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Determinants of Profitability in Smallholder Beef Cattle Farming: Evidence from Langkat Regency, Indonesia

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ABSTRACT

Beef cattle farming is one of the livestock sectors that plays an important role in food security and economic growth. This study aims to identify the production factors that affect the profitability of beef cattle farmers in Langkat Regency. The research method used was a survey, with multistage random sampling as the sampling technique. The respondents were 80 beef cattle farmers. Data collection methods included observation and direct interviews with the farmers. The statistical test used was multiple linear regression using SPSS. The results demonstrate that feed cost, artificial insemination (AI) cost, labour cost, and farmer age have a significant impact on farm profit. The results demonstrate that feed cost, artificial insemination (AI) cost, labour cost, and farmer age have a significant impact on farm profit. In part, feed cost, AI cost, labor cost, and farmer age all significantly affect profitability. Feed costs account for 54.46% of total production costs, followed by labor (41.11%) and AI (4.43%). The results indicate that the key cost items are determinants for beef cattle profitability. Furthermore, to the extent that older farmers tend to be less profitable, farmers' age has a negative and significant effect on profitability. This association could be explained by higher resilience to change, lesser management adaptability, and limited digital proficiency, which themselves impair access to information and business opportunities through digital means.

Keywords: *Production factors, profitability, economic growth, beef cattle farming.*

BACKGROUND

Beef cattle farming is one of the livestock sectors that is an important part of the livestock sector, contributing continuously to food security and economic growth (FAO, 2020). In Indonesia, 90% of beef cattle farming comes from smallholder farms with 6.5 million farmers from rural areas, and the remaining 10% from commercial farms (Moss et al., 2016). Langkat Regency has the most beef cattle in North Sumatra. The beef cattle population in 2023 was 146,952 and increased to 156,650 in 2024 (Central Statistics Agency of Langkat Regency, 2024). Smallholder beef cattle farming is

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one of the livelihoods of the people in Langkat Regency. The extensive agricultural area in Langkat Regency supports livestock production. Beef cattle farming offers many benefits for millions of farming households in developing countries, increasing their income (Jobirov et al., 2021).

Beef cattle breeding efforts in Langkat Regency are still traditional in nature. Farmers still raise cattle as a side business and as a form of savings. Smallholder farming businesses usually generate low profits. Beef cattle farming businesses are capable of producing commercial products. Commercial livestock farming requires farmers to be able to manage various production factors in order to produce maximum output (Sari et al., 2016). Therefore, beef cattle farmers need to understand the production factors that affect livestock farming. The production factors used will affect output and business efficiency. Efficiency is an indicator of competitiveness that is needed for commodity development. Government intervention will affect the competitiveness of a commodity system (Ekowati et al., 2018).

A number of studies have explored the profitability of beef cattle production and have identified several factors found to influence this, including the costs of feed, the level of labor inputs used, herd size, and the proximity to key cattle markets (Haloho et al., 2024). Nonetheless, most previous research usually takes these factors separately into consideration and focuses on a single facet, such as production cost or income level, without a clear exploration of the link between production cost structures and the farmers' socio-economic characteristics. Furthermore, much of the research is carried out at a wider provincial or national level, which can be misleading about location-specific variations faced by smallholders.

Further, there is a lack of empirical information that combines cost components such as feed, AI, and labor costs with farmers' attributes (age, experience, and managerially oriented) to explain profit variability at the regional level. This is even more pronounced in major beef-producing locations such as the Langkat Regency. This is very important because smallholder farmers' decision-making processes, levels of efficiency, and responsiveness to innovation significantly depend on their socio-economic attributes, which, in turn, interact with the allocation of inputs and the management of costs. Without such comprehensive analyses, policy interventions and extension programmes will be poorly targeted and relatively ineffective at improving farm profitability.

Accordingly, the goal of this study is to fill that research gap by investigating the production factors that determine the profitability of small-scale beef cattle farming in the Langkat Regency, focusing on the production cost structure and farmer characteristics. In this sense, production factors are everything that is given or produced by nature, and that is transformed, refashioned, or reorganized, directly or indirectly, in the process of producing a good or service. To provide a region-specific empirical basis, this study offers practical implications for policymakers, extension services, and farmers on how to develop more effective strategies to improve efficiency, profitability, and the sustainability of beef cattle production systems.

RESEARCH METHODS

The material is the farming activities carried out by beef cattle farmers in Langkat Regency. The research method used is a survey method. The data used are primary and secondary data. Primary data were obtained through direct or open interviews with beef cattle owners using questions prepared

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in the form of a questionnaire. Secondary data were obtained from government and non-government agencies.

