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Article

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GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

Analysis of profit efficiency of smallholder beef cattle farms in South-West Nigeria

Suliyat Omolade Jimoh¹, Olayinka Isiaka Baruwa¹ and Adetomiwa Kolapo^{1*}

Abstract: The study was carried out to analyze the profit efficiency in beef production in South West, Nigeria. These were with a view to improving beef cattle production to meet its increasing demand and income generated from it for producers. Multistage sampling techniques were used to select respondents used for the study. Primary data were collected with the aid of a well-structured questionnaire. Budgetary analysis and stochastic production frontier were used to analyze the data collected. The result of the study shows that total revenue generated was ₦1,879,928.11 while the Gross margin and Net return to management were ₦835,443.63 and ₦726,295.65, respectively. In addition, the Profit efficiency average is $62.2\% \pm 22.52$. Beef cattle production on the average was operated at two-thirds of the profit efficiency frontier.

Subjects: Economics; Finance; Industry & Industrial Studies

Keywords: Beef cattle; Efficiency; Profitability; Stochastic frontier; Nigeria

1. Introduction

Beef is an important agricultural commodity in the world economy. Generally, world beef production constitutes about 40% of the livestock output (Nell, 1990; FAO, 2015). The total beef output in 2019 was estimated to be 335 million metric tonnes (FAOSTAT, 2019). The livestock sub-sector (LSS) has always been an important component of Nigeria's economy (FAO, 2014). In addition to its contribution to the Gross Domestic Products (GDP) of the country, it contributes substantially also to the supply of animal protein (Federal Department of Livestock, 2013). By its population and



Suliyat Omolade Jimoh

ABOUT THE AUTHOR

Suliyat Omolade Jimoh was a graduate student of the department of agricultural economics, Obafemi Awolowo University, Nigeria. My research interests focus on agribusiness enterprises with a keen interest in livestock production while enhancing farmers' productivity without compromising on equally important ecological, ethical, social and welfare goals. My research experience dated few years back having collaborated with other scholars in the field of agricultural economics in Nigeria. My quest is to work on agribusiness development in Nigeria and beyond while maintaining values for profitable agribusiness enterprise.

PUBLIC INTEREST STATEMENT

In Southern Nigeria, beef cattle production represents one of the least produced livestock which is invariably due to lack of information on its profitability. Many of the farmers would rather go for the production of other livestock most especially birds production. In this study, we found that beef cattle production is a profitable enterprise even in the Southern region of Nigeria. Thus, the rate of return on investment and benefit cost ratio calculated implies that investment in beef cattle is a lucrative business idea in the context of Nigeria. We suggest that subsidizing the cost of the production by the government and stakeholder will help increase the investment in beef cattle production while also improving the profit efficiency of the beef cattle farmers.

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, 2010).

Beef is indeed a highly traded commodity and these suggest that there might be considerable opportunities for trade in beef, especially in developing countries such as Nigeria. Nigeria's cattle herds are estimated at over 16 million herds, far ahead of Niger (8.7 million), Mali (8.2 million) and Chad (7 million; FAO, 2014). Perhaps, Nigeria could benefit by improving its beef production and possibly export to the North African market where it might have relative geographical advantage in trade, due to proximity. Beef cattle are produced and marketed in all parts of Nigeria but with the North-Eastern and North-Western parts predominating. Beef cattle are also exchanged not only between northern markets but also between the northern and southern parts of Nigeria (Inuwa, 1989; Fricker, 1993 as cited in Saleh et al. (2016)). There is deficiency in the intake of beef, which is an important source of protein in human diet. For instance, in Nigeria, the intake of animal protein is 5.46 g/day (Saleh et al., 2016) as against a minimum requirement of 35 g recommended by FAO (2014). It is obvious that Nigeria, with an estimated population of about 206 million people in year 2020, requires not less than 47 million herds of cattle to satisfy its demand for cattle and cattle products annually (FAO, 2014). Again, with a population growth rate nearing 2.8% per year, the country's own domestic production is by far from being able to meet recommended demand (Grain De Sel, 2010). Also, considering the size of the human population that depends on beef cattle production in Nigeria, the development of domestic and export markets is critical to ensuring food security, alleviating poverty, raising revenue and continuing the trend towards more market orientation (Saleh et al., 2016; Food and Agriculture Organization, 2020). These issues suggest that it is important to improve the manner in which inputs are used in beef cattle production systems (Offor et al., 2018). Improving the management production system is considered as a possible strategy that could reduce the economic costs of production. This should entail producing optimal output per unit input, for instance, by use of better cattle breeds and enhancing other farm management practices, including feeding (Scollan et al., 2010). Efficient production is important in order to improve supply for beef cattle domestic and export markets in Nigeria. These issues might have a considerable bearing on farmers' production decisions and efficiency. Efficiency means the production situation where there is minimal waste. Thus, production efficiency occurs at the point where there is minimum cost of production. Ettah and Nweze (2016) noted that profit efficiency is a concept used in assessing whether an input is expending an optimally balanced level of rent for the use of such a capital. Profit efficiency is an economic performance measure of farms (Offor et al., 2018). Output that provides insufficient returns to the input used are said to be profit inefficient. The level of profit efficiency of a particular farm is therefore characterized by the relationship between observed production and some ideal or potential production. The measurement of firm specific profit efficiency is based upon deviations of observed output from the best production or efficient production frontier. If a farmer's actual production point lies on the frontier, it is perfectly efficient. If it lies below the frontier then it is profit inefficient, with the ratio of the actual to the potential production defining the level of profit efficiency of the individual farm. Attempts to increase the productivity will yield an appreciable growth in the sector and this will undoubtedly increase income and farm profit. Therefore, the evaluation of profit efficiency will improve its production, increase farmers' revenue and consequently profit.

1.1. Problem Statement and Objectives of the Research

Crop and livestock enterprises in Nigeria are generally characterized by stagnating or declining productivity, partly due to high unit cost of production and inability of farmers to afford high-yielding farm inputs (Omonona et al., 2010). According to Scollan et al. (2010), there is a decline in beef cattle production especially, in Nigeria. This decline could be traced to many factors including the production system being utilized and high cost of production among others.

