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Examining the Factors Influencing Technical Efficiency in Nigerian Cattle Fattening Businesses in Kebbi State

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Abstract: When animals are fed in a way that causes them to acquire a lot of body weight quickly, it's called fattening (Alawa et al., 2008). The input-output ratio is the measure of efficiency. Researchers in Nigeria's Kebbi state looked at the factors that affect technological efficiency in the cattle fattening industry. A total of 160 fatteners were surveyed utilizing a multistage sampling method. For this investigation, we used a translog stochastic frontier production function model, where technical efficiency impacts are defined as a function of socioeconomic factors calculated using the maximum likelihood technique. With coefficient values of (0.053, 0.452, 6.804, 1.058, 0.986, and 0.197), respectively, the analysis showed that the level of technical efficiency in cattle fattening was most affected by medication, feeds, fattening animals, depreciation, water, and transportation. With a mean of 0.90% and a range of 0.74 to 0.98%, technical efficiency indicators showed that the top fatteners were not significantly different from the average fattener in terms of efficiency. There was a need to broaden the scope since it also showed that the fatteners weren't working as efficiently as they might. There was a 1% correlation between fattening experience and technical efficiency, a 1% correlation between herd size and technical efficiency, and a 10% correlation between household size and technical efficiency. This suggests that the technical effectiveness of fattening cattle is enhanced by herd size and fattening experience, and decreased by family size. Cattle fatteners are advised to raise their herd size to take advantage of economies of scale and improve their technical efficiency.

Keywords: Productivity, Factors, Livestock, and Commercial Fattening

Introduction

There has been a persistent focus on food insecurity and hunger by experts and governments around the globe in recent years (Babatunde et al., 2002). The bulk of people cannot afford the high prices, limited availability, and high levels of animal protein, particularly meat (Tanko and Jiya, 2010). Because most of the animals' feed comes from low-quality, overgrazed ranges, the conventional way of raising domestic meat animals produces low productivity (Iwuanyanwu, 2001). The use of such ranges for industrial purposes, such as agricultural development initiatives focused on crop production in particular, is also reducing their size. So, it's unrealistic to think that the current method of raising animals for meat can keep up with the demand for both meat and animal protein in the future. Alternative sustainable production methods must be used in Nigeria in order to close the demand-supply gap for animal protein in the form of meat. As a result, raising cattle for their flesh seems to be a viable option to satisfy the nation's growing need for meat. The economic feasibility of a cow fattening firm is assured, according to Oni (2006), due to the ease of sourcing raw materials, simplicity of production technology, and the capacity to meet personnel requirements via family labor.Rapid ways of increasing production are offered by fattening, an economical method of feeding animals that increases the yield of edible carcass within a short time. Situations when range cattle are severely undernourished and need a brief period of high-calorie nutrition to enhance productivity

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and get them ready for sale may be addressed by fattening.Additionally, it helps to avoid some of the issues that cause herders and crop farmers in Nigeria to battle so often. Given the importance of developing sustainable livestock production technologies to increase meat availability quickly and the numerous agricultural programs and policies aimed at improving farmers' efficiency and productivity, it is crucial to quantify the current level of technical efficiency and the factors that influence it among cattle fatteners. This is because production efficiency directly impacts agricultural productivity as a whole (Ajibefun, 2002). Both emerging and mature economies continue to place a premium on research into efficient measurement. A company's bottom line is heavily dependent on efficiency metrics, and agricultural expansion is directly proportional to financial success. Livestock fattening businesses have lacked enough research on the connections between efficiency, market indicators, and household characteristics. Studies that assessed the technological efficiency of cattle fattening businesses using a stochastic frontier production function technique are almost nonexistent, attesting to the paucity of empirical research in this area. Therefore, in order to assess technical efficiency and its drivers across cattle fattening firms in Kebbi State, Nigeria, this research used the translog stochastic frontier production function technique.