The location was determined using a purposive method, considering that Langkat Regency is one of the centres for beef cattle development (Central Statistics Agency of Langkat Regency, 2024). The sampling technique was carried out using the Multistage Random Sampling Method, which is a combination of random sampling and proportionate sampling with varying sequences. The number of respondents was 80 beef cattle farmers.

Data Analysis

Data analysis was conducted using descriptive quantitative methods. The analysis measuring the influence of independent variables (X) on dependent variables (Y) used multiple linear regression analysis with the SPSS program (Mayulu et al., 2018).

The multiple linear regression model is

$$\mathbf{Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + \mu}$$

Data Analysis

$$Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + \mu \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where

Y= Farmer's profit (Indonesian Rupiah (IDR)/year)
a = constant
X1 = Feed cost (IDR/kg) (IDR/month)
X2 = Artificial insemination cost (AI) (IDR)
X3 = Labour costs (IDR/HKP)
X4 = Livestock sales (IDR)
X5 = Family dependents (persons)
X6 = Age of farmer (Years)
X7 = Length of time farming (years)
X5 = Ownership Scale (Livestock Units)
b = Regression coefficient of the independent variable
μ = Error (disturbance term)

RESULT AND DISCUSSION

Respondent characteristics consist of age, number of livestock owned, and length of time engaged in livestock farming. Based on Table 1, the age of farmers is dominated by the productive age group ranging from 31 to 60 years old, accounting for 98.75%, with only 1.25% above the age of 60. The number of beef cattle owned was 1 to 3 heads for 39 farmers (48.75%). The number of cattle owned was 4-6 heads for 30 farmers (37.5%). Cattle ownership was > 6 heads for 11 farmers (13.75%). The experience of raising beef cattle in Langkat Regency ranges from 1-10 years for 20 farmers (25%). The experience of raising cattle for 11-20 years is 51 farmers (63.75%). The experience of raising cattle for 21-30 years is 9 people (11.25%).

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Table 1. Characteristics of cattle farmers in Langkat District

Description	Number (people)	Percentage
Age (years)		
31-40	16	20
41-50	47	58.75
51-60	16	20
>60	1	1.25
Number of livestock owned (heads)		
1-3	39	48.75
4-6	30	37.5
>6	11	13.75
Years of cattle farming (years)		
1-10	20	25
11-20	51	63.75
21-30	9	11.25

Source: Primary data, 2025

Beef cattle farming

The beef cattle farming business includes feed costs, artificial insemination costs, and labour costs. Based on Table 2. Average production costs, revenue, and income of beef cattle farmers in Langkat Regency

Table 2. Beef Cattle Farming Business Analysis

Description	Average (IDR)	Percentage (%)
Production costs (A)		
Feed costs (IDR/month)	5,508,000	54.46
Artificial insemination cost (IDR/month)	447,500	4.43
Labor cost (IDR/month)	4,156,500	41.11
Total	10,112,000	100.00
Revenue (B)		
Cattle sales (IDR/month)	47,812,500	
Income (C)		
(A) - (B)	37,700,500	

Source: Processed primary data, 2025

Feed costs, AI costs, and labour costs are components of production costs in beef cattle farming in Langkat Regency. The largest proportion of production costs is spent on cattle feed at 54.46%, followed by labour costs at 41.11% and AI costs at only 4.43%. The high feed cost tends to

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be due to the quantity of feed required during the beef cattle rearing period, which is adjusted to the desired weight gain of the cattle until they are ready for sale.

Sugiarto et al. (2019) stated that the contribution of AI costs was small (only 2.8%) of the total cattle production costs, while the largest contribution was still for feed costs (60,2%) of the total production costs, stating that the contribution of AI costs was small (only 2.8%) of the total cattle production costs. while the largest contribution is still allocated to feed costs (60.2%) of total production costs (Haloho and Saragih, 2020). The reproductive aspect is important in beef cattle farming because farmers need to produce calves as the main output of their farming business. Total production costs amounted to IDR 10,112,000, revenue amounted to IDR 47,812,500, and farmer income amounted to IDR 37,700,500.

Factors Affecting Beef Cattle Farmers' Profits in Langkat District

The independent variables consist of feed costs, artificial insemination costs, labour costs, livestock sales, family dependents, age, length of time in farming, and livestock ownership. These independent variables are analysed using multiple linear regression analysis in relation to the dependent variable of farmer income. The determination of these variables is based on the assumption of causality of the aforementioned factors on farmer income. Before being analysed using multiple linear regression, the data were tested for classical assumptions, with the results shown in Table 3.