Past studies of Nigeria's beef profitability have investigated performance under various projected price regimes and trade agreements (Akpa et al., 2012; Jefferis, 2007), estimating multifactor productivity and technical inefficiency (Irz & Thirtle, 2004; Thirtle et al., 2000) and exploring the

beef value chain (Bahta et al., 2013; FAO, 2014). Limitations of these studies include that they either failed to account for farmers' management-related adjustments to farm budgets in the presence of broader economic change, and/or that they assumed technical efficiency in terms of input use and production technology. Hence, efficiency has not been estimated and examined for its actual and potential influence on profitability and the factors affecting it. Food and Agriculture Organisation (FAO; 2013) demonstrates substantial differences in profitability across different technological models, but the analysis was based on a deterministic treatment of constructed household types rather than estimated from representative data. These limitations created a dearth in knowledge on the determinants of the profit efficiency of beef farmers.

Previous studies (Olafadehan and Adewumi, 2010; Saleh et al., 2016; Zekeri & Mukhtar, 2015) have been directed at examining productive efficiency of cattle farmers with little or no attention focus on measuring the profit efficiency of cattle farmers. However, computing profit efficiency of cattle farmers constitutes additional important source of information for policy makers. It is against this backdrop that this study tends to estimate the costs and returns to beef cattle production; determine the profit efficiency of beef cattle farmers; and examine the factors influencing the profit efficiency of beef cattle farmers in Nigeria.

The need for this study was borne out of the fact that investigating the profit efficiency of beef cattle production in Nigeria would provide insights on how to better integrate livestock development into the national and economic agenda, as well as guidance to farmers on resource allocation in order to generate optimum revenue from their farms. Computing the profit efficiency of beef cattle production in the study area will provide an important source of facts for policy makers than the results from analyzing its cost efficiency.

1.2. Theoretical framework

This study is centered on theory of production. Production is the transformation of factor inputs such as land, labour, capital, water resources, and management, through the farm-firm or producing unit to other goods and services called output (Olayide & Heady, 2006). The objectives are for profit maximisation, output maximization, cost minimisation or the maximisation of satisfaction. The theory of production presents the theoretical and empirical framework that facilitates the application of alternatives methods so that anyone or a combination of the firm's objectives can be attained (Olayide & Heady, 2006). In production, the relationship between inputs and output could be either of one factor-one product, many factors-one product, one factor-two products and many factors-many products but the focus of this study is on many factors-many product (beef, blood, hide and skin).

The decision of whether or not to produce is influenced by a myriad of factors. Economists and other scholars have identified three theories underlying farmers' production decisions. The literature suggests that farmers may be motivated to produce on the basis of their attitude towards risk; the utility derived from production; and for profit reasons (Samboko, 2011).

1.3. Stochastic Profit Efficiency Function/Analytical framework

Tsue et al. (2012) and Tijani et al. (2006) analyzed profit efficiency in their study using the stochastic profit function frontier. Production efficiency is usually analyzed by its two components: technical and allocative efficiency. Recent developments combine both measures into one system, which enables more efficient estimates to be obtained by simultaneous estimation of the system (Wang et al., 1996). The popular approach to measure efficiency—the technical efficiency component—is the use of frontier production function (Trounelekas et al., 2001). However, it has been argued that a production function approach to measure efficiency may not be appropriate when farmers face different prices and have different factor endowment (Ali & Flinn, 1989). This led to the application of stochastic profit function models to estimate farm specific efficiency directly (Wang et al., 1996).

The profit function approach combines the concepts of technical and allocative efficiency in the profit relationship and any errors in the production decision are assumed to be translated into lower profits or revenue for the produce (Ali et al., 1994). Battese and Coelli (1995) extended the stochastic production frontier model by suggesting that the inefficiency effects can be expressed as a linear function of explanatory variables, reflecting farm-specific characteristics. The advantage of this model is that it allows the estimation of farm specific efficiency scores and the factors explaining the efficiency differentials among farmers in a single stage estimation procedure. Following Rahman (2002), this study utilises the Battese and Coelli model by postulating a profit function, which is assumed to behave in a manner consistent with the stochastic frontier concept.

The stochastic profit function is defined as

$$\pi_j = f(P_{ij}, Z_{ik}) \cdot \exp e_j \quad (1)$$

π_j = normalized profit of the j th farm and it is computed as gross revenue less variable cost divided by the farm specific output price P .

P_{ij} is the price of j th variable input faced by the i th farm divided by output price;

Z_{ik} is level of the k th fixed factor on the i th farm; e_i is an error term; and $i = 1, \dots, n$, is the number of farms in the sample. The error term e_i is assumed to behave in a manner consistent with the frontier concept (Ali & Flinn, 1989) that is

$$e_i = v_i - u_i \quad (2)$$

v_i is the symmetric error term and it is assumed that it is an independently and identically distributed two sided error term representing the random effects, measurement errors, omitted explanatory variables and statistical noise.

u_i is the one sided error term. It is a non-negative one sided error term representing the inefficiency of the farm. Thus it represents the profit shortfall from its maximum possible value that will be given by the stochastic profit frontier.

The inefficiency profit frontier model

The inefficiency effects u_i in equation (2) above are assumed to be a function of a set of non-negative random variables that reflect the efficiency of the farm. They are assumed to be independently distributed, such that efficiency measures are obtained by truncation of the normal distribution with mean, $\mu = \delta_0 + \sum_d \delta_d Z_{di}$ and variance σ_u^2 where Z_{di} is the d th explanatory variable associated with inefficiencies on farm i and δ_0 and σ_i are the unknown parameters.

The profit efficiency of the farm i in the context of the stochastic frontier profit function is defined as

$$EFF_i = E[\exp(-u_i) | e_i] = E[\exp(-\delta_0 - \sum_{d=1}^D \delta_d Z_{di} | e_i)] \quad (3)$$

Where, E is the expectation operator. The method of maximum likelihood is used to estimate the unknown parameters, with the stochastic frontier and the inefficiency effects functions estimated simultaneously. The likelihood function is expressed in term of the variance parameters, $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / \sigma_u^2 + \sigma_v^2$ (Battese & Coelli, 1995).

1.4. Distribution of Cattle in Nigeria

Cattle command a prominent position in our meat supply and livestock industry. Beef is estimated to supply about 45% of total meat consumed in Nigeria, while the next in rank is sheep and goat

meat with 35%. National herd contains an estimated 9.2 million herds of cattle in 1981 (FAO, 2015). Over 90% of these are in the hands of traditional producers and in the Northern parts of the country (Ken, 1982). The growth rate in the National herd is estimated at 1.5% annually. It is interesting to note that although developing countries have about two-thirds of the World Cattle Production, about two-third of total beef production is accounted for by developed countries (Akpa et al., 2012). Whatever their level of production, livestock in developing countries provide millions of families with better nutrition, family income and employment opportunities, draft power etc. (Akpa et al., 2012; Haruna & Murtala (2005).

