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Milk production performance of dairy cattle in selected backyard dairy farms in Bukidnon, Philippines

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Abstract
Aim: This study aimed to describe the milk production performance of dairy cattle in selected backyard dairy farms in Bukidnon, Philippines.
Methodology: A descriptive research design was employed using secondary data from farm milk production records collected from June to October 2025. Farms were selected through purposive sampling based on the presence of at least two lactating cows and the availability of consistent data. Milk yield (L/cow/day) was analyzed using mean, minimum, maximum, and standard deviation.
Results: The findings revealed significant variation in milk production among farms, with Farm B recording the highest average yield (10.38 L/cow/day), while Farms A and C had lower yields (6.15 and 6.67 L/cow/day). The overall mean milk yield was 8.12 L/cow/day, with a range of 4.80–11.06 L/cow/day and a standard deviation of 2.10, indicating variability in production performance.
Conclusion: The results indicate inconsistencies in feeding and management practices across farms. Improving and standardizing dairy management practices can enhance productivity, strengthen smallholder dairy systems, and contribute to food security and sustainable agricultural development in rural communities.
Keywords: *milk yield, dairy cattle, backyard farming, smallholder dairy systems, food security*

INTRODUCTION

Milk production plays a vital role in global agriculture, contributing significantly to food security, human nutrition, and rural livelihoods. In many developing countries, dairy farming—particularly in smallholder systems—serves as an important source of income and sustenance for rural communities. However, productivity in these systems is often constrained by limited resources, inconsistent feeding practices, and variations in farm management (Duguma, 2022). These limitations result in low milk production and high variability, reducing the efficiency and sustainability of small-scale dairy operations.

In addition, climate change poses increasing challenges to dairy production systems worldwide. Rising temperatures, heat stress, and fluctuating feed availability negatively affect animal performance, milk yield, and overall farm productivity. These challenges highlight the importance of climate adaptation strategies and improved environmental management practices to ensure sustainable and resilient dairy production systems. Such concerns are particularly critical in tropical regions, where smallholder farms are highly vulnerable to environmental stressors and resource limitations.

In the Philippines, the dairy industry is largely composed of smallholder farmers and remains characterized by low productivity and heavy dependence on imported milk (Turaja et al., 2024). In Bukidnon, backyard dairy farms provide livelihood opportunities to rural households; however, milk production is often inconsistent due to differences in feeding practices, resource availability, and farm management strategies. These variations contribute to uneven production performance among dairy cattle and limit the overall efficiency of the local dairy sector.

Milk production performance can be evaluated using key indicators such as average daily milk yield, minimum and maximum values, and standard deviation, which describe both productivity and variability. Despite the importance of these indicators, there is limited farm-level information in the Philippines—particularly in Bukidnon—that systematically

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utilizes these basic statistical measures to characterize milk production. Most available studies focus on regional or cooperative-level data, with insufficient attention given to variability among individual farms and animals. This lack of localized, farm-specific data impedes a clear understanding of production patterns in smallholder dairy systems. Therefore, this study aims to describe the milk production performance of dairy cattle in selected backyard dairy farms in Bukidnon by determining average daily milk yield, identifying the production range and measuring variability. The findings provide baseline farm-level information that can support extension services, guide management improvements, and inform policy and development programs aimed at enhancing productivity, sustainability, and resilience in smallholder dairy systems. These results are particularly relevant to farmers and dairy cooperatives, as they offer practical insights for improving feeding practices and reducing milk production variability. Although the study employs a descriptive approach, its contribution lies in providing localized evidence on milk production variability, which is essential for designing targeted interventions in smallholder dairy systems.

Review of Related Literature and Studies

This review covers related studies on milk production performance of dairy cattle in backyard farming systems. It focuses on factors affecting milk yield, such as feeding practices, particularly Total Mixed Ration (TMR), forage quality, and management practices. It also highlights the use of statistical measures, such as the mean, range, and standard deviation, to evaluate milk production and variability. Additionally, the review discusses common challenges in small-scale dairy farming and emphasizes the importance of proper nutrition and management in improving milk yield and consistency.