According to Alawa et al. (2008), Osuhor (2008), and Umar et al. (2014), animal fattening is the preferred way of feeding animals to rapidly increase their weight and meat production. Smallholder livestock fatteners and farmers primarily aim to rapidly raise the animal's living weight and meat amount.

Theoretical Framework

A stochastic frontier analysis which requires a parametric representation of the production technology was employed in this research. In addition, it incorporates stochastic output variability by means of a two part error term. This approach was pioneered independently by Aigner et al (1977) and Meeusen & Van den Broeck (1977). The general notation of the model is as follows:

$$\gamma_i = h(x_i;\ \alpha)\exp(\varepsilon_i)\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where: γi is output of producer I (bounded above by the stochastic component $h(x_i;\ \alpha)\ \exp(\varepsilon_i)$, x_i is vector of inputs used by producer I, α is a vector of unknown technology parameters, $h(x_i; \alpha)$ is production frontier. The composed error, term is $\varepsilon_i = v_i - u_i$. Where V_i captures the effect of pure noise in the data attributed to measurement error extreme weather conditions etc. and $u_i$is one-sided error that captures the inefficiency effects. The symmetric element v_i account for random variation in output quantity attributed to factors outside farmer's control e.g. disease and weather while u_i account for random variation in output quantity attributed to factors under farmer's control. A one-sided component $u_i \leq 0$ reflects technical inefficiency relative to stochastic frontier. Thus $u_i = 0$ for farm output that lie on the frontier (100% technical efficiency in resource use) and $u_i = 0$ for farm output below the frontier as $N\delta^2, v$.

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Conceptual framework

The conceptual framework for the study is based on the concept of the technical efficiency of resource utilization and the concept of production by Coelli *et al.* (1998). Technical efficiency shows the success of a firm enterprise, as it indicates ability of a firm to produce maximum output from a set of input mix (Farrell, 1957; Ali and Flinn 1989; Moses, 2017). Figure 1.1 illustrates the concept of a feasible production set which is the set of all inputs-output combination that are feasible. This set consists of all point between the production frontier, 0F and X-axis. The points along the production frontier define the efficient subset of this feasible production set. Point A represents an inefficient point whereas points B and C represent efficient points. A firm operating at point A is inefficient because technically it could increase output to the level associated with the point B without requiring more input.