1.5. Demand for and Supply of Beef

At present, the Fulanis provide over 85% of Nigerian meat supplies (Akpa et al., 2012). However, their nomadic system of production is increasingly coming under pressure from rapidly changing social, economic and political situations as Nigeria develops (Akpa et al., 2012). For example, the proliferation of states, opening of huge areas of land by River Basin Development Authorities for irrigated agriculture, the development of new cities like Abuja the new Federal Capital and the land use Act which failed to recognize the rights of the Fulani herdsmen to transient usage of land for grazing, all serve to make nomadism increasingly untenable as a method of cattle production. Unfortunately, we do not have a viable alternative in place, as most government and private beef production projects, making use of modern methods, are yet to make an appreciable impact (Federal Department of Livestock, 2013).

1.6. Beef Supply in Nigeria

The national meat supply position is very critical. The situation appears to be deteriorating with time. But for the needed support given in the form of massive importation of meat and meat products, in recent years, the national meat shortage situation would have attained crises dimension (Oyenuga, 2002).

Beef accounts for more than 50% of Nigerians total meat supply. Although it has always been difficult to specify by number or by its proportion of the national herd, it is, nevertheless, known that a significant portion of the locally produced beef derived from trade cattle from Nigeria's neighbors like Chad, Niger and Cameroon. This has significantly reduced the acute beef shortage that would have been experienced if Nigeria had relied entirely on her own resources for meat supply. The estimated demand for, supply of and demand/supply gap of beef is presented in Table 1. From the table, the beef demand/supply gap kept increasing at an alarming rate as demand for beef was increasing at a rate faster than the rate of increase in supply. In order to meet up with the ever increasing demand, the government complimented the supply with imported beef (Akpa et al., 2012).

1.7. Concept of Profit Efficiency/Conceptual framework

The question of how to measure efficiency has received considerable attention in economic literature. A profit function is an extension and formalization of the production decisions taken by a farmer. According to production theory, a farmer is assumed to choose a combination of variable inputs and outputs that maximize profit subject to technology constraint (Farrell, 1957). Following the work of Farrell (1957), efficiency can be defined as the ability to produce a given level of output at lowest cost. The concept of efficiency has three components: technical, allocative and economic.

The profit function approach combines the concepts of technical and allocative efficiency in the profit relationship and any errors in the production decision are assumed to be translated into lower profits or revenue for the producer (Babayemi et al., 2014). Yotopolous and Lau (1973) popularized the use of the profit function approach, in which farm- specific prices and levels of fixed factors are incorporated in the analysis of efficiency. The advantage of using this approach is that input and output prices are treated as exogenous to farm household decision making, and they can be used to explain input use.

Table 1. Estimated Demand for and Supply of Beef and gap in Nigeria between 1990 and 2010 (000mt)

Year	Demand	Supply	Demand/Supply Gap
1990	252.52	180.56	91.94
1991	272.65	165.24	107.41
1992	294.41	171.60	122.81
1993	317.90	176.88	141.02
1994	343.28	182.16	160.66
1995	370.67	187.44	183.23
1996	400.25	190.77	204.48
1997	432.19	196.33	235.86
1998	466.67	202.05	264.62
1999	503.92	207.94	295.98
2000	544.13	214.00	330.13
2001	587.55	220.24	361.31
2002	634.44	226.66	407.78
2003	685.07	233.26	451.81
2004	739.74	240.06	499.69
2005	798.72	247.06	551.71
2006	862.52	254.26	608.26
2007	931.30	261.67	669.68
2008	1005.67	269.30	736.37
2009	1058.92	277.15	807.85
2010	1172.58	285.23	887.55

Source: (Federal Department of Livestock and Pest control, 2010)

Profit efficiency, therefore, is defined as the ability of a farm to achieve highest possible profit given the prices of variable inputs and levels of fixed factors of that farm and profit inefficiency, in this context, is defined as loss of profit for not operating on the frontier (Ali and Flin, 1989).

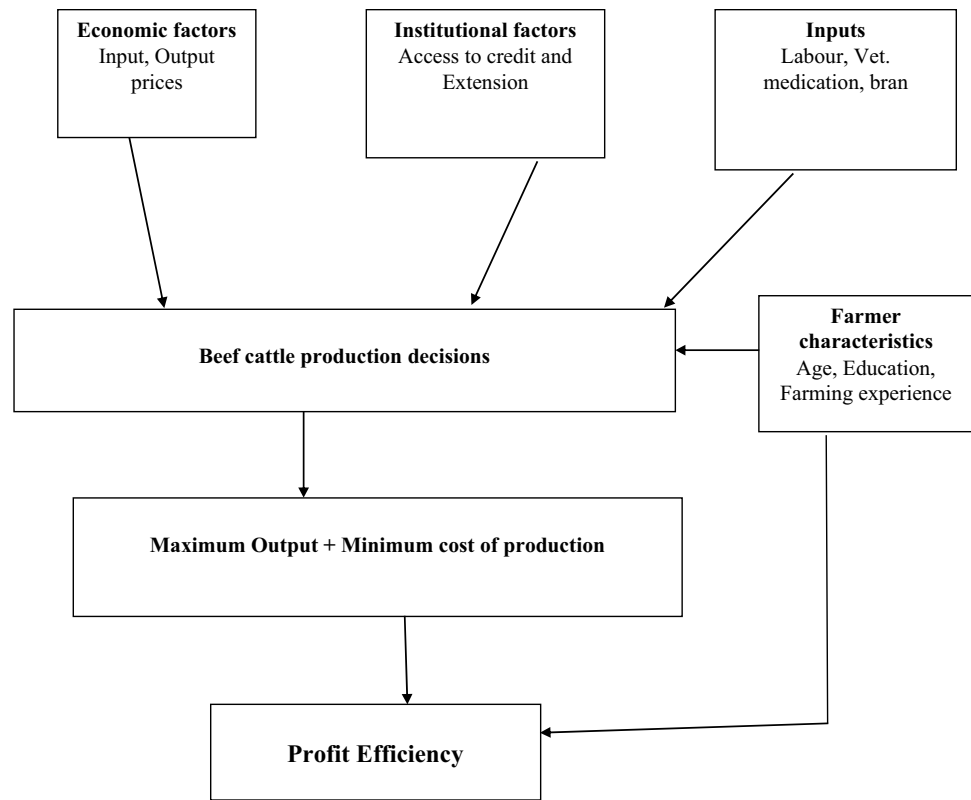
From Figure 1, economic factors, institutional factors and inputs used can affect beef cattle production decisions.

