

Elasticity of Dairy Cow Milk Production in Pacet, Mojokerto District

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ABSTRACT

Milk production plays a strategic role in supporting food security and reducing Indonesia's dependence on imported dairy products. However, milk productivity among smallholder dairy farmers remains highly variable due to differences in the use of production inputs. This study aimed to analyze the factors affecting dairy milk production and to evaluate the production elasticity of dairy farming in Pacet District, Mojokerto Regency. The research was conducted at Dana Mulya Cooperative, involving 35 dairy farmers selected through simple random sampling. Primary data were collected through structured interviews, field observations, and documentation. The relationship between milk production and production factors was analyzed using a Cobb–Douglas production function estimated through multiple linear regression. The independent variables consisted of forage feed, concentrate feed, and labor, while milk production served as the dependent variable. Classical assumption tests, including normality, multicollinearity, and heteroscedasticity tests, were performed prior to regression analysis.

Keywords: Dairy Cattle, Milk Production, Production Elasticity, Cobb–Douglas Production Function, Dairy Farming, Pacet.

INTRODUCTION

The livestock sector is an important subsector in Indonesia's agricultural development because of its role in providing nutritious food, particularly animal-based protein. One of the livestock commodities with high economic value and increasing demand is dairy milk. Milk contains protein, fat, vitamins, and minerals that are essential for human nutrition. Therefore, increasing domestic milk production has become an important effort to reduce Indonesia's dependence on imported dairy products (Nugraha et al., 2024).

Indonesia still faces major challenges in meeting national milk consumption needs. National milk consumption continues to increase, while domestic milk production is only able to meet around 20-25% of national demand (BPS, 2023). The remaining demand is fulfilled through imports of dairy raw materials, mainly from countries such as New Zealand, Australia, and the United States. This condition indicates that the development of dairy farming still has broad opportunities, especially in areas with suitable environmental conditions, such as highland regions.

One area with considerable potential for dairy farming development in East Java is Pacet District, Mojokerto Regency. Pacet is located in a highland area at an altitude of approximately 700-1,200 meters above sea level, with relatively cool temperatures ranging from 18°C to 25°C and sufficient rainfall. These agroclimatic conditions are suitable for dairy cattle because dairy cows require a cool environment to support optimal milk production. In addition, the availability of forage in Pacet provides an important supporting factor for dairy farming activities.

Despite this potential, milk production among dairy farmers in Pacet remains varied and tends to fluctuate between farmers. Some farmers are able to achieve relatively high milk production, while others experience lower productivity. This variation indicates differences in production factors, including technical, managerial, and environmental aspects. In Pacet, most dairy farmers are members of dairy cooperatives that play an important role in collecting milk,



providing concentrate feed, and supporting livestock health services. However, the adoption of technology and efficient farm management practices remains uneven. Many farmers still apply conventional methods and have not optimized feed provision according to livestock nutritional requirements, which may reduce milk productivity.

In addition to feed and technical management, labor also contributes to milk production. Farmers with higher levels of education and longer farming experience generally have better knowledge of dairy cattle management, including feeding practices, barn sanitation, and disease control. In contrast, farmers with limited knowledge and capital often face difficulties in increasing production, even when they have a similar number of dairy cows. Therefore, understanding the influence of production factors on milk output is necessary to support the formulation of productivity improvement strategies at the farmer level.

Milk production is closely related to farmers' income and welfare. Higher daily milk output can increase farmers' earnings and improve the sustainability of dairy farming businesses. However, this requires efficient and data-based farm management. An analysis of the factors affecting dairy milk production can help identify the dominant variables influencing productivity. The results can provide useful information for local governments, cooperatives, and related institutions in designing extension programs, improving production capacity, and strengthening the competitiveness of local dairy products.