Global Perspective on Dairy Production

Multiple factors, including nutrition, health, genetics, and environmental conditions, influence milk production in dairy cattle. Studies in smallholder dairy systems show that limited access to quality feed, poor animal health management, and lack of technology significantly reduce milk yield and overall productivity. For example, a study of Hailemariam et al. (2022) conducted in Ethiopia found that smallholder dairy farms commonly face problems such as poor animal condition, inadequate water supply, and limited housing facilities, which negatively affect milk production performance. Environmental factors also play a critical role in global dairy production(Mehta et al., 2024). Heat stress, for instance, has been shown to reduce milk yield by up to 10% in dairy cattle, with effects lasting several days after exposure. This highlights the vulnerability of dairy systems to climate change and environmental stressors, especially in tropical regions. In addition, global studies emphasize the importance of proper nutrition and feeding systems in improving milk yield. However, in many smallholder systems, feeding practices are inconsistent and depend on locally available feed resources, leading to production variability.

Dairy Farming in the Philippines

According to Turaja et al. (2024), the Philippine dairy sector is an emerging industry primarily driven by smallholder farmers who face significant obstacles, including low local milk yields, limited adoption of advanced technology, inadequate infrastructure, and insufficient government support. With local output covering only about 1% of requirements, the Philippine dairy sector is heavily dependent on imports, placing immense pressure on smallholder farmers who, despite their key role, are hindered by these limitations (Turaja et al., 2024). Small-scale producers in the country often face significant productivity challenges due to insufficient financial backing and limited access to modern, environmentally sustainable technologies. Taer & Taer (2025) suggest that the promising shift toward IoT-driven livestock management is largely restricted by inadequate technological connectivity, limited digital literacy among practitioners, and weak policy incentives. Smallholder dairy buffalo farmers in the Philippines often operate with sub-optimal technical and economic efficiency. Technology transfer hurdles, such as funding limitations, poor coordination, and policy mismatches, exacerbate these challenges. Strengthening extension services and adopting best management practices are essential to improve performance and productivity. Casauay (2021) found that the efficiency of dairy farming is hindered by structural limitations—specifically, land scarcity, limited technical capacity, and limited access to technology— leading to lower forage quality and decreased milk production. According to Aquino et al. (2024), improving the competitiveness and sustainability of livestock systems involves a multifaceted approach: upgrading animal genetics, enhancing feed quality through localized forage production and balanced nutrition, improving farm management techniques, investing in infrastructure, and strengthening government policy support. Valiente et al. (2025) highlight the critical role of tailored extension services and training in enhancing manure handling and waste management, key factors in achieving sustainable agricultural productivity. Based on findings from Oca et al. (2025), a Geographic Information System (GIS) analysis indicates that for dairy buffalo production to be efficient,

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selecting a suitable site is essential, with proximity to water sources, markets, and road networks being the most critical factors.

Milk Production in Backyard Dairy Farms

Various socio-economic, managerial, and environmental factors influence milk production in small-scale and backyard dairy setups. Studies indicate that limited feed supplies, low-yielding breed types, and small herd sizes primarily constrain productivity in these systems. Consequently, farmers often depend on natural pastures and agricultural by-products (crop residues) to feed their livestock (Hailemariam et al., 2022). According to Mitu (2023), milk production increases significantly when farmers receive training and education, which improves their management skills, while access to financial credit enables them to acquire more milking cows, further boosting output. Crossbreeding dairy cows, particularly involving Holstein and Jersey breeds, has been shown to improve milk yield and overall productivity compared to purebreds. For example, Holstein × Jersey first-cross cows produced more milk solids than the mid-parent average. They exhibited better reproductive traits, including younger age at first calving and shorter calving intervals. A 2020 study by Kargo et al. confirmed that crossing Danish Holstein, Red, and Jersey breeds generates strong heterosis, significantly boosting milk, fat, and protein yields in first-lactation cows. These breeds indicate that systematic three-way crossing enhances production efficiency in dairy cattle.

Crossbred cows offer advantages in low-input dairy farming, such as better feed efficiency and shorter calving intervals, while maintaining good health and fertility. However, to fully capitalize on their higher production potential, these animals require superior nutrition and improved management. (Ormston et al., 2022). Production levels suggest that integrated approaches addressing both technical and socio-economic constraints are essential for improving backyard dairy farm productivity.

