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Determinants of Profit Efficiency among Cattle Producers in Oyo State, Nigeria

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Abstract

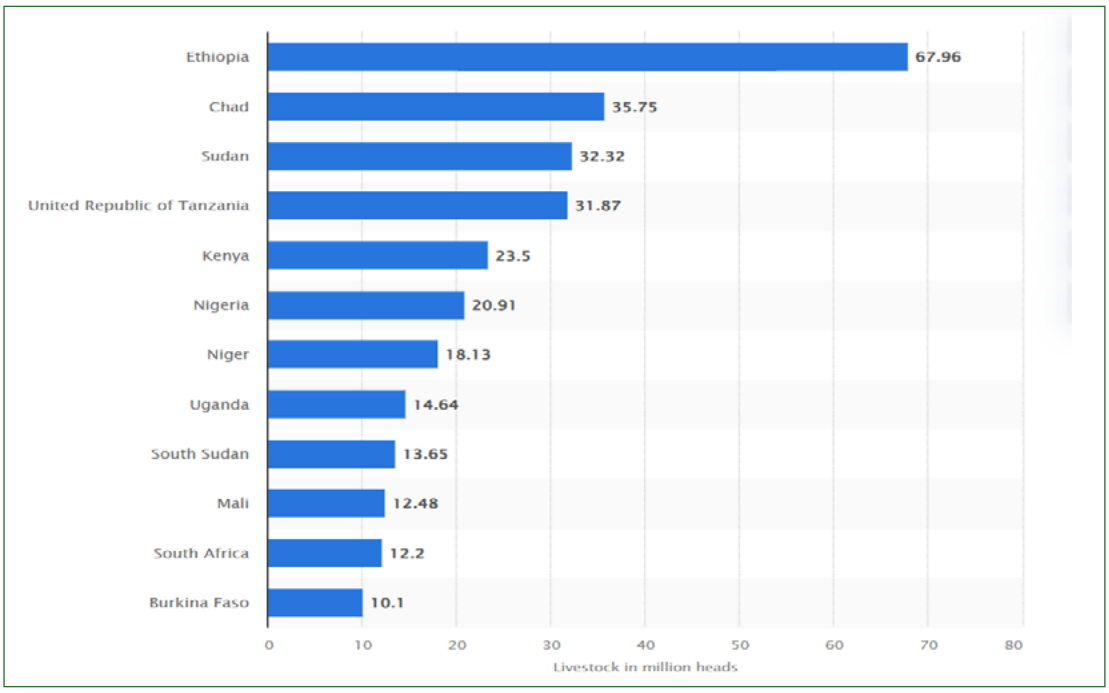
Cattle production is a cornerstone of the Nigerian government's livestock policy, mainly because of the potential revenue accruable from beef and dairy production. However, the profit efficiency of cattle farmers in Nigeria may be undermined by poor production techniques. While different aspects of cattle production have been examined in the literature, there are knowledge gaps concerning profit efficiency among cattle producers, particularly in the study area. The study therefore investigated profit efficiency among cattle producers in Oyo State. A multistage sampling technique was used to collect data in a cross-sectional survey of 174 randomly selected cattle producers. The data were analyzed using descriptive statistics, Gross Margin Analysis, and Stochastic Frontier Profit Function. The mean age of cattle producers in the area was 48.67 years, 94.25 percent of the farmers were married, and households consist of seven members on average. Cattle production was profitable with an average annual gross margin in Nigerian naira of 545,841.70. The mean profit efficiency among the cattle farmers was 0.24. This suggests that an estimated 76 percent of profit is lost due to inefficiencies in cattle rearing. Age, extension, labor source, and primary occupation were significant factors influencing profit inefficiency. Profit efficiency among the cattle farmers was extremely low. Comprehensive steps must therefore be taken to expose cattle farmers to modern production techniques that could improve their efficiency.

Keywords: Cattle Producers, Profitability, Profit Efficiency, Gross Margin

1. Background

Over 70 percent of the Nigerian population is engaged in agriculture, therefore making the sector the highest non-oil contributor to the Nigerian economy. Agriculture contributed 29.9 percent to the Nigerian GDP in the third quarter of 2021. The contribution of livestock to the Nigerian economy is significant, contributing 5% to the Nigerian GDP(ILRI, 2024). The term livestock is used in this report to refer to domestic or domesticated animals that are raised mainly for agriculture purposes and include, for example, large ruminants such as cattle, and small ruminants such as goats, pigs and poultry. Livestock is a main source of income for one in five people across the globe (Livestock Global Alliance 2016). Cattle constitute the major ruminant among the livestock population in the area studied (65 percent) while sheep and goats account for 23 percent and 11 percent, respectively (Olafadehan and Adewumi 2010; FAO 2018). Cattle production involves keeping bulls and cows for meat (beef) or milk (dairy) purposes. Cattle feed on grasses, legumes, roughage, etc. They are the most common type of large domesticated animals. Nigeria is among the top cattle producers in Africa and it is in sixth position behind Ethiopia, Chad, Sudan, Tanzania, and Kenya (see Figure 1).

