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DETERMINANTS OF TECHNICAL EFFICIENCY OF SHEEP PRODUCTION IN BAMA LOCAL GOVERNMENT AREA OF BORNO STATE, NIGERIA

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ABSTRACT

This study examines the technical efficiency and its determinants in Sheep production in Bama Local Government Area of Borno State, Nigeria. A two-stage sampling procedures were used for the selection for the respondents, while, Stochastic frontier model was used for the analysis. Primary data were collected using the interview method with the aim of a structured questionnaire and respondents selected using random sampling. The result of the study revealed a mean technical efficiency of 0.83, implying that there is scope for farmers to improve their technical efficiency by about 17 % in the study area given the same resources under utilisation. The main sources of inefficiencies displayed by the average farmer were; level of education, management record keeping, herd size, and extension services. The study therefore recommends that informal and extension education should be channelled to the farmers in addition to the practice of artificial insemination to upgrade the present breeds for higher weight gain through feed conversion and higher productivity.

Keywords: Stochastic, Sheep, Technical, Efficiency, Determinants, Questionnaires

INTRODUCTION

Over half of the world's, one billion extreme-poor are estimated to fully or partially depend on livestock for their livelihoods. Livestock products make a substantial contribution to nourishing people around the world, providing almost one-third of humanity's protein intake. Furthermore, the livestock sector has a substantial economic role, accounting for some 40 per cent of world agricultural GDP. At the same time the demand for livestock products continues to expand due to growing population and income along with changing food habit and preference (ILEIA 2010).

The potential of livestock to reduce poverty is enormous; livestock contribute to the livelihood of more than two-thirds of the worlds' rural poor and to a significant majority of the peri-urban poor. The poorest of the poor do not have livestock, but if they can acquire poultry/animal their livestock can help start them along a path way out of poverty (Gefu, 2014). Sheep production is highly crucial to the economics of many rural communities in Nigeria. Apart from serving as a source of meat, skin and employment, they act as a buffer against unforeseen economic hardships of vulnerable upstream agents. They are easily sold to finance immediate family financial obligations in addition to being used for religious ceremonies. They serve also as a security against fluctuating and unpredictable risk and uncertainty in crop enterprises. In many Nigerian societies, they are slaughtered to honour a visiting relation or an important guest (Umar, 2007).

Nigeria has a population of between 8 to13.2 million sheep out of which about 3.4 million are found in the southern/humid region and the larger proportion of the animal in the northern

region of the country. Available breeds of sheep in the country are mainly indigenous and these are the West African Dwarf (WAD) sheep, Balami, Uda and Yankasa. Out of these four major breeds of sheep in the country, the WAD breed is common to southern region against the widespread of Balami, Uda and Yakansa breeds in the northern region of the country. Characteristics analysis of sheep in the country, especially among the Fulani pastoralists showed that ewes had approximately 120% fertility rate, 12% rate of twinning and 25% lamb mortality rate at 3 months old. Sheep productivity index puts lamb weight at 0.327 kg at a weaning age of 90 days, and 0.490 kg at a weaning age of 180 days per ewe per year. Mature males of the local breeds of sheep have a live weight of about 30 to 65kg and their female counter parts often weigh between 30 and 45kg.

Generally, Small ruminants which production is regarded as a venture meant for the poor segment of the society because of their relative low initial investment cost. Sheep have a better advantage over the large ruminants due to their easy adaptation to the environment. They can adapt to a broad range of environments and efficiently utilise poor pasture and forage. They can equally be fed with household or domestic kitchen waste and leftover food. As a result of this, the proportions of small ruminants to their larger counterparts tend to increase (Fakaya and Oloruntoba, 2009). Farmers in the rural areas used Sheep as a means of starting an animal husbandry because they require low initial capital investment and low cost of operation and quick reproduction rate (Chah *et al*, 2013). The poorest are not disposed to purchasing larger ruminants. As a result, the market trend towards smaller ruminant. Small ruminants remain popular among the rural resource-poor communities (Aphunu *et al*. 2011)

Bama local government area is one of the major centres for Sheep and Goat production and because serves as route through which livestock are imported into the country from the neighbouring Republic Niger, Chad and Cameroun (Umar, 2007). This has made possible the presence of good market network and a seemingly flourishing socio-economic life of the producers/farmers and marketers. The potentials of Sheep production in Bama Local Government Area and likelihood of sustaining the economic and living standard of the rural dwellers have received much recognition in the recent past. However, little research is known about the determinant of productivity of Sheep production in the study area. Hence, this study was meant to provide empirical information on the determinants of technical efficiency of Sheep production in Bama Local Government Area. The main objective of the study was to estimate the technical efficiency of Sheep production and to identity the major sources of efficiency in Sheep production in the study area to make policy recommendations.

