPCS, 2013). By its population and capacity for animal production, with 25% of livestock herds in the sub-region, Nigeria is by far the leading livestock producer in Central and West Africa (Grain de sel, 2012). Cattle are indeed the most predominant and highly valued livestock in Nigeria. A wide gap exists between the level of local production and national needs and demand. The average demand for beef in Nigeria from 2006 to 2015 stood at 286 MT whereas the supply was 235 MT for the same period, a deficit of 51 MT (OECD-FAO, 2015).To bridge the demand-supply gap of animal protein in terms of meat in Nigeria, there is need to adopt other sustainable means of production. Thus, livestock fattening appears to be an alternative to meeting the increasing demand for meat in the nation (Mohammed et al., 2015). Beef cattle fattening has been earmarked as one of the means to improve beef cattle productivity. Cattle fattening involves procuring feeder cattle, putting the animal on concentrate feeds for 1 - 4 months and dispose for slaughter, after which it might have added weight. Cattle fattening helps to meet the rising demand for high-protein foods in the country and plays a great role in: (i) enhancing food security, (ii) providing households with employment, income, investment opportunity and a store of value, and (iii) providing draught power and manure for sustainable agriculture and (iv) cattle fulfilling cultural roles. The growing demands for ruminants' meats from city dwellers also present opportunities for fattening as well as improved markets for the animals. Fattening of animals is

a highly profitable venture with return of premium to the farmer (Maikasuwa et al*.,* 2012).

At present, there is no comprehensive and up to date information as regards the level of resource use efficiencies of the beef cattle farmers, given the existing technologies. The few available ones were either system based or location specific. Most of these studies focused mainly on the profitability of the enterprise without an in depth inquiry into efficiencies of farmers and factors that determine their level of efficiency. Thus the main focus of this study is to determine the levels of technical efficiency of beef cattle farmers and explain those factors that determine their levels of efficiency. Specifically, the objectives of the study were:

i) To describe the socioeconomic characteristics of the beef cattle fattening farmers;
ii) To determine the technical efficiency of the beef cattle fattening farmers

METHODOLOGY

Yobe state is in the Northeast of Nigeria and was created in 1991 from the western half of Borno state. The state borders the Republic of Niger to the north and the Nigerian states of Borno to the east, Gombe to the southwest, Bauchi to the west, and Jigawa to the northwest. Yobe state consists of 17 Local Government Area and has a total land area of 45,502 km^2 with an estimated population of 2,757,000 by 2011. Sorghum, millet, peanuts (groundnuts), cowpeas, corn (maize), sesame, and cotton are the primary crops. Cattle herding and farming are the chief occupations.

The sample for this study was selecting using simple randomized sampling technique. 100 hundred cattle fatteners were selected from Fika, Potiskum and Nangere Local Government areas of Yobe State as the form the hub of cattle fattening enterprise in the state. The analytical tools that were employed in this study include: descriptive statistic and Cobb-Douglas functional form of the stochastic frontier analysis. The Cobb-Douglas functional form of the stochastic frontier was used to determine the technical efficiency or inefficiency of beef cattle fattening farmers in the study area:

The Cobb Douglass frontier production function is defined as follows:

$LnY_i = Ln\beta o + \beta_1 LnX_{1i} + \beta_2 LnX_{2i} + \beta_3 LnX_{3i} + \beta_4 LnX_{4i} + \beta_5 LnX_{5i} + \beta_6 LnX_{6i} + \beta_7 LnX_{7i} + V_i - U_i$

Where;Y = Cattle weight (Kg); X_1= Feeder cattle (Kg); X_2= Feed/Supplement, X_3=Drug/Veterinary services, X_4= Labour, X_5 =Water, X_6 =Potash/Salt lick and X_7 = Capital

V_i = Random error that is assumed to be normally distributed with zero mean and constant variance ($\sigma 2vi$).

U_i = Technical inefficiency effects independent of V_i, and half normal distribution with zero mean and constant variance ($\sigma^2 u_i$).

The technical inefficiency effects, U_i is defined by:

$Ui = \delta o + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \delta_7 Z_{7i}$

where Z_1 = Age of farmer (years); Z_2 = Level of education of farmer (years); Z_3 = Farming experience (years), Z_4= Herd size, Z_5= Membership of cooperative(Yes =1, No =0), Z_6 = Extension Visit(Yes =1, No =0) and Z_7= Access to capital (Yes =1, No =0)

The βs and δs are scalar parameters that will be estimated. The variances of the random errors, $\sigma^2 v$ and that of the technical inefficiency effects $\sigma^2 u$ and the overall variance of the model σ^2 are related thus: $\sigma^2 = \sigma^2 v + \sigma^2 u$ and the ratio $\gamma = \sigma^2 u / \sigma^2$, measures the frontier which can be attributed to technical inefficiency (Coelli et al., 2005). The estimates for all the parameters of the Stochastic Frontier production function and the inefficiency model would be simultaneously obtained in a single stage maximum likelihood estimation procedure, using the computer software frontier version 4.1.