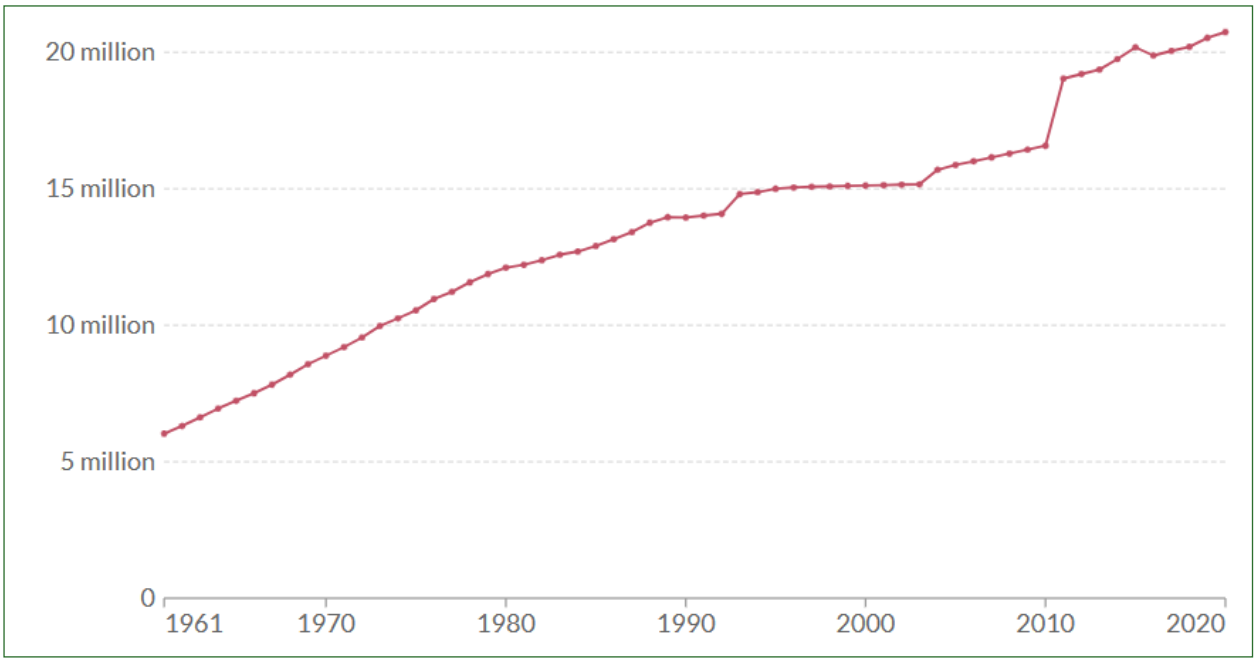
Figure 1. Cattle population in Africa by country



Source: Retrieved from www. Statista.com/statistics

Figure 2 shows the number of cattle owned in Nigeria between 1961 and 2020, indicating a steady increase over the years. This increase is closely connected to the growth of the Nigerian population, which in turn has driven an increase in demand for beef and dairy products.

Figure 2. Number of cattle in Nigeria from 1961 to 2020



Source: Retrieved from https://ourworldindata.org/grapher/cattle-livestock-count-heads

Various agricultural policies such as the Agricultural Transformation Agenda have played an important role in increasing the number of cattle in Nigeria over the years. Despite this, Nigeria currently imports more than 25 percent of the beef it requires to meet domestic demand (World Bank, 2017). This is partly because most farmers in Nigeria rear traditional, low-yielding varieties. The dominant breeds of cattle in Nigeria are the Bunaji (White Fulani), N'Dama and Keteku (Rutledge 1997; Olafadehan and Adewumi 2010; Oni *et al.* 2021; Molina-Flores *et al.* 2020). In addition, the majority of the farmers do not provide timely vaccinations and quality medications for their cattle (Uwagie-ero *et al.* 2018). About eight out of 10 agropastoralists in Nigeria depend on the use of local herbs and self-medication for treating their animals, as against a few who use proper medication and vaccines to treat their cattle (Adeniran *et al.* 2020).

Furthermore, cattle in Nigeria are raised predominantly on grass which is inherently poor in terms of digestibility and nutritive value, as well as being unavailable in the off-season. Natural pasture is seasonal, with grass availability fluctuating in line with the arrival and departure of rains. A short rainfall cycle consigns herders to prolonged dry seasons, with pastures becoming scarce and leading to a shortage of the essential nutrients and minerals required for the growth and performance of animals. Lack of sufficient pasture and water has led to forced migration and has brought herders and crop farmers into conflicts, which often result in the loss of lives of both livestock and their herders. This has severe economic consequences for cattle farmers (Lamidi and Ologbose 2014; Balehegn et al. 2020; Paul et al. 2020; Fafiolu and Alabi 2020). In addition, the low level of literacy among cattle farmers has reduced the adoption of technologies that would enable the farmers to add value to their cattle products. This means they are mostly restricted to producing beef and local dairy products and have limited ability to earn revenue from other high-value cattle products such as leather products. This invariably leads to lower profits and exacerbates inefficiency among cattle farmers (Seré et al. 2020).

The bulk of beef and dairy production comes from cattle in low-input and low-yield pastoral systems. According to FAO (2018), over 80 percent of cattle in Nigeria are produced under the extensive system, about 16.8 percent are produced under a semi-intensive system while only a minimal number are produced under the intensive system (1.1 percent). This implies that only about 1.1 percent of cattle – those raised under intensive conditions – could bring meaningful profit to farmers. It also explains why cattle production has underperformed in Nigeria even though it occupies an important position in Nigeria's agricultural policy, as the factors stated above have continuously undermined the policies

aimed at increasing cattle production in Nigeria. Different aspects of cattle production have been examined in the literature: some studies have focused on productivity among livestock farmers in Nigeria, and others have examined technical efficiency and the profitability of cattle production (Ogunniyi 2011; Oladeebo and Oluwaranti 2012). Only a few studies have examined profit efficiency among cattle farmers in Nigeria. In particular, studies on profit efficiency among cattle farmers in Oyo State are very limited despite the vast potential of the state and the large scale of the cattle farming sector there. It is therefore pertinent to examine not only the profitability but also the efficiency of cattle production in Oyo in order to address this knowledge gap. The key determinants of profit efficiency among cattle producers in Oyo State were therefore investigated. Based on the above, this study addressed the following research questions:

i. What is the level of profitability among cattle producers in Oyo State?
ii. What is the level of profit efficiency among cattle producers in Oyo State?
iii. What are the factors that influence profit efficiency in Oyo State?

The broad objective of this study was to examine the determinants of profit efficiency among cattle owners in Oyo State. The specific objectives were to:

i. Determine the profitability of cattle production in Oyo State.
ii. Measure the profit efficiency of cattle production in the study area.
iii. Examine the determinants of profit efficiency among cattle producers.

2. Literature review

Efficiency is the ability to produce a given level of output at the lowest cost (Farrell 1957). According to production theory, a farmer is assumed to choose a combination of variable inputs and outputs that maximize profit subject to technology constraints (Sadoulet and De Janvry 1995). Efficiency measurement is useful in the identification of farm-specific input factors that hinder production along the frontier and provides an opportunity to separate production effects from managerial weakness (Ogundari and Ojo 2005). Economic theorists have, over the years, identified three components of efficiency: technical efficiency, allocative efficiency, and economic efficiency.