Table 3. Analysis of Classical Assumption Test Results for Livestock Businesses in Langkat Regency

Classical assumption test	Value	Description
Normality	Kolmogorov-Smirnov: 0.200 ($p > 0.05$)	Normally distributed
Multicollinearity	Tolerance >0.10 VIF < 10	Small effect of multicollinearity
Autocorrelation	Durbin-Watson 1.484 < 2	No autocorrelation
Heteroscedasticity	The scatterplot does not show any particular shape/pattern	No heteroscedasticity

Source: Processed primary data, 2025

The results of the classical assumption test in Table 3 show that the data meet the requirements, namely, normally distributed data, small multicollinearity effects, no autocorrelation, and no heteroscedasticity. The classical assumption test requirements have been met, and the data can now be tested using multiple linear regression (Sholihah et al., 2023). Multiple linear regression was performed to obtain the regression equation for farmer income. The variables tested in the multiple linear regression included farmer income (Y), feed costs (X1), artificial insemination costs (X2), labour costs (X3), cattle sales (X4), family dependents (X5), farmer age (X6), length of cattle farming (X7), and livestock ownership (X8). The results of the multiple linear regression test and the regression equation are presented in Table 4.

Table 4. Results of multiple linear regression analysis of beef cattle farming businesses

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Description	Coefficient	p-value
Constant (a)	15238485.93	
X1 (Feed Cost)	1.196	<.001**
X2 (AI cost)	2,461	0.031*
X3 (Labor costs)	-0.788	0.035*
X4 (Livestock sales)	0.002	0.374ns
X5 (Family dependents)	-559,631.067	0.094 ns
X6 (Age of farmer)	-86,991.847	0.047*
X7 (Length of cattle farming)	-15,404.063	0.779 ns
X8 (Livestock ownership)	453,626.343	0.191 ns
Coefficient of Determination (*Adjusted R-squared*)	0.792	
Calculated F	38.614	<.001**

Note: ** significance at the 1% level, * significance at the 5% level, ns = not significant p>0.05
Source: Processed primary data, 2025

The coefficient of determination as an indicator describing the independent variables in the regression model is reflected in the Adjusted R-square value, showing that the regression model is capable of predicting well (Chicco et al., 2021).An adjusted R-square value of 0.792 means that 79.2% of the cattle farmer income model can be explained by the variables of feed costs, AI costs, labour costs, livestock sales, family dependents, farmer age, length of cattle farming, and cattle ownership. A total of 20.8% is explained by other variables outside the model studied.

The next discussion is the simultaneous effect test to determine the combined effect of independent variables on the income of cattle farmers in Langkat Regency. The calculated F value of 38.614 ($p<0.01$) can be interpreted to mean that the variables of feed costs, artificial insemination costs, labour costs, livestock sales, family dependents, farmer age, length of time raising cattle, and cattle ownership have a significant simultaneous effect on the income of cattle farmers in Langkat Regency. Tey et al. (2015) explained in their research that livestock farming profits can be achieved by reducing operational costs through increasing business scale and efficiency, enhancing livestock production capacity, and obtaining higher livestock selling prices.

The results of the multiple linear regression analysis can be formulated into the following regression equation model.

$$Y = 15{,}238{,}485.93 + 1.196X_1 + 2.461X_2 - 0.788X_3 + 0.002X_4 - 559631.067X_5 - 86991.847X_6 - 15404.063X_7 + 453626.343X_8$$

Based on the analysis results, it is known that the coefficient values vary, with some variables having positive values and some having negative values. The feed cost variable (X1) has a coefficient of 1.196 ($p<0.01$), which means that every one rupiah increase in feed costs can increase the income of farmers in Langkat Regency, North Sumatra, by 1.196 rupiah, assuming that other variables remain constant. According to Jobirov et al. (2022),one way to increase beef cattle farmers' profits is to reduce feed costs and require government involvement in providing suitable pastures that are freely accessible to farmers. However, this study shows that increasing feed costs can increase farmers' profits, analogous to the fact that if feed costs increase in line with the amount of feed given, which

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is certainly more, as an effort to increase higher cattle weight gain, so that farmers can also obtain high sales results. As explained by Koknaroglu et al. (2005),the formula for profit per head is calculated as profit = (selling weight × feed price) − [(total weight gain cost × weight gain) + (fattening price × initial weight)]. The feed price is used as a "multiplier" for the selling weight of the cattle.

Beef cattle farmers focus on producing cattle with large weights because they will have high selling prices (Mohammed et al., 2013).In addition to increasing cattle weight, farmers also need to increase the number of cattle and select cattle breeds with high productivity (Achmad, et al., 2019).

Similarly, the artificial insemination/AI cost coefficient (X2) is 2.461 ($p<0.05$), which means that for every 1 rupiah increase in AI costs, the farmer's income increases by 2.461 rupiah, assuming other variables remain constant. According to Kalangia et al. (2016),several things can be done to increase the profitability of beef cattle farming, such as using AI, allowing farmers to optimally regulate the birth rate per cow, striving to obtain high selling prices for cattle, and conducting regular health checks on animals by paramedics.

