HEURISTIC
Vol. 22, No. 1, April 2025

ISSN(p) 1693-8232
ISSN(e) 2723-1585

Engineering Livestock Feed for Goat Fattening to Increase Farmer Profit and Sustainable Supply Chain

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Article history:
Received: 17 June 2025
Accepted: 19 June 2025
Published: 10 July 2025

Keywords:
Efficiency;
Farmer Profitability;
Feed Innovation;
Goat Productivity;
Sustainability

ABSTRACT

The demand for goat meat continues to increase annually, both for daily consumption and religious events such as Aqiqah and Qurban. However, production has not kept up with demand due to the limitations of goat growth and fattening processes, mainly caused by dependence on green feed which relies on land availability and weather conditions. This supply-demand imbalance often results in the slaughter of young goats. Factors contributing to this gap include the continued reliance on forage and concentrate-based feeds, which are not only costly but also slow in promoting meat growth and reproductive cycles. Feed innovation is introduced to support sustainable goat farming systems. The innovation involves providing dry feed without forage, using a fermentation process of liquid nutrients mixed with ground corn cobs and added concentrate. Dry feed helps reduce operational costs by eliminating the need for forage collection. It also simplifies the fattening and care process, increases meat productivity, and ultimately enhances farmers' social welfare through greater profits. The study applied dry feed to 30 goats using a dynamic simulation model to evaluate growth and income, contributing to food security. Dry feed increased monthly weight gain to 3 kg from the previous 2 kg using green feed and concentrate. It yielded a net profit of IDR 104,600 per goat/month, compared to IDR 55,000. When applied to 30 goats, farmer profits increased from IDR 1,650,000 to IDR 3,138,000/month. The results show that dry feed significantly increases farmer income, encouraging more goat farming activities and strengthening food security in the goat meat sector.

INTRODUCTION

Protein is an essential nutrient required by humans to support growth and maintain optimal body functions. Most people obtain their protein from eggs, beef, and chicken, as these sources are familiar and widely accessible. However, there are other alternatives that are equally beneficial for health, such as goat and lamb meat. In addition to being rich in protein, goat and lamb meat contain lower levels of saturated fat compared to beef (Devendra & Liang, 2012; Babiker et al., 1990). As such, goat and lamb meat offer healthier dietary options for consumers. Incorporating goat meat into daily consumption can also add diversity to the protein sources in the community's diet while fulfilling nutritional needs. The consumption of goat meat also contributes to dietary variety while continuing to meet the community's protein requirements. The production of goat meat has consistently shown an upward trend in the market each year.

Several factors have driven this increased demand, including a strong consumer preference for goat meat, which is commonly featured in a variety of traditional dishes such as satay and curry, as well as its role in religious and cultural ceremonies (Wibowo et al., 2021; Kurniawan et al., 2024).

Indonesia, with its large Muslim population, has a high demand for goat and sheep livestock, primarily driven by religious practices such as Aqiqah and Qurban. Aqiqah is a recommended Islamic tradition involving the slaughter of a goat as an expression of gratitude for the birth of a child, resulting in consistent year-round demand. Meanwhile, during Eid al-Adha, the demand for goats rises significantly due to Qurban, a ritual sacrifice encouraged for financially capable Muslims. This surge in demand creates a major opportunity for goat farmers and meat industry players in Indonesia Market demand for goat and lamb meat continues to rise, both for daily consumption and religious purposes like Aqiqah and Qurban (Wibowo et al., 2021). Generally, the ideal slaughter age for goats is around 1.8 years, at which point meat quality is considered optimal. However, the current population growth of goats is insufficient to meet market demand, resulting in an imbalance between supply and demand and leading to price increases (Maesya & Rusdiana, 2018).