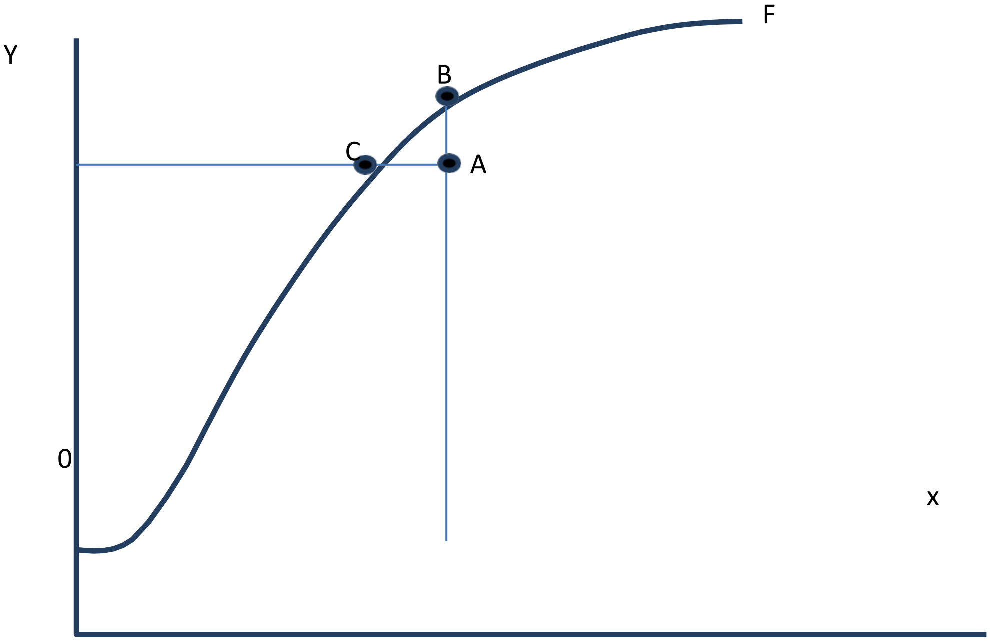

Figure 1.1 Production Frontiers and Technical Efficiency

Source: Coelli *et al*., 1998

Model specification

To any empirical research, the decision to select a functional form is very important because the selected functional form can significantly affect the parameter estimates (Kebede, 2001). The two common functional forms of stochastic frontier model generally used are: Cobb-Douglas and Trans-log functional forms. Cobb- Douglas functional form is very easy to adopt but it imposes a severe restriction on production elasticity to be constant and the elasticity of input substitution to be unitary. On the other hand, Trans-log functional form is

known to be less restrictive, permitting for the combination of square and cross product terms of the exogenous variables with the view of having goodness of fit of the model.

Mean Production Function Specification

This research employed the trans-log stochastic production function model specified as follows:

Where: γ_i is output of producer j, x_i is vector of inputs used by producer j, α_0, α_i, α_{ii} *and* α_{ik}

are vectors of unknown technology parameters, j is j-th farmer where j- 1,2,3, …, n and i is i-th input where i – 1,2,…, n. The composed error term is $\varepsilon_j = v_i - u_i$. Where v_i captures the effect of pure noise in the data attributed to measurement error, extreme weather conditions etc and u_i is one-sided error that captures the inefficiency effects.

Inefficiency model specification

Following the specification in equation above, the linear technical inefficiency model is specified as follows:

$$u_i = \delta_o + \sum \delta_r W_{rj}$$

$r=1$

Where $u'_i s$ are inefficiency effects, δ_o and δ_r's are estimated coefficients of technical inefficiency model and W_r's are vectors of I producer technological/socioeconomic variables that consists of age, level of education, fattening experience, household size, herd size and credit access.

Methodology

Study Area

The study was conducted in Kebbi State, Nigeria. This was purposively selected due to its importance in livestock fattening.

Sampling Technique and Sample Size

The sampling method used was the multi-stage sampling technique. The State was divided in to four according to Kebbi State Agricultural Development Project (ADP) zones, namely Argungu, Bunza, Yauri and Zuru Zones. In the first stage, two Local Government Areas (LGAs) were randomly selected in each zone through lottery method (drawing lots), making a total of eight LGAs in the study. These include Argungu and Dandi LGAs in Argungu zone, Jega and Bunza LGAs in Bunza zone, Yauri and Ngaski LGAs in Yauri zone and Danko- Wasagu and Zuru LGAs in Zuru zone. Secondly, from each of the LGAs, two leading villages noted for cattle fattening were purposively selected giving a total of sixteen villages and from each village ten livestock fatteners were randomly selected through snow ball technique, giving a total of 160 fatteners that were interviewed for the study.

Data Analysis and the model

Data were collected at fortnight intervals so as to get comprehensive data using the cost route approach. Information on primary data collected includes input – output data on fattening enterprises. The weights of cattle fattened were obtained using a weigh band. The weigh band is set at the circumference of the body of the animal at a point immediately behind the fore- legs, perpendicular to the body axis. The weight in kilogram wasthen recorded. The difference between the initial body weight and the final body weight gives the weight gain.

Empirical model

$Ln\ y = \beta_o + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 Ln\ X_3 + \beta_4 Ln\ X_4 + \beta_5 LnX_5 + \beta_6 Ln\ X_6 + \beta_7 LnX_7 + ½ \beta_{11} Ln\ X_1^2 + ½ \beta_{22} LnX^{2} + ½ \beta^2 + ½ \beta$