RESULTS AND DISCUSSION

Socio-economic characteristics of respondents

The result of the socio-economic characteristics of the respondents is presented in Table 1. The findings of the study revealed that majority (70%) of the respondents fell within the productive age bracket of 31 - 50 years old. This may not be unconnected with the fact that bull fattening is laborious, therefore requires active individuals and a farmer's age affects her efficiency in performing farm management decisions. Eighty eight (88%) percent of the respondents were males while 12% were females. This implies that men constitute a greater percentage of those involved in beef cattle fattening in the study area. Most (80%) of the respondents had no form of formal education but were schooled in Quaranic education, while only 20% had formal education. Educated farmers are expected to be more receptive to improved farming techniques (AbbaSidi and Ahmed, 2014). On the number of cattle fattened by respondents in a season, it was revealed that 28% of respondents fattened less than or equal to 5 cattle, 41% reported 6-10 cattle and 19% fattened 11-15 cattle. Only 12% of the respondents reported that they fattened 15 cattle fattened per season. This could be as a result of huge capital required by the business. Higher number of cattle fattened could improve profitability of the enterprise as a result of economies of scale in feeds and drugs used. It was revealed by the study that 36% of the respondents had fattening experience of 1- 5 years and 44% had fattening experience of 6 - 10 years. Only 20% of the respondents had experience above 10years. Experience improves

Table 1. Socio-economic characteristics of the respondents.

Variable	Frequency	Percentage
Age		
20-30	24	24
31-40	31	31
41-50	39	39
>50	6	6
Gender		
Male	88	88
Female	12	12
Education		
Formal	20	20
Non formal	80	80
No of Cattle Fattened		
≤ 5	28	28
6-10	41	41
10-15	19	19
>15	12	12
Fattening Experience (Years)		
1-5	36	36
6-10	44	44
>10	20	20

Source: Field Survey, 2017

Table 2. Maximum likelihood estimate and inefficiency function of beef cattle fatteners.

Variable	Parameter	Coefficient	t-ratio
Constant	β_0	5.004	5.117***
Feeder Cattle	β_1	0.569	3.047***
Feeder/Supplement	β_2	0.329	5.225***
Drugs/Veterinary services	β_3	0.153	2.103**
Labour	β_4	0.034	1.813*
Water	β_5	0.019	1.860*
Potash/Salt lick	β_6	0.267	2.356**
Capital	β_7	0.037	1.896*
Variance Parameters			
Sigma squared	σ^2	3.498	2.299**
Gamma	γ	0.771	5.262***
Log Likelihood		-129.734	
Inefficiency Function			
Constant	δ_0	0.015	3.533***
Age	δ_1	-0.009	5.297***
Education	δ_2	-0.026	2.405**
Experience	δ_3	-0.030	1.955*
Herd size	δ_4	-0.130	4.441***
Membership of cooperative	δ_5	-0.238	2.296**
Extension Visit	δ_6	-0.020	2.602**
Access to credit	δ_7	-0.247	3.391***

Source, Field Survey, 2016
***P<0.01, **P<0.05,*P<0.10.

efficiency in resource-use of agricultural activities (Ogunniyi, 2011).

Estimate of Stochastic Frontier production parameter

The model specified for the study was estimated by the maximum likelihood method using Frontier 4.1 software. Result on Table 2 shows the maximum likelihood estimates and inefficiency determinants. The variance parameter sigma (δ2) was 3.498 and statistically significant at 1% level which indicates good fit and correctness of the specified composite error term distribution. The gamma estimate was 0.771 and was statistically significant at 1% level meaning that 77% variation in total cost of production was due to allocative

Table 3. Frequency distribution of technical efficiency.

Efficiency	Frequency	Percentage
0.51- 0.60	17	17
0.61- 0.70	53	53
0.71- 0.80	30	30
0.81- 0.90	-	-
0.91- 1.00	-	-

Minimum = 0.51; Maximum = 0.79, Mean = 0.64.

inefficiency.

The result revealed that the coefficient for feeder cattle (0.569) was positive and statistically significant at 1%. This implies that 1% increase in the cost of feeder cattle will lead to 0.569% increase in the efficiency of input use in beef cattle fattening enterprise. A plausible explanation to this is that in cattle fattening, feeder cattle is the most important input used. The initial cost of the feeder cattle greatly influence the total cost of the production of the farms. The coefficient of feed (0.329) was positive and significant at 1% level. The cost of feed influences the cost of the fattening and hence the profitability of the farms. The coefficient of drugs and veterinary services (0,153) was positive and statistically significant at 5%, implying that 1% increase in the use of drugs and veterinary services and leads to 0.2% increase in the efficiency of resource use in beef cattle fattening enterprise. The quality of veterinary services not only improves the efficiency of the animal in terms of feed conversion, but also reduces rate of mortality in the farm. The coefficient of labour (0.034) was positive and statistically significant at 10%. This implies that 1% increase in labour use will result in 0.034 % increase the efficiency of resource use in beef cattle fattening enterprise. The coefficient of water (0.019), potash/salt lick (0.267) and capital were positive, but were significant at 10%, implying that these variables had little influence on the efficiency of resource use in fattening. These findings also agree with those of Isyanto et al. (2013).