This may also be corroborated by farmers' characteristics including age of the farmers, education and farming experience. The farmers' characteristics can directly influence the profit efficiency of the farmers. Also, the beef cattle production decisions made by the cattle farmers may subsequently leads to a minimized cost of production and maximum output will be attained. When this is done, it is expected to influence the profit efficiency of the cattle farmers as illustrated in Figure 1.

1.8. Empirical review

Studies have been carried out on cattle production in Nigeria indicating that cattle production is a profitable business in Nigeria and other countries around the world. For instance, Umar et al. (2008) conducted a research study on the economics of small-scale of cow fattening enterprise in Borno State, Nigeria using a random sampling to select 45 respondents from two districts that have large number of beef fattening enterprise. The result of the study showed that the net margin was N40, 528.58 per cow that is, for every one naira invested in cow fattening business, 67 kobo was realized as net margin. The study shows that small scale cow fattening enterprise is profitable. Zekeri and Mukhtar (2015) conducted a study which was aimed at providing information on profitability of dairy product processing among small scale producers and marketers in Kaduna State, Nigeria. An average processor was found to realized Net Income of N92.51 per litre, hence

Figure 1. Framework for Profitability and Profit Efficiency in Beef Cattle Production.



dairy products processing was found profitable in the study area. An average marketer at rural and urban market had a marketing efficiency of 101.1% and 103.4%, respectively which implied that the market was also efficient. Mohammed et al. (2015) conducted a study that assessed the determinants of profitability of cattle fattening enterprise in Adamawa State, Nigeria. It was observed from the study that on the average, respondents obtained about ₦30,500 per cattle as profit. Regression estimates of factors affecting Gross Margin (GM) of cattle fattening enterprise show that the coefficient of cost of feeds, number of cattle fattened were positive and significant ($p \leq 0.10$) to gross margin of the enterprise. The coefficient of cattle fattening experience, was also positive and significant ($p \leq 0.01$) to gross margin of the cattle fattening business. In a similar study, Sirak and Derek (2015) examined the determinants of profit efficiency among smallholder beef producers in Botswana. Results of the study found a considerable capacity to improve beef profitability. Scale effects on profit efficiency are generally positive, but the results indicate a number of interactions between scale and other variables such as off-farm income and the use of credit. Policy analysis and commercial decisions using models that assume efficiency were found to be presenting a misleading picture, particularly on the elusive subject of Botswana smallholders' beef supply response. Furthermore, Kalangia et al. (2016) conducted a study on factors affecting profit of beef cattle farming in East Java, Indonesia and to quantify the profit gained by farmers in lowland and upland areas. Data were analyzed by a Unit Output Price Cobb-Douglas Profit Function (UOP-CDPF) model and estimation was conducted by using an Ordinary Least Square (OLS) method. The result of the study showed that the average profit gained by farmers in the upland area was higher than that gained by farmers in the lowland area. Based on the review, this study aims to shed more light on how profitable the farmers are in producing beef cattle, how they make use of scarce resources to maintain their established enterprise in the face of current situation in the Osun State, Nigeria. Different studies have shown different levels of profitability but none has expatiated on the profit efficiency in the study area. Therefore, this study intends to fill this gap in knowledge in terms of production systems, costs and benefits, also the

factors affecting the profit efficiency and steps needed to be put in place for different beef cattle producers to enhance their level of profitability in Nigeria.

2. Research Methods

2.1. Study Area

The study was carried out in Osun State, Nigeria. Osun State is located between latitudes 7.0°—9.0° North of the equator and longitudes 2.8°—6.8° East of the meridian. It lies in the rain forest belt and approximately has a land area of about 8,602 km² and lies between 300 and 600 metres above sea level with a largely gentle and undulating landscape and its capital is Osogbo. It is bounded in the East and West, respectively, by Ondo and Oyo State, while Kwara and Ogun States are its boundaries in the North and South, respectively. Administratively, Osun State comprises of 30 Local Government Areas. The Osun State Agricultural Development Programme (OSSADEP) divided Osun state into 3 zones namely Osogbo, Ife/Ijesa and Iwo Zones. The zones contain thirteen (13), ten (10) and seven (7) Local Government Areas, respectively (NPC, 2006). The predominant ethnic group in Osun State is Yoruba. The vegetation comprises of rainforest, derived savannah and savannah. The people of Osun State are mostly farmers who engage in cultivation of both cash and food crops and rearing of livestock. Osun State is also known for its high involvement in dairy and beef production and processing due to her increasing population with statistics showing that, in the private sector, there were about 1,500 rural ruminant commercial farms (FAO, 2014). The state was also selected because of the recent emergence of farmer's interest in livestock production to combat the twin problem of unemployment and poverty.

2.2. Sampling Procedure and Sample size

A multistage sampling technique was used to select beef cattle farmers for this study. The first stage involved purposive selection of six Local Government Areas (LGAs) based on the prevalence of cattle producers in the area. These include Ede north, Ede south, Egbedore, Ejigbo, Irewole and Isokan. The second stage involved a random selection of 20 beef cattle farmers from each LGA based on the list of beef cattle farmers through registered cattle farmers' association in the LGA, making a total of 120 respondents for the study. Primary data were collected from beef cattle producers using a survey method involving a pretested structured questionnaire. Furthermore, selected respondents in the study sites were asked for consent to voluntarily participate in the study before the interviews began. Interviews proceeded only when consent was obtained from the respondents. Data were collected by trained enumerators using personal interviews. Data were collected on socio-economic characteristics of beef cattle farmers such as age, sex, household size, level of education, income, marital status, level of experience in cattle production, herd size, quantity and price of inputs and output etc. Others were membership of association.