At present, many goat farmers still rely heavily on green forage such as grasses for the fattening process. However, obtaining sufficient forage is challenging due to limited land availability, as this type of feed requires expansive areas for cultivation (Maesya & Rusdiana, 2018). In addition, forage supply is weather-dependent, making its availability unstable throughout the year. With this conventional fattening method, it is also difficult for goats to reach their ideal weight gain target of 3 kg per month. This leads to increased production costs, while selling prices do not always cover these expenses. Therefore, an alternative feeding strategy is needed to accelerate goat growth and reduce dependence on green forage (Wahid et al., 2024). High-nutrient feed is proven to be effective in significantly increasing livestock weight (Siregar & Ilyas, 2018; Nugroho et al., 2023). A sustainable livestock system requires strategies that enhance both farmer profitability and feed efficiency. Regeneration efforts must be supported by proper production management to ensure year-round availability of goat meat. Furthermore, the adoption of alternative feed technologies with high nutritional value can accelerate growth and reduce high production costs. Nutrient-rich feed supports optimal livestock performance (Siregar & Ilyas, 2018). A sustainable livestock system requires strategies that enhance farmer profitability and improve feed efficiency. Regeneration must be supported by effective production management to ensure a continuous supply of goat meat throughout the year. Additionally, the use of alternative feed technologies with high nutritional value can accelerate livestock growth while reducing high production costs. Nutrient-dense feed plays a vital role in supporting optimal livestock performance (Siregar & Ilyas, 2018). Furthermore, input-output efficiency in livestock production serves as an important indicator of economic success for small-scale farmers (Daryanto, 2013). A sustainable livestock system must deliver stable profits for farmers, whether operating at a micro or macro scale. With the implementation of these strategies, goat farming can sustainably meet market demand while providing long-term economic benefits to the farmers. A system dynamics approach can be used to account for various stages of production and simulate the expected outcomes (Ramadhan et al., 2024; Khirzin et al., 2023).

MATERIALS AND METHODS

This study was designed to evaluate the effectiveness of alternative feed in improving the productivity and profitability of goat farming in a sustainable manner. The research began with a literature review and preliminary surveys to identify common challenges faced by farmers in the goat fattening process and to determine potential alternative feed ingredients. The feed formulation was then tested experimentally on livestock to assess its impact on goat growth and health. The resulting data were analyzed from both economic and sustainability perspectives, including evaluation of production costs and the profitability of goat farming using alternative feed. The experimental research on seasonal crop-based feed optimization was conducted in Minggirsari Village, Kanigoro District, Blitar. A system dynamics approach was employed to simulate various scenarios of goat feed usage aimed at increasing farmer profit. This method was used to analyze the impact of system complexity on farm outcomes. A total of 30 goats were used as the sample to examine the effectiveness of dry feed. The research stages included designing a dry feed innovation using a nutritional formulation composed of finely ground corn cobs, goat pellets, and water; simulating the system dynamics of feed use to increase farmer profitability. The scenario development involved creating a causal loop diagram, stock and flow diagram, model verification and validation, and final scenario construction (Ramadhan et al., 2024). The development of feed technologies, such as fermentation-based approaches, has shown significant improvements in livestock nutrition and productivity (Junaidi & Widiantoro, 2024; Khaeri et al., 2023).