Technical efficiency is measured as the ratio between the observed output and the maximum output, under the assumption of fixed input, or as the ratio between the observed input and the minimum input under the assumption of fixed output (Porcelli 2006). For a farm to be technically efficient, it has to produce at the production frontier level. Allocative efficiency deals with the extent to which farmers make efficiency decisions by using inputs up to the level at which marginal contribution to production value is equal to the factor cost. Badunenko et al. (2008) believed allocative efficiency traditionally attracted the attention of economists by asking: what is the optimal combination of inputs so that output is produced at minimal cost? How much could profits be increased by simply reallocating resources? To what extent does competitive pressure reduce the heterogeneity of allocative inefficiency within industries? A firm is said to have realized allocative efficiency if it is operating with the optimal combination of inputs given the prices of inputs. Economic efficiency is defined as the capacity of a firm to produce a predetermined quantity of output at minimum cost for a given level of technology. Another concept is that of profit efficiency, which refers to the ability of a farm to achieve the highest possible profit given the prices and levels of fixed factors of that farm, and profit inefficiency is the loss of profit from not operating on the frontier (Ali and Flinn 1989). Technical and allocative efficiencies are both necessary conditions for economic efficiency. Producers are efficient if they have produced as much as possible with the inputs they have employed and if they have produced that output at minimum cost (Greene 1997; Porcelli 2009). There are two methods of estimating farm efficiencies: parametric and non-parametric methods. The parametric method includes the deterministic and stochastic frontier approaches, while the non-parametric method uses mathematical programming techniques such as Data Envelopment Analysis (DEA). In this study, stochastic frontier analysis (SFA) was used to determine the profit efficiency of the dairy farmers. The SFA approach requires that a functional form be specified for the frontier production function. SFA takes into account measurement errors and other noise in the

data and is important for studies of farm-level data that usually include measurement errors. 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. The common approach to measuring profit (economic) efficiency involves the use of the stochastic profit frontier function (Ali and Flinn 1989; Kumbhakar and Bhattacharyya, 1992; Wang et al. 1996; Rahman 2003). SFA has been used severally in literature to measure profit efficiency.

2.1. Stochastic frontier

The stochastic frontier model was independently proposed by Aigner et al. (1977) and Meeusen and Van den Broeck (1977) and it uses econometric techniques to estimate a frontier function. A stochastic frontier production function is defined by:

$$Y_i = f(X_i;\beta)\exp(v_i - u_i), i = 1,2,\ldots.n$$

Where:

Yi = output of each farm;

Xi = vector of input quantities used by each farm;

β = the vector of unknown parameters to be estimated;

f() = represents an appropriate function (e.g. Cobb Douglas, translog, quadratic etc);

v_i is the symmetric error, which accounts for random variations in output due to factors beyond the control of the farmer e.g. extreme weather conditions, cattle disease outbreaks, measurement errors, etc; and u_i is the non-negative random variable representing inefficiency in production relative to the stochastic frontier.

The profit/economic efficiency of a farmer in the context of stochastic frontier profit function is derived as a ratio of the predicted, observed profit (π_i) to the corresponding predicted maximum profit (π_i^*) for the best farm or frontier profit given the variable inputs, price and level of a farmer's fixed factors of production. Mathematically, it is expressed as:

$$Profit\ Efficiency\ (EE) = \frac{Actual\ profit}{Frontier\ profit} = \frac{\pi_i}{\pi_i^*} = \frac{(p_i, Z)\exp(v_i - u_i)}{(p_i, Z)\exp(v_i)}$$

The random error v_i is assumed to be independently and identically distributed as $N(0, \sigma_v^2)$ random variables independent of u_i which are assumed to be non-negative truncation of the $N(0, \sigma_u^2)$ distribution (i.e. half-normal distribution) or have an exponential distribution. Based on the assumption that u_i and v_i are independent, the parameters of the production frontier are estimated using the Maximum Likelihood Estimation (MLE) method.

The advantages of stochastic frontier analysis include:

i. Estimation can be done using a single-step procedure; it estimates the frontier profit function and an inefficiency model simultaneously.
ii. It accommodates the measurement errors and other noise in the data; it effectively specifies the relationship between output and input levels and decomposes the error term into separate components representing random errors and inefficiency.

Its limitations are:

i. An assumption regarding a specific functional form of the stochastic frontier is required a priori; a wrong choice of production function may influence the result.
ii. The simple production frontier model does not permit the prediction of the technical efficiencies of firms that produce multiple outputs.
iii. The maximum likelihood does not allow for assessing the reliability of inferences in small samples.

A number of functional forms exist for estimating production functions but the most commonly used is the Cobb-Douglas and normalized translog.

2.2. Cobb-Douglas functional form

The Cobb-Douglas functional form is useful in the analysis of surveys where many variable inputs are involved and it is necessary to measure returns to scale, intensity of factors of production and overall efficiency of production. It provides a means of obtaining coefficients for testing hypotheses. A production function $y = f(x_1; x_2)$ is a Cobb-Douglas type if it can be written in the form:

$$Q = AX_1^aX_2^b$$

Where:

Q = output

X_i = inputs

A, a, and b are estimated from empirical data.

The Cobb-Douglas functional form can be estimated as a linear relationship using the expression below.

$$\ln(Y) = a_o + \sum_i a_i \ln(I_i)$$

Where:

Y = output

I_i = inputs

a_i= model coefficients.

The Cobb-Douglas is however limited as it is restrictive compared to the more flexible functional forms such as the translog and quadratic forms. The Cobb-Douglas function cannot also show both increasing and diminishing marginal productivity in a single response curve. As a result, it does not give a technical optimum and may lead to the overestimation of the economic optimum.

2.3. Translog production function

The translog production function was derived from the "transcendental logarithmic production function" proposed by Christiansen, Jorgensn and Lau in two papers published in 1971 and 1973. The function deals with the problems of strong separability (additivity) and homogeneity of Cobb-Douglas and CES production functions (Pavelescu 2011). The generalized form of the translog production function, which takes into account a number of n inputs (production factors), can be expressed as:

$$\ln Y = \ln A_{\alpha i,\beta ij} + \sum_{i=1}^{n} \alpha_i . \ln X_i + \left(\frac{1}{2}\right) . \sum_{i=1}^{n} \sum_{j=1}^{n} \beta_{ij} . \ln X_i . \ln X_j$$

Where:

ln represents the natural logarithm

Y = output

X = inputs

$A_{\alpha i,\beta ij}$ are parameters to be estimated.