Sirajuddin et al. (2018)explain that AI technology can increase livestock productivity and solve genetic quality issues at the farmer level, thereby increasing farmer income. In addition, farmers must have knowledge related to cattle estrus synchronisation and the timing of AI implementation to successfully implement AI (Rodgers et al., 2012),so that the AI costs incurred by farmers are not wasted.

In contrast to the previous variable, the coefficients for the labour cost variable (X3) and farmer age (X6) were -0.788 ($p<0.05$) and -86991.847 ($p<0.05$), indicating a negative causal effect on farmer income in Langkat Regency. These results show that every increase in labour costs of one rupiah reduces the farmer's income by 0.788 rupiah, and every increase in the farmer's age by one year reduces the farmer's income by 86,991.847 rupiah in Langkat Regency.

Several farmers in Langkat Regency employ relatives or family members in their beef cattle farming businesses, but labour costs are still calculated based on wage rates, even though the workers are family members (Ervina et al., 2019). In the study by Roessali et al. (2011), it is explained that farmers invite family members to participate in the farming business because family members play an important role in helping farmers make decisions to increase the scale of their business. Beef cattle farmers in Langkat Regency are accustomed to involving family labour in the form of unwritten cooperation, whereby the beef cattle farming business is the responsibility of all family members. This is because the profits from the farming business are enjoyed by all family members. Jobirov et al. (2022) added that the number of family members involved is also a factor affecting farmers' profits.

Apart from labour costs, it turns out that the age of the farmer also affects the income of cattle farmers in Langkat Regency. The age of the farmer has a significant negative relationship with a decline in income, indicating that, indirectly, older people or those above the age of 55 tend to have lower productivity (Apipoonyanon et.al., 2021), thus hindering their ability to earn money. The obstacles experienced by farmers in the age group above 55 years old can include declining health, weakened physical strength, limited access, and declining perception (Gunawan et al., 2019). The most productive age group in the agricultural sector ranges from 35 to 44 years old (Tauer, 2019).. Age, however, does not fully account for farmers' economic performance. Martin-Collado et al.

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(2021) reported that differences in farmers' attributes and their perceptions of attitudes toward innovation uptake do not depend solely on age but also correlate significantly with education level. Education of farmers. Farmers with higher levels of education are likely to adopt technical and breeding innovations more quickly, which could help offset age-related productivity limitations

The results of the analysis also reveal that the livestock sales (X4), family dependents (X5), length of cattle farming (X7), and livestock ownership (X8) have no statistically significant relationship with farmers' profits (Y), given that their corresponding coefficients are not significantly different from zero at 5% level of significance. These variables accordingly seem to have only a negligible effect on the variation in profit among the observed cattle farming systems.

The non-significance of livestock sales (X4) indicates that profitability is not only production-volume-based but also cost-efficient and price-marginal, driven by feed costs and animal health services (Jobirov et al., 2022). Also, the number of family dependents does not significantly influence profit levels, implying that household economic support is not reflected in financial performance at the farm level. This can be attributed to the diversification of income among rural households, which supplements family expenses (Setiadi et al., 2012).

Moreover, the non-significant relationship between farming experience suggests that more years of raising cattle may not necessarily lead to higher profitability, provided that traditional management is still used and technological use is low (Haloho et al., 2024). Similarly, the number of livestock owned does not significantly affect profit; that is, larger herd sizes do not necessarily yield better financial results when management practices and input use are less efficient (Ekowati et al., 2018).

The results suggest that policy interventions targeting either an increase in herd size or farming experience are unlikely to lead to significant increases in profitability. Instead, strategies of development should focus on increasing input use efficiency and cost control by promoting the suitable production technology being used for cattle farming enterprises' economy.

CONCLUSION AND SUGGESTION

Based on the analysis of production factors affecting farmers' profits in Langkat Regency, it can be concluded that feed costs account for 54.46%, labour costs 41.11%, and artificial insemination (AI) costs 4.43% of the total production costs of beef cattle farming in Langkat Regency. The factors influencing the profits of beef cattle farmers in Langkat Regency include feed costs, artificial insemination costs, labour costs, and farmers' age. These findings have important policy implications for improving the profitability and sustainability of smallholder beef cattle farming. First, because feed costs account for the largest share of total production costs and significantly affect profits, policies should prioritize feed efficiency and cost-reduction strategies. This may include promoting locally available feed resources, improving forage production systems, encouraging feed conservation technologies (such as silage and hay making), and supporting farmer access to affordable concentrate feeds through cooperatives or input subsidies.

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