The estimated coefficients of the inefficiency function provide some explanations for the relative technical efficiency levels among the individual farms. The result of Maximum Likelihood Estimates of sources of efficiency revealed that coefficients of age, herd size and access to credit were negative and significant at 1% level. This implies that these variables reduce allocative inefficiency of the cattle fatteners in the study area. However, the coefficient of educational qualification, cooperative membership and extension contact were also negative but significant at 5%, while the coefficient of experience was 10%, implying that they have little influence on the efficiency of the farmers. Similar findings were reported by Alemdar and Yilmaz (2011) in their study of resource use efficiency of Turkish small scale dairy farmers

The estimate of the parameter for age variable is negative and significant at 1%. This suggests that older farmers are more technically efficient than their younger counterparts are. This result is consistent with the findings by (Isyanto et al., 2013).

The estimate of education variable is negative and significant at 5% level. This suggests that higher level of education increases technical efficiency. This result is consistent with the findings by Mor and Sharma (2012). More educated farmers are able to perceive, interpret and respond to new information and adopt improved technologies such as seed and feed much faster than their counterparts.

The coefficient of experience variable is negative and significant at 10% level. This suggests that farmers with more experience achieved higher levels of technical efficiency. This result is consistent with the findings by AbbaSidi and Ahmed (2014).

The estimate of the parameter for number of Herd size variable is negative and significant at 1% level. This results show that farmers who raised a higher number of cattle achieved a higher level of technical efficiency. This result is consistent with the findings by Alemdar and Yilmaz (2011). The higher number of cattle needs more allocation of working time by the farmers thereby reducing technical inefficiency. In addition, farmers will try to improve their knowledge and skills in rearing livestock so that it will achieve a high level of technical efficiency.

The coefficient of credit variable is negative and significant at the 10% level. This suggests that increasing credit use would enhance technical efficiency of sample farms. This result is consistent with the findings by Mohammed et al. (2015) and Javed et al. (2012). Access to credit permit farmers to enhance efficiency by overcoming liquidity constraints which may affect their ability to purchase and apply inputs and implement farm management decisions on time hence increasing efficiency.

The frequency distribution of technical efficiency levels achieved by the farmers is presented in Table 3. Technical efficiency ranged from 0.51 to 1.00 with an average of 0.64. The average technical efficiency of 0.64 indicates inefficiency gap of 0.36. This implies that about 36% higher production could be achieved without additional resources, or input use could be reduced to achieve the same output level. For an average farmer to attain the technical efficiency level of their most efficient partner, they will increase their efficiency level by 36% [i.e. 1- (0.64/1.00)]. On the other hand, the least technical efficient farmers will have to increase their efficiency level

by 49% [i.e. 1-(0.51/1.00)].

Conclusion

The study has shown the distribution of technical efficiency of beef cattle fatteners in Yobe State, Nigeria. Farmers' specific factor like Feeder cattle, feed/supplement and veterinary services contributed positively to technical efficiency level of the beef cattle fatteners' farmer in the study area. Also production inputs like Potash/salt lick, labour, water and capital contributed positively to technical efficiency level. Furthermore, 77% of the variations in input use among the beef cattle fatteners' farmers were due to inefficiency on the part of the farmers rather than random variability.

More so the distribution of efficiency estimates among the beef cattle fatteners' farmers has shown a low level of technical efficiency. On an average, technical efficiency of the pig farmers could be increased by 36%, using the current production technology. This study has revealed that beef cattle fattening enterprise in the study area are not fully technically efficient and therefore there is allowance of efficiency improvement by addressing some important policy variables that negatively and positively influenced farmers' levels of technical efficiency in the area.

It was shown that age, education, herd size, membership of cooperatives, extension services and access to capital had a positive correlation with technical efficiency.

Recommendation

Therefore based on these findings, the following recommendations were made:

i.) Farmers should be encouraged to improve their levels of education by registering in Adult/Continuing Education Centres in the area.

ii.) Farmers' membership of association was also positively related to efficiency, implying that the making and implementing of policies that would encourage farmers to form cooperatives or farmers organization or join existing ones will be a step in the right direction.

iii.) The positive relationship between access to credit and efficiency of the farmers implies that policies that will make micro-credit from government and non-governmental agencies accessible to these farmers will go a long way in addressing their resource use inefficiency problems.

iv.) Extension agents should be properly trained and the frequency of their visit increased

v.) Local firms producing feeds/supplement should be encouraged and incentives be created for establishment of new ones.

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