2.3. Method of data Analysis

2.3.1. Budgetary analysis

Farm Budgetary techniques were used to analyze the costs and returns of beef cattle production. The various types of inputs used and their costs were identified. These costs were divided into variable costs and fixed costs. The variable costs included the cost of labour, cotton seed cake, bran, groundnut seed cake, chaff, transportation and fuel etc. Fixed costs include depreciation on fixed assets (e.g., building and equipment) and this was calculated using straight line method.

$$TC = TFC + TVC \quad (4)$$

$$TR = PxQ \quad (5)$$

The gross profit (π) is computed as:

$$\text{Profit}(\pi) = \text{TR} - \text{TC} \quad (6)$$

$$\pi = \text{PQ} - \text{TVC} - \text{TFC} \quad (7)$$

$$\text{NFI} = \text{GM} - \text{TFC} \quad (8)$$

$$\text{ROI} = \text{NFI}/\text{TC} \quad (9)$$

$$\text{BCR} = \text{TR}/\text{TC} \quad (10)$$

Where:

GM = Gross margin; NFI = Net farm income; TC = Total cost incurred; ROI = Return on investment; BCR = Benefit cost ratio; TVC = Total variable cost incurred; TFC = Total fixed cost incurred; TR = Total revenue generated from production; P = price, Q = quantity.

2.4. Stochastic Profit Function Analysis

A Cobb-Douglas functional form was used to determine the profit efficiency of beef cattle farmers and determine the factors influencing profit efficiency of beef cattle farmers. This has been used in many empirical studies (Adewuyi and Okunmadewa, 200; Ettah & Nweze, 2016), particularly those relating to developing countries' agriculture because the functional forms meet the requirement of being self-dual (allowing an examination of economic efficiency). In addition, this functional form fits better in cases where there exist high frequencies of observations.

According to Adesina and Djato (1997); Ettah and Nweze (2016), the Cobb-Douglas stochastic profit frontier function is as expressed:

$$\text{LnY} = \beta_0 + \beta_1 \text{LnX}_1 + \beta_2 \text{LnX}_2 + \beta_3 \text{LnX}_3 + \beta_4 \text{LnX}_4 + \beta_5 \text{LnX}_5 + V_i - U_i \quad (11)$$

Where Y = Normalized profit (gross margin) in Naira (gross margin divided by output price)

X_1 = Normalized price of labour (N); X_2 = Normalized price of rice straw (N); X_3 = Normalized rent of farmland (N); X_4 = Normalized price of young animals (N); X_5 = Normalized price of veterinary medication (N); β_0 — β_5 = unknown parameters to be estimated; U_i = Farmer specific characteristics related to profit efficiency; V_i = Statistical disturbance term.

2.5. The inefficiency model

The U_i are the profit inefficiency variables.

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 \quad (12)$$

In this study, they are defined as:

Z_1 = Age of farmer (years); Z_2 = Formal education, measured in years; Z_3 = Household size in number; Z_4 = Off farm income (1—off farm income, 0—otherwise); Z_5 = Access to credit (1—access, 0—no access); Z_6 = Experience in beef cattle production (years); Z_7 = Marital status (Married = 1, Otherwise = 0); Z_8 = Membership in cooperative (1—member, 0—otherwise) δ_0 — δ_8 = parameters to be estimate.

The variables of interests, units of measurement and expected sign were presented in Table 2.

3. Results and discussion

3.1. Socio-economic Characteristics of the Respondents

This sub-section presents the socio-economic attributes of the beef cattle producers using descriptive statistics. Table 3 shows that 90.0% of the beef cattle farmers were male while 10% were female.

This finding shows that the production of beef cattle in the study area were mainly prevalent among the men as they were actively involved in beef cattle production. Thus, the results may not be unconnected with the fact that, beef cattle production require much time and labour which of course will be endured by male farmers. For any agricultural enterprises most especially production process, the age of respondents is very crucial and has an important bearing on the effectiveness of the enterprise. Largest proportion (75.0%) of the beef cattle farmers were around the ages of 31–50 years. The mean age is 45.74 ± 9.9 years. This suggests that majority of the beef cattle farmers are in their active age and thus expected to be productive and be open to accepting new innovations as regarding beef cattle production. The result conforms with the work of Mohammed et al. (2015) that age is one of the socio-economic attributes which affects the level of farmers' productivity. In the same vein, the result is in conformity with work of Offor et al. (2018) which found out that ruminant producer in Ohafia Agricultural Zone of Abia State, Nigeria had average age of about 39 years.

Also, findings presented in Table 3 revealed the marital status of the respondents in the study area. This result shows that majority (85.83%) of the respondents are married and thus have responsibilities. It could also be implied that marriage is highly cherished in the study area especially among the sampled beef cattle farmers. This implies that the use of family labour for beef cattle production might be possible in the study area. The results agree with the results of Busisiwe et al. (2018) that majority of the beef cattle farmers were married.

The result from Table 3 shows that majority (95.83%) of the respondents had some form of education with 55.83% of the beef cattle farmers having primary education. As low as 17.50% had secondary education while 5.0% had tertiary education. However, 17.50% of the beef cattle farmers had Arabic education while only 4.17% of the beef cattle farmers sampled had no formal education. This distribution shows a considerable level of literacy as majority of the respondents had at least primary education. This is expected to positively affect the profit efficiency of the beef cattle production. The result agrees with the findings of

Table 2. A priori expectations for Cobb-Douglas stochastic profit frontier inefficiency model

Variables	Units	Expected Signs	Authors
Age	Years	\pm	Kalangia et al. (2016)
Level of education	Years	\pm	Zekeri and Mukhtar (2015)
Household size	Number	\pm	Mohammed et al. (2015)
Off farm income	Off farm income = 1; Otherwise = 0	-	Mohammed et al. (2015) Busisiwe et al. (2018)
Access to credit	Access = 1; No access = 0	\pm	Mohammed et al. (2015) Busisiwe et al. (2018)
Production experience	Years	\pm	Mohammed et al. (2015)
Marital status	Married = 1; Otherwise = 0	\pm	Mohammed et al. (2015)
Extension contact	Yes = 1; Otherwise = 0	+	Zekeri and Mukhtar (2015)
Membership in association	Member = 1 Non- member = 0	+	Tsue et al. (2012)