METHODOLOGY

The Study Area

Bama Local Government Area is located between in Borno State on latitudes $11^{o}15'$N and $11^{o}50'$ and longitudes 13^{o} 24'E and 14^{o} 41'E. It covers an area of about 6,176km^2 (Umar, 2007). It has a total population of about 296,986 people (NPC, 2006) which is projected to be 760284.16 in 2014 based on 3.2% annual growth rate. The people of the study area are mainly agro pastoralist/ farmers. The dominants crops cultivated include sorghum, maize, millet, rice, cowpea, groundnut, onion, tomato and pepper, while, the livestock commonly kept are cattle, sheep and goats (Umar *et al.*, 2013).

This study uses two-stage sampling procedures, the first stage, involves a purposive selection of four villages, namely; New Bama, Old Bama, Soye and Goniri based on concentration of Sheep producing. In the second stage, 5% of the farmers were randomly selected from each of the districts making a sample size of 127 respondents. Primary data were collected using farm survey method. The data gathered includes those on socio-economic variables of the livestock farmers, quantity of inputs used and the level of output produced.

Literature review

Measurement of the efficiency of agricultural production is an important issue in developing countries. A measure of producer's performance is often useful for policy purposes, and the concept of economic efficiency provides a theoretical basis for such a measure (Russel and Young, 1983). Farrell (1957) formulated a linear programming model to measure technical efficiency of a firm with reference to benchmark technology characterized by constant returns to scale.

This efficiency measures corresponds to the coefficient of resource utilization defined by Debreu (1951). Charnes *et al*. (1978) introduced the method of data envelopment analysis (DEA) to address the problem of efficiency measurement for decision making units (DMU) with multiple inputs and multiple outputs in the absence of market prices. They coined the phrase decision making units in order to include non-market agencies like schools, hospitals and courts, which produces identifiable and measurable input but lack market price of output and inputs. This approach is based work of Farrell (1957) and Fare (1994) has since been improved upon and extended by Battesse (1992) and Coelli (1996).

The term technical efficiency of a farm is its ability to produce the largest possible quantity of output from a given set of inputs. The modern theory of efficiency dates back to the work of Farrell (1957), who proposed that the efficiency of a farm consist of technical and allocative efficiencies: the two components combine to give a measure of economic efficiency.

Stochastic Frontier Production Function Model

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

Model specification

Following Aigner, *et al.* (1977) and Van de Brock (1979), 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…….... 1

Where: Y = Output (live weight)

X_i = Quantity of Input Used (kg)

β_i = 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 farmers 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 or determines technical inefficiency of the farm, which are assumed to be non-negative truncation of the half-normal distribution $N(U\ \sigma^2)$.

$TE; = Y_1/Y_i^*$

$= f(X_i; \beta)\exp(V_i - U_i)/f(X; \beta)\exp V_i - \exp(-U_i)$ ……...……. 2

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

Specification of the Empirical Model for Sheep production

The linear form of Cobb-Douglas stochastic frontier production function is specified as follows:

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

Where:

Y_i = Output (Number of Sheep) per farm/year
βo = Intercept
β_1- β_2 = Unknown Scalar Parameters to be Estimated
X_1 = Total Feed Used (kg)
X_2 = Number of Labour (in Man days)
X_3 = Stocking Rate (Number of matured animals per farm)
X_4 = Medicare (₦)
X_5 = Number of lamb gave birth per year
μ_i = Random error
V_i = Technical inefficiency effects

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:

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

Where:

μ_i = Represents the Technical Inefficiency of the i-th farmer
Z_1 = Farming Experience (years)
Z_2 = Educational Qualification (Number of years of schooling)
Z_3 = Number of Young Sheep/lamb
Z_4 = Management Record of Mortality on Farm (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 farmers. 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, 1977). 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 Sheep Production

Determinants of technical efficiency of sheep production

Table 1 revealed the estimates of the parameters for the frontier production function and the variance parameters of the model. The gamma (γ) which is the proportion of deviation from frontier that is due to inefficiency estimate was 0.732 and is statistically significant at 1% level of probability. It shows the amount of variation resulting from the technical inefficiency of Sheep production. This means that more than 73% of the variation in farmers output is due to the difference in their technical efficiencies.