The translog model is beneficial in the following ways:

i. The functional form is more flexible than the Cobb-Douglas, which is restrictive.
ii. It is able to give a technical optimum which does not allow for over-estimation of the economic optimum.

However, it is limited in the following ways:

iii. It has potential problems of insufficient degrees of freedom due to the presence of interaction terms; the probability of the occurrence of harmful collinearity is high.
iv. In correcting for collinearity using ridge regression, it is uncertain whether the solution obtained is optimal.

Bahta and Baker (2015) applied a stochastic profit frontier model to a large sample of beef-producing households to identify the drivers of profit efficiency in smallholder beef production in Botswana. Identified efficiency drivers including education level, distance to commonly used markets, herd size,

access to information, and income from crop production were recorded in the study. It was also found that training and education are vital routes to improved efficiency, and peer groups of producers that occur both within and across arbitrary size groupings may offer models for application to less efficient producers. Several elements of this analysis of profit efficiency indicated that improved infrastructure and government services can contribute to beef producers' profit efficiency.

Musaba and Chibalani (2021) examined profit efficiency and its determinants in small-scale broiler production in Zambia. Data collected from 120 smallholder broiler farmers in the Kabwe district in the Central province of Zambia were analyzed using descriptive statistics and the Cobb-Douglas stochastic profit frontier model. The result indicated that smallholder broiler farmers were not operating at full profit efficiency level. The profit efficiency ranged from 2 percent to 77 percent with a mean of 38 percent. This implies that profit efficiency for an average broiler farmer in the study area could be increased by 62 percent by improving technical and allocative efficiencies of available resources through the adoption of the management practices used by the best-performing farmer. While studying the profit efficiency of dairy farmers in Kenya using smallholder farmers in the Rift Valley and central province as a case study using the stochastic profit frontier, Leone (2013) found that the mean profit efficiency was 68 percent and that 54 percent of these farmers were skewed to profit efficiency of more than 70 percent. Following Musaba and Chibalani (2021) the stochastic profit frontier analysis was used to estimate the profit efficiency and determine the farm-specific factors affecting profit efficiency among cattle farmers in Oyo State.

3. Methodology

3.1. Study area

The study area was Oyo State, southwestern Nigeria located between latitudes 2^0 38^1 N and 4^0 35^1 E. The state covers a total area of 28,454 square kilometers (FOS 1996) and it is bounded in the south by Ogun State, in the north by Kwara State, in the west partly by Ogun State and partly by the Republic of Benin, and in the east by Osun State (OYSG 2019). According to NPC (2006), the state has a population of 5,591,589. It has two ecological zones: the rainforest to the south and the savannah to the north. The state is divided into four agricultural zones: Ibadan/Ibarapa, Oyo, Ogbomosho, and Saki (as grouped by the Oyo State Agricultural Development Programme). Agriculture is the main occupation of the people of Oyo State, with the climate favoring the cultivation of crops such as maize, yam, cassava, millet, rice, plantain, cocoa tree, palm tree, and cashew. There are also cattle ranches at Saki, Fasola, and Ibadan, and a dairy farm at Monatan, Ibadan (OYSG 2019).

3.2. Type and source of data

Primary data were used in the study, obtained through the use of a well-structured questionnaire. The questionnaire was designed to obtain information on output in the form of quantity of cattle sold, price of cattle sold, inputs, feed prices, veterinary prices, price per man day of labor, total fixed capital, family labor in hours, land size in hectares, and the socio-economic characteristics of cattle producers in the study area. These characteristics included age, educational level, household size, years of experience, access to credit, and access to extension services.

3.3. Sampling technique

A multistage sampling technique was used for this study. The first stage involved the purposive selection of the Oke-Ogun zone, based on the high prevalence of pastoralists in this zone (Eniola 2016). The second stage involved the random selection of three local governments within the zone. These were Saki East, Saki West, and Atisbo. In the third stage, two villages were randomly selected from each local government, making a total of six communities. The last stage involved the random selection of 29 cattle producers in each of the selected villages to give a total of 174 respondents for the study.

3.4. Data analysis

3.4.1 Profitability of cattle production was analyzed using Gross Margin Analysis following Bahta and Baker (2015). Farm profit is measured in terms of gross margin (GM) which is the difference between the total revenue (TR) and total variable cost (TVC);

$$\text{GM } (\pi) = \Sigma(TR - TVC) = \Sigma(PQ - WX_i) \quad (1)$$

The profit function is normalized by dividing both sides of the equation by the output price (P)

$$\frac{\pi(p,z)}{P} = \frac{\Sigma(PQ - WX_i)}{P} = Q - \frac{WX_i}{P} = f(X_i, Z) - \Sigma p_i X_i \qquad (2)$$

Where:

TR = total revenue

TVC = total variable cost

Q = output

P = price of output

X = optimal input quantity used

Z = fixed inputs

p_i = W/P; normalized price of input X_i

$f(X_i,Z)$ = production function

3.4.2. Stochastic profit frontier model

Following Bahta and Baker (2015) the stochastic profit frontier model was expressed as:

$$\pi_i = f(p_i, Z)\exp(v_i - u_i)$$

Where:

π = gross margin

p_i = input price

Z = fixed input

v_i= random error

u_i = profit inefficiency effect

Following Rahman (2003), the Cobb-Douglas functional form for estimation is specified as

$$ln\pi = ln\beta_0 + \beta_1 lnp_{1i} + \beta_1 lnp_{21} + \beta_1 lnp_{3i} + \beta_1 lnZ_{2i} + \beta_1 lnZ_{3i} + (v_i - u_i) \qquad (4)$$

Where:

π = normalized profit

p_1= feed prices

p_2= veterinary prices

p_3= price per man day of labor

Z_1= total fixed capital

Z_2= family labor in hours

Z_3= land size in hectares

3.4.3 The determinants of profitability among cattle producers were obtained with the aid of the inefficiency model from the Cobb-Douglas model above following Leone (2013):

$$u_i = \partial_0 + \partial_1 K_1 + \partial_2 K_2 + \partial_3 K_3 + \partial_4 K_4 + \partial_5 K_5 + \partial_6 K_6 + \partial_7 K_7 \qquad (5)$$

Where:

K_1 = age of the respondent (year)

K_2 = educational level of respondents (years)

K_3 = household size (number)

K_4 = marital status

K_5 = production experience (years)

K_6 = access to credit

K_7 = access to extension

∂ = vector of unknown coefficient

The variance of the error terms σ_v^2 and that of the profit inefficiency effect σ_u^2 and the overall variance of model σ^2 are related thus: $\sigma^2 = \sigma_v^2 + \sigma_u^2$ measures the total variation of profit from the frontier which can be attributed to profit inefficiency.