Table 3. Socioeconomic characteristics of beef cattle producers

Variables	Frequency	Percentage (%)
Sex		
Male	108	90.0
Female	12	10.0
Age (years)		
<30	9	7.50
31–40	28	23.33
41–50	47	39.17
51–60	30	25.0
>61	6	5.0
Mean	45.74	
Std dev.	9.9	
Marital Status		
Single	8	6.67
Married	103	85.83
Widowed	8	6.67
Divorced	1	0.83
Level of Education		
No formal Education	5	4.17
Primary	67	55.83
Secondary	21	17.5
Tertiary	6	5.0
Arabic	21	17.5
Household Size		
1–5	51	42.5
6–10	49	40.5
11–15	10	8.33
16–20	8	6.66
>21	2	1.67
Mean	8.4	
Std. dev.	3.7	
Years of Production Experience		
1–10	22	18.33
11–20	56	46.67
21–30	23	19.16
>31	19	15.84
Mean	28.8	
Std. dev.	14.83	
Membership of Association		
Belong	87	72.5
Do not belong	33	27.5

(Continued)

Table 3. (Continued)

Variables	Frequency	Percentage (%)
Herd Size		
10–20	81	67.5
21–30	36	30.0
>31	3	2.5
Mean	17.6	
Std. dev.	7.6	

Source: Data Analysis, 2019

Offor et al. (2018) that found out that a greater percentage of ruminant producer in Ohafia Agricultural Zone of Abia State, Nigeria only attended secondary school or its equivalent with average of 12 years of schooling. Thus, the result suggests that majority of the beef cattle farmers in the study area could at least read and write.

From Table 3, it was revealed that majority of the beef cattle farmers (40.84% and 42.5%) have household size of 6–10 and 1–5 people, respectively, while 8.33% have between 11–15 people in their household. The mean of the household size is 8.4 ± 3.7 people. This implies that the use of family labour might be prominent in the study area as they had a relatively big family size. Family labour is recognised as a source of labour supply in small holder agricultural production in most part of Africa with Nigeria inclusive. The result agrees with the finding of Otitoju and Arene (2010) that majority of the cattle farmers had average family size of about 7 persons.

The result presented in Table 3 also revealed the years of experience in beef cattle production. The results showed majority (46.67%) of the respondents had been into the production of beef cattle between 11–20 years. The average years of experience for the respondents were 28.8 ± 14.8 years. This indicates that farmers in the study area have acquired necessary experience in beef cattle production, and adoption of new innovations will pose no problem. The result is also in line with the work of Adewuyi and Okunmadewa (2001) who reported a positive relationship between farming experience and profit efficiency. Tashikalma (2011) reported that farmers with more years of farming experience in terms of farm operations, handle better, compared to farmers with few years of farming experience.

The data in Table 3 further shows the membership in association status of the respondents in the study area. It was shown that majority (72.50%) of the respondents belong to farmers' association. This implies that they have a very good platform for dissemination of vital information and also experience the benefits of group dynamics. This result is in accordance with the result of Akinseinde (2006) that reported that beef cattle farmers belong to farmers' associations.

The herd size of the respondents is also shown on Table 3. The results indicated that 67.5% of the respondents had a herd size of between 10–20 beef cattle, 30.0% had between 21–30 beef cattle while 2.5% had 31 beef cattle and above. The average herd size of the respondents was 18 ± 8 . The result therefore implies that, majority of the farmers in the study area are relatively small-scale beef cattle farmers. This result agrees with the findings of Offor et al. (2018), who stated that small-scale farmers are those that reared not more than 50 herds cattle flocks.

3.2. Purposes of Keeping Cattle and Breeds of Cattle Reared

The reasons why farmers venture into beef cattle farming are presented in Table 4.

Table 4. Distribution of Respondents by Purpose of Keeping Cattle

Purpose	Frequency	Percentage (%)
Meat	24	20.00
Work/draft	2	1.67
Blood	1	0.83
Hide	2	1.67
Cash from sales	76	63.33
Investment	11	9.17
Ceremonies	3	2.50
Cultural	1	0.83
Total	120	100.00

Source: Data Analysis, 2019

It was revealed that majority (63.33%) of the respondents reared beef cattle for cash. Considerable proportion (20.0%) also reared cattle for meat purpose. This may be due to the fact that they tend to eat from their farm produce although their ultimate aim is to realize cash from the beef cattle production.

The different breeds of beef cattle reared in the study area are presented in Table 5.

It was shown that 10% reared Bungi, majority (46.67% and 36.67%) reared N'dama and Keteku, respectively, while 6.67% reared other breeds of beef cattle. This indicates that rearing of N'dama and Keteku was prevalent in the study area. This may be due to the fact that N'dama and Keteku exhibited superior growth and yield better components and also they are more resistant to diseases in the study area. This result agrees with (Akpa et al., 2012) who ascertained that some breeds of cattle including N'dama and Keteku grow proportional to feeding and are also resistant to foot diseases.

3.3. System of Production

The systems of beef cattle production in the study area are presented in Table 6.

It was revealed that 5.83% were nomadic, 27.5% were rearing beef cattle by ranching while majority (66.67%) were Agro-pastoralists. This implies that production of beef cattle in the study area were majorly by Agro-pastoralist. This is made possible because majority of the producers ventures into other crop production which normally been supplemented with other supplementary regime in the study area. In Agro-pastoralist production, cattle farmers often cultivate some leguminous grass together with cattle production. The cattle were often allow to feed on the grass field thus helping the cattle farmers to reduce their cost of purchasing feed stuffs, thus decreasing cost of production. The result is in conformity with work of Offor et al. (2018) which found out that ruminant producer in Southern Nigeria were mostly through Agro-pastoralists and ranching.

Table 5. Distribution of Respondents by Breeds of Beef Cattle reared

Breeds	Frequency	Percentage (%)
Bungi	12	10.00
N'dama	56	46.67
Keteku	44	36.67
Others	8	6.67
Total	120	100.00

Source: Data Analysis, 2019

Table 6. Distribution of Respondents by Systems of Production

System of production	Frequency	Percentage (%)
Nomadic	7	5.83
Agro-pastoralists	80	66.67
Ranching	33	27.50
Total	120	100.00

Source: Data Analysis, 2019

3.4. Costs and Returns of Beef Cattle Enterprise

In order to ascertain the profitability of beef cattle production, the average gross margin, net returns, returns on investment and benefit cost ratio of the beef cattle producers were calculated. The input used, costs, output data generated from the beef cattle producers were used to compute the gross margin and net returns to beef cattle production.

The average costs and returns for the beef cattle producers are presented in Table 7.