The mean technical efficiency of the farmers was 76%. This implies that on the average, the Sheep producers were able to obtain about 76% of the potential output from a given quantity of inputs. This implies that there exist the scope of increasing their productivity by about 24%, by adopting the practices and production techniques of the most efficient producer using the same input resources in the study area. The result revealed that the coefficient for feed (0.572) was positive and significant ($p<0.01$). This implies that 1% increase in the quantity of feed will lead to 0.572% increase in output. A plausible is that feed constitutes the most important input in the farms. The quality and the quantity of feed influence the performance of the animals.

The coefficient of labour (0.042) was positive, but not statistically significant, implying that labour have little or no influence on the productivity of Sheep production. The availability of labour implies that these services are easily provided to the animals as and when due which will in turn improves their efficiency. Similarly, the coefficient of stocking rate (0.354) was positive and significant ($p<0.01$). However, the coefficient of water (0.025) was positive and significant ($p<0.10$). This implies that quantity of water taken or availability to the animal had little influence on the level of output of the animals. This result was against the apriori expectations and may be because of the Sahelian environment, suggesting that Sheep production done in an environment with higher water availability may increase output.

The coefficient of medicare (0.372) was positive and significant ($p<0.01$), suggesting improved health care was necessary for a profitable Sheep production. The quality of veterinary services does not only improve 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 significant at ($p<0.10$).

Table 1: Maximum Likelihood Estimates of Technical Efficiency of Sheep Production in Bama Local Government Area

Variables	Parameter	Coefficient	t-ratio
Constant	β_0	2.431	5.163***
Feed	β_1	0.572	3.652***
Labour	β_2	0.236	2.407**
Stocking rate	β_3	0.354	2.931***
Water	β_4	0.025	1.420
Medicare	β_5	0.372	2.343**
Potash/salt	β_6	0.165	1.732*
Variance parameter			
Sigma	(δ^2)	4.253	
Gamma	(γ)	0.891	
Log likelihood		36.33	
Mean efficiency		0.831	

Note: *** sig at 1%, ** sig at 5%, * sig at 10

Distribution of Technical Efficiency of Sheep Production

Table 2, further revealed that the mean technical efficiency was 0.831, indicating substantial efficiency in Sheep production in the study area. The implication of this is that for the average farmer to achieve efficiency level of the most efficient farmer, he could reduce his inputs level by about 17 per cent and still produce same level of output. Similarly, the least efficiency farmer in the sample could reduce his inputs usage by 49 per cent and produce same level of outputs. The greater proportion (72%) of farmers had technical efficiency scores exceeding 70%, indicating that Sheep producers in the study area are operating near the frontier level.

Table 2:Distribution of Technical Efficiency of Sheep Production

Efficiency	**Frequency**	**Percentage**
0.10 – 0.49	08	6.3
0.50 – 0.59	12	9.4
0.60 – 0.69	16	12.6
0.70 – 0.79	27	21.3
0.80 – 0.89	58	45.7
0.90 – 0.99	06	4.7
Total	127	100

Determinants of Technical Efficiency of Sheep Production

The maximum likelihood estimates for the sources of technical inefficiency is presented in Table 3. The result revealed that coefficient of years of experience (5%), educational qualification (5%), management record keeping (10%) and access to credit (1%) were positive and significantly related to technical inefficiency. This implies that these variables increase the level of technical efficiency of the sheep production farms in the study area. However, the coefficient of access to extension services and stocking rate were positive but not statistically significant, implying that they have little or no influence on the efficiency of the sheep production farmers. These findings also agreed with those of Ceyhan and Karem (2010) and Mlote *et al*. (2013) which reported similar findings for cattle-fattening farms in Turkey.

Table 3: Estimates of Technical Inefficiency Effects in Sheep Production

Variables	**Parameter**	**Coefficient**	**t-ratio**
Inefficient Model			
Constant	δ_0	0.034	5.263
Experience	δ_1	0.003	2.671**
Educational qualification	δ_2	-0.002	2.530**
Stock rate size	δ_3	0.004	1.231
Management record	δ_4	-0.004	2.340**
Extension service	δ_5	0.003	1.823
Access to credit	δ_6	-0.003	3.256***

CONCLUSION AND RECOMMENDATIONS

Determinants of technical efficiency of sheep production

The technical efficiency of Sheep production was moderate; however, there is the possibility for improving the level of efficiency by adopting the production technology of the best practising producer in the study area. Therefore, to improve the efficiency of small ruminant production and specifically Sheep production, the following were recommended: there is the need for farmers take advantage of breeding centers to be train on the techniques of cross breeding and artificial insemination (AI) to improve the local breed of Sheep. Similarly, the farmers need to be knowledgeable on local feed resources formulation for better productivity. Furthermore, 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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