$In\ X_3 + B_{14}LnX_1LnX_4 + \beta_{15}LnX_1LnX_5 + \beta_{16}LnX_1LnX_6 + \beta_{17}LnX_1LnX_7 + \beta_{23}LnX_2LnX_3 + \beta_{24}LnX_2LnX_4 + \beta_{25}LnX_2LnX_5 + \beta_{26}LnX_2LnX_6 + \beta_{27}LnX_2LnX_7 + \beta_{34}LnX_3LnX_4\beta_{35}LnX_3LnX_5 + \beta_{36}LnX_3LnX_6 + \beta_{37}LnX_3LnX_7 + \beta_{45}LnX_4nX_5 + \beta_{46}LnX_4LnX_6 + \beta_{47}LnX_4LnX_7 + \beta_{56}LnX_5LnX_6 + \beta_{57}LnX_5LnX_7 + \beta_{67}LnX_6LnX_{7+} Vi – Ui$

Where:

β_o	=	Constant term
β_1- β_{67}	=	Parameters to be estimated
Ln	=	Logarithm to base e.
Y	=	Output (Weight gain in Kg)
X_1	=	Labour in Man-days

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X_2	=	Expenses on medication and veterinary services (₦)
X_3	=	Expenses on feeds and feed supplements (₦)
X_4	=	Expenses on fattening animals purchased (₦)
X_5	=	Depreciation on livestock fattening facilities such as housing, drinkers, ropes, rake,watering basin etc. (₦)
X_6	=	Quantity of water utilized in (liters)
X_7	=	Cost of transportation (₦)
Vi	=	Normal random errors which are assumed to be independently and identically distributed having zero mean and constant variance.
Ui	=	Non – negative random variables associated with the technical inefficiency of the enterprise(s) involved.
Ui	=	$\delta_o + \delta_1 z_1 i + \delta_2 z_2 i + \delta_3 z_3 i + \delta_4 z_4 i + \delta_5 z_5 i + \delta_6 z_6 i$
Z_1	=	Age of the livestock fattener in years
Z_2	=	Level of education in number of years spent in school
Z_3	=	Fattening experience in years
Z_4	=	Household size
Z_5	=	Herd size
Z_6	=	Dummy variable for credit access (1 for access to credit, 0 otherwise).
δ - δ_6	=	Unknown parameters estimated

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Results and Discussion

Parameter estimates for technical efficiency in cattle fattening enterprises are presented in Table 1. Result from Table 1 shows the sigma squared value of 0.018, is statistically significant at 1% level. This parameter estimate ascertains the goodness-of-fit and the correctness of the specified distributional assumptions of the composite error term. The estimate of the variance ratio/the gamma was 0.912 indicating that 91.2% of the disturbance in the system is due to inefficiency, one sided error and therefore 8.80% is due to stochastic disturbance with two–sided error, supported by the high t-value. Ohajianya (2005) and Moses (2017) in their various investigations obtained similar results.

Table1: Translog parameter estimates for technical efficiency in cattle fattening enterprise, Kebbi State, Nigeria