The ratio of the errors in equation (6) provides the log-likelihood function (Battese and Coelli 1995) and estimates:

$$\gamma = \frac{\sigma_u^2}{\sigma_v^2 + \sigma_u^2} \qquad (6)$$

Where γ (gamma) represents the share of inefficiency in the overall residual variance with values in the 0,1 interval; gamma between 0 and 1 indicates the presence of inefficiency. A value of 1 suggests a deterministic frontier and that inefficiency effects are important explainers of profit across farms. Conversely, a γ value of 0 indicates the absence of inefficiency. Such absence of inefficiency favors OLS estimation due to the absence of u_i.

4. Results and discussion

4.1. Socio-economic characteristics of farmers

The socioeconomic characteristics of the cattle farmers is presented in Table 1. The mean age was 48.67. The majority of farmers were between the ages of 36 and 45 years, with those aged less than 25 years being the smallest group within the cattle farmers. This indicated that most of the cattle farmers are mature, which is helpful for the rigorous work involved in raising cattle and grazing them over long distances. This is also in line with Amimo et al. (2011), Hamidu (2014) and Rekwot et al. (2021) who found that most cattle farmers in Nigeria are elderly, mature and experienced.

Most of the cattle producers in the study area were married (94.25 percent). Marriage is important among the cattle farmers for cultural and religious reasons, and can support the need for family labor. This finding chimes with Muhammad et al. (2013) who found that most farmers are married. The results also show that while 35.6 percent of the farmers were educated to secondary level, a large proportion (24.1 percent) had no formal education and 17.8 percent had only completed primary education. This indicates that the overall level of education among many cattle farmers is very low, which may affect their capacity to adopt new technologies in the cattle production business. This is in line with Suleiman et al. (2015) and Rekwot et al. (2021) who also found very low education levels among cattle farmers. Most of the farmers had a household size of 6-10 members. The mean household size among cattle farmers was 7.12. All household members participated in the activities involved in cattle production, so large household sizes increased the labor available to the cattle farmers. This is in line with Rekwot et al. (2021) who also found that most cattle farmers in Nigeria had large household sizes. Table 1 further shows that nearly in nine in 10 (88.5 percent) of the cattle farmers had no access to credit or funds from any financial institution. This limits their ability to purchase inputs such as feed and drugs for their cattle and invariably limits the ability of the farmers to expand the size of their herd.

4.2. Farm characteristics among the cattle farmers

As shown in Table 2, the majority of the cattle farmers had a herd size of 11-20 cattle, with the smallest minority (10.3 percent) having a herd size of more than 40 cattle. The average herd size among cattle farmers was 15.5. This indicates that the majority of the cattle farmers are smallholder farmers with very small herd sizes. This is in line with Olafadehan and Adewumi (2010) who also found that most cattle farmers in Nigeria have small herd sizes and operate as smallholder farmers.

Table 2 further shows that the majority of the respondents (81.03 percent) rear cattle as their primary occupation, 59.2 percent practice a semi-intensive system characterized by low input use and low yields. This is supported by Olorunnisomo et al. (2010) who found that an intensive system of management is not a common practice among cattle farmers.

Furthermore, a significant proportion of the farmers (28.7 percent) had less than 10 years of experience. This low degree of experience could affect the ability of those farmers to deal with the major challenges that can arise in the cattle production process. According to the findings of Ogunmefun and Achike (2015), having more years of experience supports farmers' knowledge of the prevalence and management of risks in agriculture. The majority (97.7 percent) of cattle producers in the study area also had no access to extension services. Lack of access to extension implies that most of the cattle producers are unaware of new developments in cattle production and therefore persist with their existing practices, missing out on opportunities to increase their output from cattle production. This matches the findings of Mbakwe et al. (2016) who found that most farmers in Nigeria had no access to extension.

Table 1. Socio-economic characteristics of the farmers

Socio-economic characteristics	**Frequencies**	**Percentages**
Age (years)		
0-25	5	2.87
26-35	29	16.67
36-45	48	27.59
46-55	43	24.71
56-65	32	18.39
>65	17	9.77
Total	**174**	**100**
Marital status		
Married	164	94.25
Single	10	5.75
Total	**174**	**100**
Educational status		
No formal education	42	24.14
Primary education	31	17.82
Secondary education	62	35.63
Tertiary education	39	22.41
Total	**174**	**100**

Household size		
1-5	54	31.03
6-10	96	55.17
11-15	12	6.9
>15	12	6.9
Total	**174**	**100**
Access to credit		
Yes	20	11.49
No	154	88.51
Total	**174**	**100**

Source: Field survey, 2019

Table 2. Farm characteristics of the cattle farmers

Farm characteristics	**Frequencies**	**Percentages**
Herd size		
1-10	51	29.31
11-20	54	31.03
21-30	26	14.94
31-40	25	14.37
>40	18	10.34
Total	**174**	**100**
Primary occupation		
Cattle rearing	141	81.03
Wage employment	14	8.05
Crop production	6	3.45
Ownership of shop	10	5.75
Others	3	1.72
Total	**174**	**100**
Cattle production system		
Intensive	19	10.92
Semi-intensive	103	59.20
Extensive	52	29.89
Total	**174**	**100**
Production experience (Years)		
0-10	50	28.74
11-20	43	24.71
21-30	33	18.97
>30	48	27.59

Total	**174**	**100**
Contact with extension		
Yes	4	2.30
No	170	97.70
Total	**174**	**100**

Source: Authors' computation field survey, 2019

4.3. Level of profitability among cattle farmers

The summary statistics of inputs used in cattle production, their costs, revenues, and profit are presented in Table 3. The mean gross margin was ₦545,841.70 (per herd size of 15.5 cattle). This indicates that the business is profitable in Nigeria. It is important to stress that most of the cattle farmers rely on traditional practices with low use of inputs, meaning they rely on free-range grazing and feeding animals on crop residues. This lowers the costs associated with inputs, and where cattle are sold at high prices this leads to increased gross margins for the cattle farmers.