The result revealed the revenue generated from the sales of an average of 19 matured cows was ₦1,521,140.00; ₦1,040.04 from the sales of 51.36 kg of manure, ₦262,453.27 from the sales of hides: ₦1,767.30 from the sales of 8.8 litres of blood and ₦93,527.50 was generated from slaughtering of 19 cows which all amounted to a total of ₦1,879,928.11 as the gross returns from the production of beef cattle. From Table 7, it was revealed that the costs of calves (₦879,900.00) accounted for the largest proportion (76.27%) of the total cost of beef cattle production in the study area (21 calves were stocked at 8 months old where the number of bulls/cows remaining at maturity was 19 (i.e 9.5% mortality) and the production period is 16 months indicating that the mature cow were ready for sale at 16 months old). It should be noted that all the cattle fattened (male and female) were sold at maturity. Although the variable cost accounted for 90.54% of the total cost of production as compared with the fixed cost which accounted for just 9.5% of the total cost of beef cattle production. Fattening of beef cattle in the study area comprised of the agro-pastoralist and ranching system. Thus, calculations were based on these two systems. The small proportion of fixed cost might be attributed to the negligible proportion of fixed capital used in Nomadic and Agro-pastoralist systems of beef cattle production. Revenue from the sales of matured cow had the highest share (81.70%) of total revenue (Table 7). The Total revenue generated was ₦1,879,928.11 while the Gross margin and Net return to management were ₦835,443.63 and ₦726,295.65, respectively.

The profit margin percentage was 38.63% while the return on investment was 0.63, indicating that for every one naira invested in beef cattle production, the farmer gains ₦0.63. The implication is that beef cattle production in the study area is profitable. This result is in agreement with the findings of (Akpa et al., 2012) in a study of determinants of profit efficiency among smallholder beef producers who find out that beef cattle production is a profitable business enterprise. The benefit cost ratio of 1.63 shows that for every ₦1.00 return to beef cattle production, 63k is been spent on the cost of producing the beef cattle in the study area. It is to be noted that that high variability of cost of production could actually affect the profit efficiency of the farmers. That is, whenever, the beef cattle farmers experiences high cost of production, it tends to reduce their profit margin in the study area.

3.5. Estimates of the Stochastic Frontier Models

The stochastic frontier model and inefficiency model were estimated simultaneously. Table 8 presents the estimated parameters for the profit function model.

Some of these coefficients have the expected positive signs and significance. Labour and calves variables were significant at 5% level of significance. This indicates that increase in farm labour

Table 7. Average Costs and Returns of Beef Cattle Enterprise

Variables	Mean amount (₦)	%Total of revenue/cost
*Revenue		
19 matured cows /Bull at ₦80,060.00 per cow	1,521,140.00	80.91
51.36 kg manure at ₦20.25/ kg	1,040.04	0.06
19 hide at ₦13,813.33/ hide	262,453.27	13.96
8.8 litres Blood at ₦200.83/litre	1,767.30	0.09
19 cows slaughtered at ₦4,922.5/ cow	93,527.50	4.98
A. Total revenue	1,879,928.11	
Variable costs		
Feeds		
922.17 kg Corn-stalk at ₦20/kg	18,443.40	1.59
465.21 kg Cotton seed cake at ₦20.00/kg	9,304.20	0.81
465.21 kg Groundnut cake at ₦30.00/kg	13,956.30	1.21
925.21 kg Bran/wheat offal at ₦40.00/kg	37,008.40	3.21
477.5 kg Chaff at ₦20.00/kg	9,550.00	0.82
927.08 kg Concentrates at ₦30.00/ kg	27,812.40	2.41
18.21 kg Table salts at ₦70.00	1,274.70	0.11
6.7 g Potash at ₦100.00/g	670.00	0.06
732.33 kg Rice straw at ₦20.00	14,646.60	1.27
18 g Dewormers at ₦30.00/g	540.00	0.05
19 g Anti-biotics at ₦40.00/g	760.00	0.07
18 g Multi-vitamins at ₦40.00/g	720.00	0.06
Labour	10,532.26	0.91
Security	10,046.22	0.87
Association levy	2,570.00	0.22
Taxes	6,750.00	0.59
21 calves at 41,900 per calf	879,900.00	76.27
B. Total Variable cost	1,044,484.48	90.54%
Fixed costs (depreciated value)		
Rent on Land	15,666.67	1.36
Sack	1830.83	0.16
Shed construction	19,350.00	1.68
Iron sheet	19,888.98	1.72
Wood	17,198.33	1.49
Well construction	30,158.33	2.61
Boots	3,004.17	0.26
Cutlass	2050.67	0.18
C. Total Fixed Cost	109,147.98	9.5%
D. Total cost (B + C)	1,153,632.46	
E. Gross Margin (A-B)	835,443.63	
F. Net return (A-D)	726,295.65	
Profit margin (%) F/A x100	38.63	

(Continued)

Table 7. (Continued)

Variables	Mean amount (₦)	%Total of revenue/cost
ROI	0.63	
BCR	1.63	

Source: Field Survey, 2019

*21 calves stocked at 8 months old; Number of bulls/cows remaining at maturity = 19 (9.5% mortality); production period = 16 months.

Table 8. Maximum-likelihood Estimate of Stochastic Profit Frontier Function of Beef Cattle Production

	Parameters	Coefficients	Std .Error	T-ratio
Profit Function				
Ln (labour)	β_1	0.610**	0.273	2.24
Ln (rice straw)	β_2	0.282***	0.058	4.48
Ln (farmland)	β_3	0.578***	0.091	6.34
Ln (calve)	β_4	0.318**	0.141	2.25
Ln (Vet. medication)	β_5	0.174***	0.049	3.56
Constant	β_6	7103.22***	1081.428	6.57
Inefficiency model				
Age	δ_1	0.013	0.021	0.63
Education	δ_2	0.020	0.020	1.01
Household size	δ_3	0.282***	0.058	4.48
Off-farm income	δ_4	-4.286***	1.281	-3.34
Access to credit	δ_5	0.110***	0.007	15.74
Experience in beef cattle	δ_6	-0.042***	0.007	-5.63
Production				
Membership of Association	δ_7	-0.045	0.029	-1.52
Marital status	δ_8	0.004	0.034	0.13
Constant	δ_9	0.174***	0.049	3.56
Diagnostic statistics				
Sigma-square	σ^2	0.045***	0.017	2.65
Gamma	γ	0.947***	0.103	9.19
Log of likelihood		59.581		
LR test		11.67		

***, **, * Significant at 1%,5%, and 10%

Source: Data Analysis, 2019

and calves (herd size) will increase the profit efficiency of beef cattle producers. In specific terms, 5% increase in farm labour and calves will both increase the profit by about 0.61% and 0.32%, respectively.