Production factor	Parameter	Coefficient	Standard error	t-ratio
Constant term/intercept	β_0	13.255	0.493	26.895***
Labour	β_1	-0.172	0.145	-1.183
Medication	β_2	0.053	0.027	1.988*
Feeds	β_3	0.452	0.241	1.875*
Fattening Animals	β_4	6.804	0.331	20.586***
Depreciation	β_5	1.058	0.257	4.113***
Water	β_6	0.986	0.284	3.473***
Transportation	β_7	0.197	0.096	2.054**
Squared terms				
Labour x Labour	β_{11}	0.023	0.032	0.712
Medication x Medication	β_{12}	0.008	0.005	1.689*
Feeds x Feeds	β_{33}	0.105	0.030	3.492***
Fattening Animals x Fattening Animals	β_{44}	0.653	0.050	12.948***
Depreciation x Depreciation	β_{55}	0.288	0.058	4.989***
Water x Water	β_{66}	0.145	0.045	3.212***
Transportation x Transportation	β_{77}	0.039	0.017	2.334**
Interaction among inputs				
Labour x Medication	β_{12}	0.006	0.013	0.504
Labour x Feeds	β_{13}	1.048	0.111	9.467***
Labour x Fattening Animals	β_{14}	-0.609	0.155	-3.927***
Labour x Depreciation	β_{15}	-0.732	0.129	-5.683***
Labour x Water	β_{16}	0.412	0.130	3.176***
Labour x Transportation	β_{17}	-0.058	0.043	-1.325
Medication /Feeds	β_{23}	-0.081	0.301	-0.269
Medication x Fattening Animals	β_{24}	-0.123	0.675	-0.183
Medication x Depreciation	β_{25}	-2.444	0.449	-5.438***
Medication x Fattening Animals	β_{26}	1.964	0.515	3.814***
Medication x Water	β_{27}	0.130	0.166	0.784
Medication x Transportation	β_{34}	3.489	0.543	6.420***
Feeds x Fattening Animals	β_{35}	2.557	0.796	3.213***
Feeds x Depreciation	β_{36}	-3.225	1.138	-2.834***
Feeds x Water		-3.038	1.437	-2.114**
Feeds x Transportation	β_{37}	-9.801	0.884	11.088***
Fattening Animals x Depreciation	β_{45}	-2.599	0.963	-2.698***
Fattening Animals x Water	β_{46}	8.210	0.810	10.135***
Fattening Animals x Transportation	β_{47}	12.692	1.491	8.512***
Depreciation x Water	β_{56}	-4.833	0.934	-5.176***
Depreciation x Transportation	β_{57}	-2.425	1.094	-2.217**
Water x Transportation	β_{67}			
Diagnostic statistics				
Log likelihood function		169.151		
Sigma square (δ°)		0.018	0.039	4.693***
Gamma		0.912	0.074	12.355***
LR test		8.682		

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Source: Computer printout of Frontier 4.1

Result from Table 1 indicates that the coefficients of the variables medication (0.053), feeds (0.452), fattening animals (6.804), depreciation (1.058), water (0.986) and transportation (0.197) carried positive signs. They were statistically significant at 1% level except for medication and feeds that were significant at 10% level. Output elasticity for fattening animals, depreciation and water utilized indicated that an increase by 1% of these variables will lead to 6.804, 1.058 and 0.986% increase in the output (weight gain) of livestock fattening, respectively. The result depicts that fattening animals and depreciation are the dominant production variablesthat influenced the technical efficiency in cattle fattening enterprise. The sum of output elasticity indicates that increasing returns to scale prevailed. Increasing returns indicates that an additional unit of input results in a larger increase in production than the preceding unit. In this scenario, resource use efficiency had not been attained and resources are misallocated. This finding disagrees with that of Nganga *et al* (2010) who found that feeds are the dominant variable that influenced profit efficiency among milk producers.

Most of the interaction terms (2^{nd} order coefficients) were statistically significant at the conventional significance levels (1, 5 and 10%), implying the suitability of the translog function (Okoye and Onyenweaku, 2007). Among the squared terms, the coefficients of feeds, fattening animals, depreciation and water are positiveand highly significant at 1% level of probability, showing a direct relationship with weight gain (output). Coefficient of squared term for medication and transportation are significant at 10 and 5%, probability levels respectively. Coefficient of interaction between feeds x transportation and water x transportation are significant at 5% level of probability and have a direct relationship with weight gain in livestock fattening while interaction between labour x feeds, labour x fattening animals x depreciation, labour x water, medication x depreciation, medication x water, feeds x fattening animals, feeds x depreciation, fattening animals x water, fattening animals x depreciation, fattening animals x water, fattening animals x transportation, depreciation x water and depreciation x transportation shows direct relationship with weight gain and are highly significant at 10% level of probability.

The negative signs recorded against the slope coefficients of the variables for the interaction terms such as labour x fattening animals, labour x depreciation, medication x depreciation, feeds x water, feeds x transportation, fattening animals x depreciation, fattening animals x water, depreciation x transportation and water x transportation indicated that as more inputs were incurred on the farm, after reaching its thresh hold, the contribution of these items reduce the level of output or weight gain of the fattening enterprises. This is a sign that these resources were not being efficiently allocated or the farm is experiencing diminishing returns with respect to the variables. The finding is in agreement with that of Onoja and Emodi (2011) who found that the contribution of these interaction terms beyond the optimal level will decrease the level of efficiency.