Academically, this study contributes to the literature on production factors in the dairy farming subsector, particularly in tropical highland areas of Indonesia. Practically, the findings can serve as evaluation material and policy recommendations for Dana Mulya Cooperative and relevant stakeholders in improving the efficiency of dairy farming. Based on this background, this study on the production elasticity of dairy milk in Pacet District, Mojokerto Regency, is important to determine the main factors affecting milk production and to support sustainable improvement in dairy cattle productivity and farmer welfare.

RESEARCH METHODS

This study was conducted in Pacet District, Mojokerto Regency, East Java, Indonesia, one of the main dairy farming centers in the region. The study area was purposively selected because Pacet has a relatively large dairy cattle population and is supported by an active dairy cooperative, namely Dana Mulya Cooperative, which plays an important role in milk collection, feed supply, and livestock management. The research was carried out in November 2025, covering the preliminary survey, field data collection, data processing, and statistical analysis.

The target population consisted of all dairy farmers registered with dairy cooperatives or farmer groups in Pacet District. According to data from Dinas Peternakan Provinsi Jawa Timur (2024), there were approximately 221 active dairy farmers in the study area. A total of 35 farmers were selected as research respondents using a simple random sampling technique. This sample size was considered adequate because the population exhibited relatively homogeneous characteristics in terms of dairy farming practices, including feeding systems, concentrate feed supplied by the cooperative, and labor utilization, which was predominantly family-based. The application of simple random sampling ensured that each farmer had an equal opportunity to be selected, thereby reducing sampling bias and improving the representativeness of the sample.

Primary data were collected directly from respondents through structured interviews using questionnaires and field observations. The interviews gathered quantitative information regarding milk production, forage utilization, concentrate feeding, and labor input, while observations were conducted to verify farm conditions, feeding practices, and milking activities. Secondary data were obtained from the Mojokerto Regency Livestock Service, Dana Mulya Cooperative, and other relevant institutional reports to complement the primary data.

The study employed a quantitative analytical approach using multiple linear regression based on the Cobb–Douglas production function to estimate the effects of production inputs on dairy milk production. Milk production (Y), measured in liters per cow per day, was specified as the dependent variable. The independent variables included forage feed (X_1), measured as kilograms per cow per day; concentrate feed (X_2), measured as kilograms per cow per day; and labor input (X_3), measured in man-days (HOK) per day.

RESULTS AND DISCUSSIONS

This study involved 35 dairy farmers affiliated with Koperasi Dana Mulya in Pacet Subdistrict, Mojokerto Regency, selected to represent the relatively homogeneous population of 221 registered cooperative farmers in the area. In terms of educational background, the respondents were predominantly primary-school graduates, accounting for 15 farmers or 42.86 percent of the sample. Junior secondary school graduates made up the second-largest group, comprising 10 farmers or 28.57 percent, while senior secondary school graduates accounted for 8 farmers, or 22.86 percent. Only two farmers, or 5.71 percent, had received no formal education at all. This distribution indicates that dairy farming in Pacet remains dominated by individuals with basic levels of formal schooling, a pattern that helps explain the largely traditional, experience-based management style observed throughout the research area, including reliance on inherited knowledge for feed dosing rather than standardized nutritional formulation.

The finding that green fodder stands out as the dominant and only statistically significant input, with an elasticity of 0.934, is consistent with earlier research by Munthe (2019), who similarly reported a positive and significant effect of fodder on milk production among smallholder dairy farmers in Karo Regency. This result also aligns closely with the physiological literature on ruminant nutrition, particularly the work of Sutardi (1997) and Hartadi et al. (2005), both of which emphasize the central role of forage in maintaining stable rumen function and consistent milk synthesis. A plausible explanation for the strength of this relationship in Pacet lies in the subdistrict's agroclimatic conditions: situated between 700 and 1,200 meters above sea level with relatively high and evenly distributed rainfall, the area naturally supports an abundant and low-cost supply of green fodder such as napier grass, field grass, and various legumes. Because this input is both locally available and comparatively inexpensive, farmers appear able to translate even modest increases in fodder quantity directly into higher milk output, giving green fodder an outsized role in the local production function.