With respect to rice straw, farmland and Veterinary medication, the coefficients were positive and significant at 1% probability level. This indicates that 1% increase in rice straw will leads to 0.3% increase in output. This might be possible as the beef cattle might convert the feed to increase body weight which subsequently leads to increase in market price and positively affect

the profit of the farmer. Also, on Table 8, it was indicated that 1% increase in farm land will lead to 0.6% increase in output. This implies that an increase in farmland will lead to more grazing area for beef cattle in the study area as majority of the cattle farmers were predominantly agro-pastoralist which means that less feed will be used thereby reducing the cost of feeding which subsequently increase the profit efficiency of the beef cattle farmers in the study area. Veterinary medication was positive and significant at 1% which indicate that 1% increase in veterinary medication will leads to 0.2 increase in output. This implies that the more Veterinary medication utilised, the less the mortality rate as the animals become more healthy and will be able to effectively convert feed to increase body weight which subsequently increase the profit efficiency of the beef cattle farmers in the study area. This agrees with the *a priori* expectation as corroborated by (Akpa et al., 2012) in their study.

The estimated γ coefficients means that about 94.7% of the discrepancies between observed output and the frontier output are due to technical inefficiency. In other words, the shortfall in observed output from the frontier output is primarily due to factors, which are within the control of the respondents in the study area while the remaining was due to random effects. This confirm the presence of one sided error component in the model thus rendering the use of OLS estimating technique inadequate in representing the data. The sigma-square (σ^2) was significant at 1% probability level, indicating a good fit and the correctness of the specified assumptions of the distribution of the composite error term. The log likelihood function was estimated to be 59.58. This value represents the value that maximizes the joint densities in the estimated model.

3.6. Profit Efficiency ratio

Distribution of profit efficiency of the beef cattle farmers (Table 9) revealed that profit efficiency index ranges from 21–99% for beef cattle farmers.

Profit efficiency averaged is $62.2\% \pm 22.52$. The mean level of the profit efficiency shows that on the average, beef cattle output was 37.8% short of the maximum possible level. The implication is that an average farmer in the sample was to achieve profit efficiency level of his most efficient counterpart, then the average farmer could realize a 37% cost saving. A similar calculation for the most profit inefficient farmer shows that cost saving of 79% (i.e $1 - (21/99) \times 100$). About (39.75%) of the respondents have profit efficiency indices greater than 60% meaning considerable proportion of the beef cattle farmers were profit efficient given the existing technology.

Table 9. Distribution of Profit Efficiency of Farmers

Efficiency Range (%)	Frequency	Percentage (%)
20–30	8	6.67
30–40	16	13.33
40–50	27	22.5
50–60	21	17.5
60–70	17	14.17
70–80	19	15.83
80–90	9	7.5
>90	3	2.25
Total	120	100.00
Mean	0.6221	
S.D	0.2252	
Variance	0.0507	
Min.	0.2118	
Max.	0.9999	

Source: Data Analysis, 2019

3.7. Factors Influencing Profit Efficiency of Beef Cattle Production

The explanatory variables included in this model have been frequently used in estimating agricultural profit frontiers for developing countries. The profit difference between the farmers could be explained by farm-specific and farmer specific variables. The significant variables include household size, off farm income, access to credit and experience in beef cattle production. The results are presented in Table 8.

3.8. Household Size

The estimated coefficient for household size had a positive influence on profit inefficiency and also significant at 1% level. The sign of the coefficient of household size indicates that household size can enhance profit inefficiency and this is due to the fact that the more the number of people in a household the more likely their contribution to the farm labour. This agrees with agrees with *a priori* expectation of Mohammed et al. (2015).

3.9. Off-farm Income

The estimated coefficient of the off-farm income had negative sign on profit inefficiency and significant at 1% level. This mean that the off farm income would lead to decline in profit inefficiency. This is expected because the income realized from outside can serve as a source of funds to the production. This follows the *a priori* expectation of Mohammed et al. (2015) and Busisiwe et al. (2018)

3.10. Access to Credit

The estimated coefficient for the access to credit had positive sign for profit inefficiency and significant at 1% level. This shows that credit was a strong factor of profit inefficiency in the study area. The positive sign implies that this factor contributes positively and significantly to inefficiency i.e., the lower the access to credit, the more profit inefficient the farmer might become. The result might be explained probably due to the fact that sufficient credit was not made available to the beef cattle farmers. Reason could be that the interest rate was higher or the credit was not disbursed on time to the farmers or lack of collaterals by the beef farmers in the study area.

3.11. Experience in Beef Cattle Production

The estimated coefficient for experience in beef cattle production had negative influence on profit inefficiency and significant at 1%. It implies that faming experience would result to a decline in profit inefficiency. The result established the *a priori* expectation that more experienced farmers are likely to have a higher level of profit efficiency than farmers with low farming experience, as beef cattle production business involves daily routine and activity. This is in agreement with the *a priori* expectation of Mohammed et al. (2015).

4. Conclusion and Recommendations

The study was carried out to analyze the profit efficiency in beef production in Nigeria. The study has shown that beef cattle production is a profitable enterprise. In term of returns, beef cattle yielded a high return on investment. Beef cattle production on the average was operated at two-thirds of the profit efficiency frontier. Both household size and access to credit decreases the level of profit inefficiency while off-farm income and years of experience in beef cattle production helped increase the profit efficiency. In accordance with the result of the study, the following recommendations were made in order to enhance the profit efficiency of beef cattle producers in the study area: The cost of purchasing calves and rice straw reduced the profit of the beef cattle farmers, as such it is important to note that subsidizing their costs by the government will help improve the profit efficiency in beef cattle production. Credit should be disbursed to the farmers at appropriate time to prevent diversion of funds and there should be proper monitoring of the funds so as to ensure it is used for the right purpose. Beef cattle farmers should try as much as possible to support their beef cattle farms with their off farm income in the absence of credit in order to expand their farm enterprise and increase their profit.

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