Estimates of technical efficiency among cattle fatteners are presented in Table 2. The results of technical efficiency estimates of cattle fattening enterprises in Table 2 indicate that technical efficiencies range from 0.74 to 0.98. The mean technical efficiency was 0.90, indicating that there was no wide gap between the efficiency of best technical efficient fatteners and that of the average fatteners. The estimates reveal that for the average cattlefattener to attain the level of the most technically efficient fattener in the sample, he/she would require a cost savings of 8.16 percent that is (1-0.90/0.98%). The least technically efficient farmer will however, experience efficiency gain of about 24.49 percent that is (1-0.74/0.98%) to be able to attain the level of the most technicallyefficient cattle fattener.

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Table 2: Distribution of cattle fatteners according to technical efficiency indices, Kebbi State, Nigeria

Technical Efficiency index	**Frequency**	**Percentage**
0.71-0.80	20	12.50
0.81-0.90	58	36.30
0.91-1.00	82	51.20
Total	160	100.00
Mean Technical efficiency	0.90	
Standard deviation	0.06	
Minimum Technical efficiency	0.74	
Maximum Technical efficiency	0.98	

Source: Computer printout of Frontier 4.1

Results from Table 2, indicate that about 51.20 percent of cattle fatteners attained between 0.91 and 0.98 technical efficiency levels. None of the cattle fatteners had an efficiency level below 60 percent. The high level of technical efficiency in cattle fattening is suggestive of the fact that only 10% is attributable to inefficiency. The efficiency distribution disagrees with that obtained by Moses (2017) who obtained efficiency level of less than 79 per cent. Although cattle fatteners in the study were inefficient in production technically, results revealed that the fatteners tended towards technical efficiency.

Results of the determinants of technical efficiency among cattle fattening enterprises are depicted in Table 3. The result in Table 3 with respect to technical efficiency determinants show that fattening years of experience (- 0.011) and herd size (-1.260) have negative coefficients and are statistically significant at 1% probability levels. Negative coefficients of these variables connotes that the variables reduces technical inefficiency (increases technical efficiency). This is likely because, more experienced fatteners are likely to have extension contacts and therefore, more willing to adopt improved technology that would enhance their technical efficiency. This resultis in consonance with that of Umar *et al*. (2014) who found out in their studies that fattening experience and herd size had negative coefficients while it disagrees with that of Moses (2017) who found out that herd size hadpositive coefficient. A negative and significant coefficient of herd size implies that herd size increases technical efficiency (decreases technical inefficiency among cattle fatteners). This result corroborates with those of Umar *et al*., (2014) who found similar outcome.

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Table 3: Maximum likelihood estimates of the determinants of technical efficiency in cattle fattening enterprise, Kebbi State, Nigeria.

Variable	Parameter	Coefficient	Standard error	t-ratio
Intercept	Z_0	4.651	0.194	23.993***
Age	Z_1	0.001	0.003	0.061
Level of education	Z_2	0.009	0.007	1.301
Fattening experience	Z_3	-0.011	0.003	-3.493***
Household size	Z_4	0.009	0.005	1.840*
Herd size	Z_5	-1.260	0.043	-29.451***
Credit access	Z_6	-0.029	0.025	-1.174

Source: Computer printout of Frontier 4.1

***, **, * are significant levels at 1, 5 and 10% respectively.

Conclusion

Based on the findings of the study it can be concluded that technical efficiency indices varied from 0.74to 0.98%, with a mean of 0.90%, revealing that there was still room for improving the technical efficiency of theaverage farmer to be able to attain the optimal technical efficient level. The results also revealed that fattening experience and herd size enhances the technical efficiency of the farmers. It is recommended that for Cattle fatteners to increase their level of technical efficiency, there is need to increase their herd size in order to gain from economies of scale.

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