Table 3. Profitability among cattle farmers

Variable	Average (₦)	Total (₦)
TVC Feed cost	2249.2816	391375
Veterinary cost	6660.3448	1158900
Hired labor cost	10656.716	714000
Total variable cost	**19566.343**	**2264275**
TR Total revenue	565408.05	98381000
GM=(TR-TVC)	545841.7	96116725

Source: Authors' computation field survey, 2019

4.4. Stochastic profit frontier estimation of profit efficiency

The result of the stochastic frontier estimation of profit efficiency among cattle producers is presented in Table 4. The results reveal a σ^2 value of 0.572 which is statistically significant at 1 percent. This is an indication of a good fit and the correctness of the specified distributional assumptions of the composite error term. However, the estimate of gamma (γ), which is the ratio of the variance of farm-specific profit efficiency to the total variance of profit, is 0.815. This implies that more than 81.5 percent of the variation in profit among the farms is due to differences in profit efficiency. These profit variations occur as a result of farmer inefficiency and exogenous factors outside the farmers' control. Table 4 further indicates that all explanatory variables except fixed capital and land area significantly and negatively influence the profitability of cattle production. Fixed capital and land area have a positive influence on profitability; however, they are not significant. Feed cost has a negative and significant relationship with profit. A unit increase in the cost of feeding will decrease profit by 0.219. This indicates that an increase in the cost of feeding contributes to a reduction in profit among cattle farmers in Nigeria. Veterinary services are often needed for cattle production; however, this comes with a cost. The result indicates that a unit increase in the cost of veterinary service will lead to a decrease in the profitability of cattle by 0.132. Labor is also required in cattle production, and the size of the herd will influence the amount of

labor required by the cattle farmers. Labor costs had a negative and significant relationship with profit: a unit increase in the cost of labor leads to a decrease in profit by 0.442. As the cost of labor increases the cost of production increases and the profit margin is reduced.

Table 4. Maximum likelihood estimates of the stochastic profit frontier

Variables	**Parameters**	**Coefficient**	**t-ratio**	**P>|t|**
General model				
Constant	β_0	-0.469	-1.98	0.047
Ln (Feed)	β_1	-0.219	-2.65	0.008***
Ln (Veterinary costs)	β_2	-0.132	-1.65	0.099*
Ln (Labor)	β_3	-0.442	-4.38	0.000***
Ln (Fixed capital)	β_4	0.047	0.61	0.543
Ln (land area)	β_5	0.099	1.16	0.245
Inefficiency model				
Constant	∂_0	0.790	2.14	0.034
Age (years)	∂_1	0.012	2.13	0.034**
Educational level (years)	∂_2	0.013	1.06	0.289
Herd size	∂_3	0.006	0.91	0.364
Extension contact (no)	∂_4	0.401	1.85	0.066*
Labor source (family)	∂_5	-0.223	-1.70	0.090*
Primary occupation (others)	∂_6	1.864	1.64	0.102*
Variance parameters				
Sigma square	$\sigma^2=\sigma_u^2+\sigma_v^2$	0.572	5.07	
Gamma		0.8147	10.598	
Log likelihood	$\gamma = \sigma_u^2/\sigma_u^2 + \sigma_v^2$	-131.05317		
Number of observation =174				

Source: Field survey, 2019. Note: ***, **,* indicate significance at 1%, 5% and 10% respectively

4.5. Determinants of profit inefficiency among cattle producers

The results of the determinants of inefficiency are also presented in Table 4. The coefficients for the inefficiency determinants are expressed as shown in the lower part of the table. A positive coefficient on s indicates profit inefficiency because the value of *u* would be higher when the farmer is further below the profit frontier. Six socio-economic characteristics, including the age of the farmer, educational level, contact with extension agents, labor source, primary occupation, and herd size were considered. The age of the farmer has a positive and significant relationship with inefficiency. This indicates that a unit increase in a farmer's age will lead to 0.012 increases in profit inefficiency, and so implies that profit inefficiency increases as farmers grow older. Furthermore, it indicates that younger farmers are likely to be more profit efficient than older farmers. This finding is consistent with Bahta and Baker (2015) who found that profit inefficiency increases as farmers get older. This could be attributed to the conservatism of the older farmers and their adherence to the traditional practices they are familiar with, leading to a reluctance to accept innovations that could boost production and increase profit.

An increase in access to extension services will lead to an increase in inefficiency by 0.401. This implies that having access to extension contributes to inefficiency among cattle farmers. However, the majority

of the farmers in the study do not have access to extension, so this may not have a meaningful impact on the cattle farmers. Labor source (family) has a negative and significant relationship with profit inefficiency. The results revealed that an increase in the use of family labor will lead to a 0.223 decrease in profit inefficiency compared to farmers who employ hired labor. This is because a large percentage of farmers employing family members do not pay for those services, which leads to a decrease in the cost of production and therefore reduces inefficiency among the farmers. This implies that the use of family labor portrays the farmers as being more profit-efficient than those who use hired labor.

Participation in other occupations has a positive and significant relationship with inefficiency. The results revealed that engaging in other occupations will lead to an increase in profit inefficiency by 1.864 compared to farmers who engage only in cattle production. Ogunniyi (2011) reported a similar result, showing that farmers who engaged in non-farm activities operate at significantly lower levels of efficiency. This is not far-fetched, because farmers whose major occupation is cattle production will expend more resources such as time, finance, and animal husbandry into production than others who engage in cattle production as a secondary occupation.