RESULTS AND DISCUSSIONS

Results

1. Causal Loop Diagram

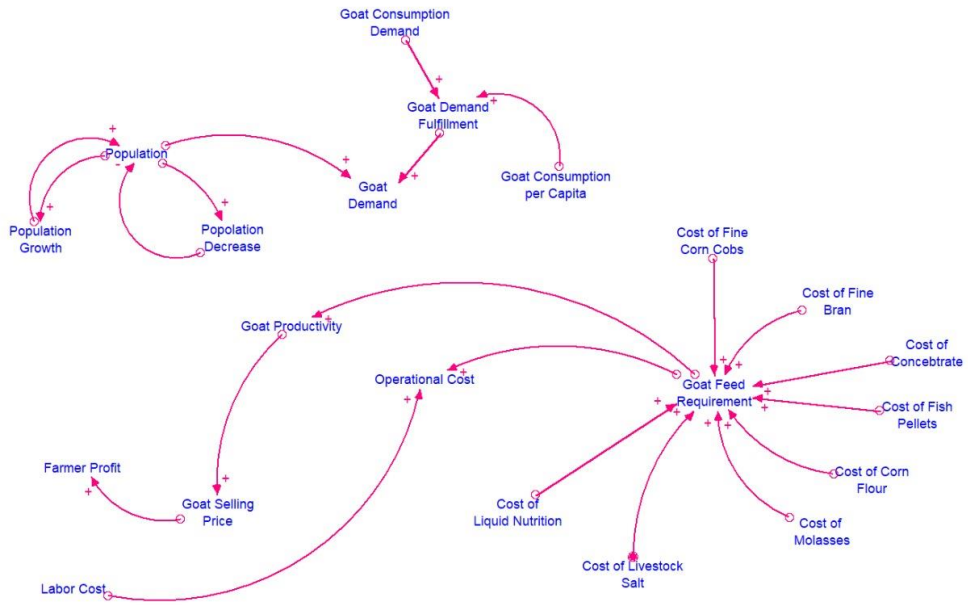

Figure 1 Causal Loop Diagram

2. Stock and Flow Diagram

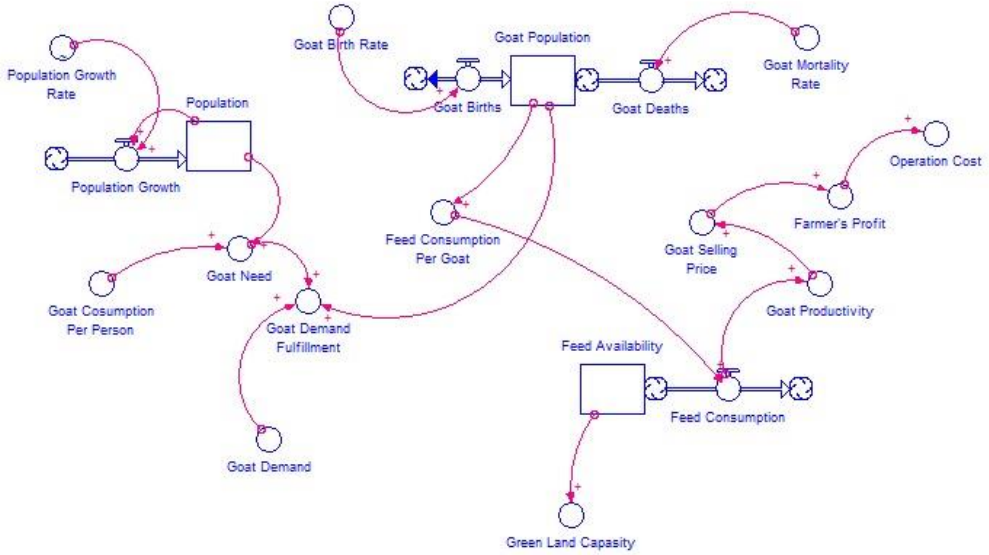

Figure 2 Stock and Flow Diagram

3. Verification and Validation

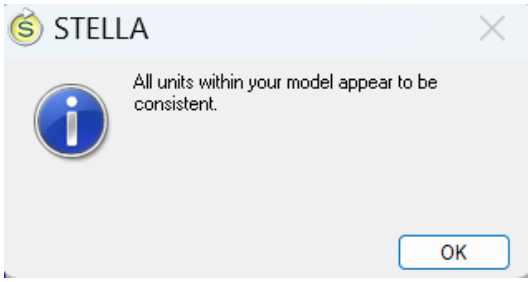

Figure 3 Structural Validation

Validation was carried out using two approaches: the mean comparison test (% mean comparison) and the amplitude variation comparison test (% error variance). A model is considered valid under the mean comparison test if the resulting error value (E1) is less than or equal to 5%. Likewise, under the error variance test, the model is deemed valid if the error value (E2) is less than or equal to 30%.

1. Mean Comparison Test

$$E_1 = \left|\frac{\bar{S}-\bar{A}}{\bar{A}}\right| \quad (1)$$

Notes:

$\bar{S}$ = Average Value of Simulation Results

$\bar{A}$ = Average Value of Actual Data

2. Amplitude Variation Comparison Test

$$E_2 = \left|\frac{S_s - S_a}{S_a}\right| \quad (2)$$

Notes:

S_s = Standard Deviation of the Model

S_a = Standard Deviation of Actual Data

Table 1 Behavior Validity Test

No	Variabel	E1 (% mean comparison)	E2 (% error variance)
1	Population	0.37%	2.34%
2	Goat Livestock Population	0.28%	0.71%
3	Feed Availability	0.25%	0.19%

The E1 values for population, goat livestock population, and feed availability indicate that the model is valid, as E1 ≤ 5% and E2 ≤ 30%. Therefore, the model can be used for scenario development.

4. Scenario Development

Scenario development involves replacing green forage with dry feed, which can increase goat weight and improve farmer profitability.