This result diverges, however, from several other studies conducted in different regions of Indonesia. Rasyid et al. (2020) and Fitriani (2018), for instance, both identified concentrate feed as the input with the highest production elasticity in their respective study areas. A reasonable explanation for this divergence is that concentrate in Pacet is distributed relatively uniformly by the cooperative at a fixed price of approximately four hundred thousand rupiah per fifty-kilogram sack, and is subsequently administered by farmers in modest, cost-conscious quantities based on informal experience rather than calculated nutritional requirements. Because most farmers therefore use concentrate within a fairly narrow and similar range, there may simply be insufficient variation in the sample to statistically detect its true marginal contribution to output, even though its theoretical importance for supplying readily digestible energy is well established in the literature on ruminant nutrition, including the work of Ranjhan (2001) and Anggraeni (2012).

The negative and statistically insignificant elasticity found for labor likewise contrasts with prior research. Adinegoro et al. (2017) identified labor as the single most influential factor affecting milk production among farmers in Bogor, while Soeyatno & Sucayono (2025) reported a similarly important labor effect in Pujon. In Pacet, however, the family-based labor structure typical of smallholder operations, in which most farms are managed by household members rather than hired workers, may mean that additional labor beyond a certain threshold does not translate

into measurable gains in output. Given that herd sizes in the study area generally range from only two to nineteen animals per household, it is plausible that the labor requirements of such small-scale operations are already adequately met by existing household members, so that any further increase in labor input yields diminishing or even negligible returns, a pattern broadly consistent with the third stage of the classical production curve described by Soekartawi (2016).

The near-constant returns to scale identified in this study, with the summed elasticities equal to approximately 1.0, are consistent with the findings of Hadiana et al. (2019) in Pangalengan and Ardiansyah et al. (2024) in the KPBS Pangalengan working area, both of which also reported constant returns to scale among cooperative-affiliated dairy smallholders. This result stands in contrast to Sundawati et al. (2023), whose study in Sukabumi identified increasing returns to scale, with a combined elasticity value of 1.172. Taken together, this pattern suggests that dairy production systems organized around smallholder cooperatives in Indonesia tend to cluster around constant returns to scale, whereas increasing returns appear more likely to emerge in settings where technology adoption and formalized input management are more advanced than what is currently practiced in Pacet.

Taken as a whole, these findings suggest that the most effective short-run strategy for improving milk production among dairy farmers in Pacet Subdistrict would be to prioritize increasing the quantity and quality of green fodder provided to their herds, given its demonstrated statistical significance and its high responsiveness relative to the other inputs studied. At the same time, concentrate feed and labor allocation should not be dismissed outright, but rather re-evaluated from the standpoint of cost efficiency: because neither input currently demonstrates a statistically significant contribution to output under existing management practices, resources currently devoted to these inputs may be better optimized through improved feeding formulation and more strategic labor scheduling, rather than through simple increases in quantity.

CONCLUSIONS

This study examined the effects of forage feed, concentrate feed, and labor on dairy milk production in Pacet District, Mojokerto Regency, using the Cobb-Douglas production function. The results demonstrated that forage feed was the only production factor with a positive and statistically significant effect on milk production, with an elasticity coefficient of 0.934 ($p < 0.001$). This finding indicates that increasing the quantity and quality of forage feed is the most effective strategy for improving dairy milk production among smallholder farmers in the study area. In contrast, concentrate feed and labor showed positive and negative elasticity coefficients of 0.127 and -0.062, respectively, but neither variable had a statistically significant effect on milk production.

The estimated production elasticities further indicate that forage feed is the most responsive production input, while concentrate feed and labor contribute relatively little to production under the existing farm management conditions. These findings suggest that improving forage management, including feed availability, quality, and feeding practices, should be prioritized to enhance milk productivity. Although concentrate feed and labor were not significant determinants in this study, their technical and economic efficiency should continue to be evaluated because better management of these inputs may indirectly improve production performance and the overall sustainability of dairy farming.

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