4.6. Distribution of profit efficiency among cattle producers

The distribution of profit efficiency among cattle farmers in Oyo State is presented in Table 5. Profit efficiency was categorized into three categories low(0-0.33), Moderate(0.34-0.66), and High(0.66-1). This was done because the minimum in the profit efficiency score was 0 and the maximum value was 1. Cattle producers with less than one-third of the maximum value were categorized as low, those between One-third and two-third were categorized as moderate while those with more than two-third were categorized as High. The minimum value for profit efficiency was 0.14 while the maximum value for profit efficiency was 0.99. The mean profit efficiency score was 0.24. This implies that an average cattle farmer in Oyo State could increase profit by 76 percent. The results in Table 5 further show that most of the cattle producers (89.7 percent) have low profit efficiency while 8.6 percent and 1.7 percent of the farmers have moderate and high profit efficiency. This means that almost nine in 10 cattle farmers have low profit efficiency, thereby limiting their ability to increase their revenue from farming activities.

Table 5. Distribution of profit efficiency among cattle producers in Oyo State

Scale	Efficiency Scores	Frequency	Percentage
0-0.33	Low	156	89.66
0.34-0.66	Moderate	15	8.62
0.67-1.00	High	3	1.72
Total		**174**	**100**
Mean	**0.24**		
Min	**0.14**		
Max	**0.99**		

Source: Field survey, 2019

5. Summary and Conclusion

The results of the study show that the mean age of cattle farmers in the area was 47.67 years with 94.25 percent of the farmers being married and having a mean household size of seven members. Cattle production was profitable. The mean gross margin among the cattle farmers was ₦545,841.7. The mean profit efficiency among the cattle farmers was 0.24. This suggests that profit efficiency could still be increased by 76 percent among cattle farmers. Age, access to extension, labor source, and primary occupation were the main factors influencing profit inefficiency. While cattle farming was found to be profitable among the farmers in Oyo State, profit efficiency was however very low. The majority of the farmers were found to have low profit efficiency while only a very few had high profit efficiency.

The provision of training and access to credit would help farmers by encouraging them to adopt new approaches in cattle production, in turn helping them to reduce inefficiency.

6. References

Adeniran, L. A., S. Okpi, T.S. Anjorin, and O.P. Ajagbonna. "Medicinal plants used in ethnoveterinary practices in the Federal Capital Territory, North-Central Nigeria." *Journal of Medicinal Plants Research*, 14(8): 377-388.

Aigner, D. L., C.K. Lovell, and P. Schmidt. "Formulation and Estimation of Stochastic Frontier Production Function Models." *Journal of Econometrics*, 6(1): 21-37.

Ali, M., and J.C. Flinn. "Profit Efficiency among Basmati Rice Producers in Pakistan Punjab." *American Journal of Agricultural Economics*, 71: 303-310.

Amimo, J. O., S. Thumbi, B.O. Inyangala, J.O. Junga, and R.O. Mosi. "Socio-economic Characteristics and Perceptions of Cattle Keepers and Constraints to Cattle Production in Western Kenya." *Livestock Research for Rural Development*, 23(6), article 138.

Badunenko, O., M. Fritsch, and A. Stephan. "Allocative efficiency measurement revisited – Do we need input prices?" *Economic Modelling*, 25(5):1093-1109.

Bahta, S., and D. Baker. "Determinants of Profit Efficiency among Smallholder Beef Producers in Botswana." *International Food and Agribusiness Management Review*. 18 (3):107-130.

Balehegn, M., A. Duncan, A. Tolera, A.A. Ayantunde, S. Issa, M. Karimou, and A.T. Adesogan. "Improving adoption of technologies and interventions for increasing the supply of quality livestock feed in low-and middle-income countries." *Global Food Security*, 26:100372.

Battese, G.E., and T.J. Coelli. "A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data." *Empirical Economics*, 20: 325-332.

Eniola, P. O., O. A. Adeleke, and O.M. Okanlawon. "Effect of Transhumance Pastoralism on Farming Activities among Crop Farmers in Oke-Ogun Area of Oyo State." *Nigerian Journal of Rural Sociology*, 16 (3):45-50

Fafiolu, A. O., and J.O. Alabi. "Beyond COVID-19 pandemic period: Strategies for sustainable livestock feed and food production." *Nigerian Journal of Animal Science*, 22(3): 107-121.

FAO. 2018. "Transforming Livestock Sector Nigeria: What do long-term projections say?" Africa Sustainable Livestock 2050. Accessed April 3, 2024. https://www.fao.org/3/ca3374en/ca3374en.pdf

Farrell, M. J. "The measurement of productive efficiency." *Journal of the Royal Statistical Society*, 120(3): 253–281.

FOS 1996. *States of the Federation Land Area Provisional Result*. Federal Office of Statistics, Nigeria.

Greene, W. H. 1997. "Frontier production functions." In *Handbook of Applied Econometrics volume II: Microeconometrics*, edited by M.H. Pesaran and P. Shmidt. Hoboken, NJ, US: Blackwell Publishers Ltd.

Hamidu, K. 2014. Profitability assessment of cattle marketing in Gombe metropolis, Gombe State, Nigeria. *Journal of Economics and Sustainable Development*, *5*(10): 108-113.

ILRI. 2024. Nigeria. Retrieved from https://www.ilri.org/where-we-work/west-africa/nigeria

Kumbhakar, S.C., and A. Bhattacharyya. 1992. "Price Distortions and Resource Use Efficiency in Indian Agriculture: A Restricted Profit Function Approach." *Review of Economics and Statistics,* 74: 231-239.

Lamidi, A. A., and F.I. Ologbose. 2014. "Dry season feeds and feeding: a threat to sustainable ruminant animal production in Nigeria." *Journal of Agriculture and Social Research*, 14(1): 17-30.

Mawa, L. I. 2013. "Profit Efficiency of Dairy Farmers in Kenya: A Case Study of Smallholder Farmers in the Rift Valley and Central Province." Master of Science Research Methods submitted to Jomo Kenyatta University of Agriculture and Technology.

Livestock Global Alliance. 2016. "Livestock for Sustainable Development in the 21st Century." Accessed April 3, 2024. https://www.livestockdialogue.org/fileadmin/templates/res_livestock/docs/2016/LGA-Brochure-revMay13th.pdf

Mawa, L.I. 2013. "Profit Efficiency of Dairy Farmers in Kenya: A Case Study of Smallholder Farmers in the Rift Valley and Central Province." Dissertation for Master of Science in Research Methods. Jomo Kenyatta University of Agriculture and Technology.