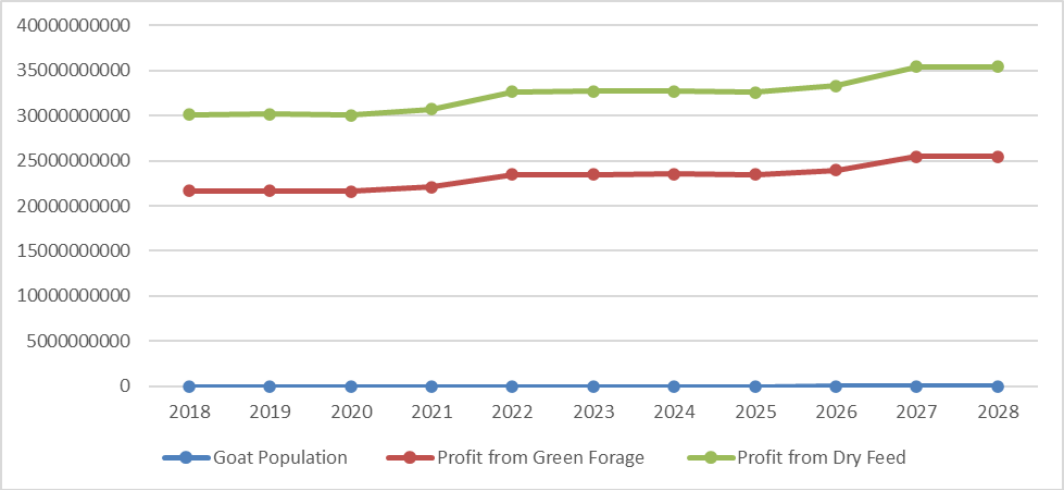

Figure 1. Comparison Between Profit from Green Forage Feed and Dry Feed Scenario

Discussions

Table 2. Price Variance for Goat Green Forage Feed per Month

Feed Ingredient	Quantity (kg)	Price per Kg (IDR)	Subtotal (IDR)
Dried/Fermented Grass	15 kg	1.000	15.000
Fine Bran	10 kg	2.000	20.000
Commercial Concentrate	7,5 kg	4.000	30.000
Total Cost			65.000

Table 3. Price Variance for Goat Dry Feed per Month

Feed Ingredient	Quantity (kg/liter)	Price per Kg/L (IDR)	Subtotal (Rp)
Finely Ground Corncob	11 kg	2.000	22.000
Fine Bran	11 kg	2.000	22.000
Commercial Concentrate	6 kg	4.000	24.000
Livestock Mineral Salt	0,5 kg	5.000	2.500
Liquid Nutrients (Vitamins & Minerals)	0,5 liter	5.000	2.500
Molasses (optional)	0,2 liter	2.000	400
Total Cost			75.400

Table 4. Farmer Profit per Month

Description	Dry Feed	Green Forage
Weight Gain	3 kg	2 kg
Revenue	3 × 60.000 = Rp180.000	2 × 60.000 = Rp120.000
Production Cost	Rp75.400	Rp65.000
Net Monthly Profit per Goat	180.000 – 75.400 = Rp104.600	120.000 – 65.000 = Rp55.000
Profit for 30 Goats	Rp104.600 x 30 = Rp3.138.000	Rp55.000 x 30 = Rp1.650.000

The table above presents a comparison of farmer profits when using dry feed versus green forage. Farmers who utilize dry feed achieve higher profits than those relying on green forage. The profit per goat using green forage is IDR 55,000, while using dry feed yields a profit of IDR 104,600. Therefore, when applied to 30 goats, the total profit earned by farmers using dry feed amounts to IDR 3,138,000.

CONCLUSION

Based on the data analysis conducted, it can be concluded that the use of dry feed serves as an effective alternative solution for improving goat fattening and reducing feed costs. The results of the system dynamics scenario—shifting from green forage to dry feed—show that monthly weight gain per goat increased from 1 kg to 3 kg. This weight gain improvement is also accompanied by more affordable feed costs for farmers. Farmer profit rose from IDR 55,000 to IDR 104,600 per goat. Consequently, with 30 goats, total profit increased from IDR 1,650,000 to IDR 3,138,000. Therefore, the implementation of dry feed has a positive impact on farmers and contributes to strengthening goat meat food security in meeting consumer demand.

ACKNOWLEDGMENT

We would like to express our sincere gratitude to the individuals and institutions that supported the completion of this research. Special thanks to the Department of Industrial Engineering, Faculty of Engineering, 17 Agustus 1945 Surabaya University for their invaluable guidance and resources. Our heartfelt thanks go to all the farmers in Minggirsari Village, Kanigoro District, Blitar, for their cooperation and participation in the research, which made this project possible.

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