Mbakwe, I., O. Judith, and N. Obaji. 2016. "A study of socio-economic characteristics of farmers to determined their perceptions on climatic variables and adaptation options in Imo State, Nigeria." *African Journal of Agricultural Economics and Rural Development*, *4*(2): 287.

Mbakwe, I., O. Judith, and N. Obaji. "A Study of Socio-Economic Characteristics of Farmers to Determine Their Perceptions on Climatic Variables and Adaptation Options in Imo State, Nigeria." *African Journal of Agricultural Economics and Rural Development,* 4 (2): 287-300.

Meeusen, W., and J. van den Broeck. "Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error." *International Economic Review*, 18 (2): 435–444.

Molina-Flores, B., P. Manzano-Baena, and M.D. Coulibaly. 2020. *The role of livestock in food security, poverty reduction, and wealth creation in West Africa.* Accra: FAO.

Muga, G. O., W. Onyango-Ouma, R. Sang, and H. Affognon. "Sociocultural and economic dimensions of Rift Valley fever." *The American Journal of Tropical Medicine and Hygiene*, 92(4): 730-738.

Muhammad, N., F.S. Muhammad, S.M. Asim, and Z. Hussain. "Impact of Socio-Economic Characteristics of Farmers on Access to Agricultural Credit." *Sarhad Journal of Agriculture*, 29 (3): 469-476

Musaba, E. C., and C. Chibalani. "Determinants of Profit efficiency in smallholder broiler production in Kabwe district, Zambia." *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 14(1): 06-14.

Ogundari, K. and S.O. Ojo. "The Determinants of Technical Efficiency in Mixed Crop Food Production in Nigeria: A Stochastic Parametric Approach." *Eastern Africa Journal of Rural Development*, 21(1): 15-22.

Ogunmefun, S. O., and A. I. Achike. "Socio-Economic Characteristics of Rural Farmers and Problems Associated with the Use of Informal Insurance Measures in Odogbolu Local Government Area, Ogun State, Nigeria." *Russian Journal of Agricultural and Socio-Economic Sciences,* 2 (38): 3-14.

Ogunniyi, L. "Profit Efficiency among Maize Producers in Oyo State, Nigeria." *ARPN Journal of Agricultural and Biological Science*, 6 (11):11-17

Oladeebo, J. O., and A.S. Oluwaranti. "Profit Efficiency among Casava Producers: Empirical Evidence from South Western Nigeria." *Journal of Agricultural Economics and Development*, 1 (2): 46-52.

Olafadehan, O. A., and M.K. Adewumi. "Livestock management and production system of agropastoralists in the derived savanna of South-west Nigeria." *Tropical and Subtropical Agroecosystems*, 12(3): 685-691.

Olorunnisomo, O. A., A.O. Olubowale, and M.A. Adesina. "Socio-Economic Characteristics of Cattle Farmers and their Perception of Commercial Milk Production in Three Agricultural Zones of Oyo State." *Journal of Agriculture, Forestry and the Social Sciences (JOAFSS),* 8 (2): 1-10.

Oni, A. A., M.O. Oyeyemi, and J. Atawalna, J. "Histomorphometry of the testes, Epididymides, and spermatozoa of four indigenous breeds of bulls in Ibadan, Nigeria." *Open Journal of Veterinary Medicine*, 11(9): 299-306.

Our World in Data. "Number of cattle (Nigeria)." Accessed April 4, 2024. https://ourworldindata.org/grapher/cattle-livestock-count-heads

OYSG. 2019. About Oyo State, Oyo State Government, Nigeria. Accessed April 3, 2024. http://www.oyostate.gov.ng.

Paul, B. K., J. Koge, B.L. Maass, A. Notenbaert, M. Peters, J.C. Groot, and P. Tittonell. "Tropical forage technologies can deliver multiple benefits in Sub-Saharan Africa. A meta-analysis." *Agronomy for Sustainable Development*, 40: 1-17.

Pavelescu, F. 2011. "Some Aspects of the Translog Production Function Estimation." *Romanian Journal of Economics,* 32 (1):131-150

Porcelli, F. 2009. "Measurement of technical efficiency: A brief survey on parametric and nonparametric techniques." *Measurement of Technical Efficiency*: 1-27.

Rahman, S. "Profit Efficiency among Bangladeshi Rice Farmers." *Food Policy* 28: 487-503.

Rekwot, Z. G., Oyinbo, O., and Achi, N. P. 2021. Poverty reduction among beef cattle value chain actors in North-West zone of Nigeria. *Nigerian Journal of Animal Production*, *48*(6): 363-373.

Rutledge, J.J. 1997. "Cattle Breeding System Enabled by in Vitro Embryo Production." *Embryo Transfer Newsletter*, 15: 14-18.

Sadoulet, E. and A. De Janvry. 1995. *Quantitative Development Policy Analysis.* Baltimore: The Johns Hopkins University Press.

Seré, C., A. Ayantunde, A. Duncan, A. Freeman, M. Herrero, S.A. Tarawali, and I. Wright. "Livestock Production and Poverty Alleviation: Challenges and Opportunities in Arid and Semi-Arid Tropical Rangeland Based Systems." Paper presented at the XXI International Grassland Conference, Hohhot, China, June 29 – July 5, 2008. Nairobi, Kenya: ILRI.

Statista. "Cattle population in Africa by country." Accessed April 4, 2024. https://shorturl.at/uwM01

Suleiman, A., E. L. Jackson, J. Rushton. 2015. "Challenges of pastoral cattle production in a sub-humid zone of Nigeria." *Tropical animal health and production*, *47*: 1177-1185.

Uwagie-ero, A.E., I. Shuaibu, and N.O. Saviour. "An Overview of Ethnoveterinary Medicine in Nigeria." *Tropical Journal of Natural Product Research*, 1(4): 153-157.

Wang, J., G.L. Cramer, and E.J. Wailes. "Production efficiency of Chinese agriculture: Evidence from rural household survey data." *Agricultural Economics* 15:17-28.

World Bank. 2017. Livestock Productivity and Resilience Support Project (P160865). Abuja.

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