Milk Production in Dairy Cattle

Milk yield in dairy cattle is influenced by both genetic and environmental factors, with heritability estimates around 25-35%, indicating that a significant portion of variation is due to management, nutrition, health, and environmental conditions (Gargiulo et al., 2025). Genetic selection has greatly increased milk production over recent decades, but intensive selection for high yield has also reduced genetic diversity and negatively affected fertility, health, and environmental resilience (Brito et al., 2021). Environmental factors such as temperature, humidity, and heat stress notably affect milk yield dynamics, with primiparous cows often more sensitive to temperature changes than multiparous cows (Bekele et al., 2023). Genotype-by-environment interactions are important in dairy cattle breeding programs to optimize genetic gains under varying conditions, including heat stress and other environmental challenges. Crossbreeding and genomic selection aim to balance genetic potential with environmental adaptability to improve both milk quantity and quality sustainably. Physiological factors that critically limit milk synthesis in dairy cattle include glucose and amino acid availability, endocrine regulation, stage of lactation, and metabolic demands. Early lactation is particularly challenging because cows experience high milk output while feed intake remains low, leading to increased mobilization of body reserves to meet nutrient demands (Gross, 2022). Glucose and amino acids are essential substrates for milk production, with their uptake by the mammary gland tightly regulated by hormonal signals such as growth hormone, insulin, and somatotropin. Amino acids also activate key signaling pathways, such as mTORC1, in mammary epithelial cells, which regulate milk protein synthesis and cell proliferation. Feed restriction or negative energy balance during early lactation alters blood metabolites and hormones, reducing glucose availability and affecting mammary gland activity, thereby limiting milk yield and altering milk composition (Leduc et al., 2021). Management practices such as breed selection, milking frequency, feeding strategies including supplementation with yeast and quality forages, and disease control—especially mastitis—significantly influence milk yield and quality on smallholder dairy farms. Studies show that breeds like Friesians produce more milk than Ayrshires, and yeast supplementation can increase daily milk yield by over 7 liters (Were et al., 2025). Mastitis remains a major challenge, reducing milk yield substantially and affecting milk quality through increased somatic cell counts and antibiotic residues; effective mastitis control through hygiene, milking procedures, and selective dry cow therapy is critical (Farag et al., 2023). Environmental factors such as temperature, photoperiod, and season also impact production; heat stress reduces milk yield and alters composition, while longer photoperiods can enhance it (Marumo et al., 2021). Smallholder farms often face low yields linked to breed type and high mastitis prevalence, highlighting the need for improved management and routine quality testing. High milk production in dairy cows is often associated with reduced reproductive performance, primarily because of metabolic and hormonal challenges arising from negative energy balance (NEBAL) during early lactation. NEBAL delays first ovulation by suppressing luteinizing hormone (LH) pulse frequency and lowering blood glucose, insulin, and IGF-I levels, which collectively reduce estrogen production and fertility. High dietary crude protein levels that support milk yield can elevate plasma urea, negatively affecting the uterine environment and fertility.

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Although statistical analyses show a significant but small negative association between individual milk yield and pregnancy rates, this effect is modulated by herd-level production and management practices. Genetic studies reveal that some gene clusters influence both increased milk yield and decreased fertility through mechanisms involving transcription regulation and energy metabolism. In contrast, others affect only one trait, suggesting complex physiological links (Ooi et al., 2024).

Factors Affecting Milk Production Performance

Milk production in dairy cattle is strongly influenced by diet quality, particularly the balance of fiber and energy intake, which supports proper rumen function essential for nutrient availability. Neutral detergent fiber (NDF) levels around 28% in the diet optimize feeding behavior, rumen fermentation, and milk production during peak lactation, whereas lower or higher NDF levels can negatively affect these parameters (Shi et al., 2023). The type of forage also plays a significant role; diets with higher levels of maize silage increase dry matter intake and milk yield but may reduce fiber digestibility and milk fat concentration compared with grass silage-based diets (Tayyab et al., 2021). Supplementing fiber enhances milk yield by activating the rumen microbiota-mammary gland axis, improving metabolic signaling under environmental stress such as hypoxia (Li et al., 2025). Additionally, balancing dietary protein with energy through strategies such as rumen-protected amino acids improves nitrogen utilization efficiency without compromising milk production (Higgs et al., 2023). Feeding methods such as total mixed rations can improve fiber digestibility by stabilizing ruminal pH, further supporting milk synthesis. Feeding practices in backyard and smallholder dairy farms often rely on locally available forages and agricultural by-products, which vary widely in nutrient composition and affect milk yield. Studies show that supplementation with yeast products, Napier grass, hay, and dairy meal significantly increases daily milk yield compared to supplemented diets (Were et al., 2025). Traditional feeding systems based on crop residues and native hay, supplemented with local brewery by-products, result in lower crude protein intake and milk yield than improved forage-based diets such as oat-vetch mixtures combined with concentrates (Ashagrie et al., 2023). Many smallholder farmers use natural pasture, crop residues, and indigenous plants as primary feed resources, but feed shortages and poor-quality nutrition remain major constraints limiting milk production (Gebremichael et al., 2025). Feeding practices such as zero grazing with concentrate supplementation tend to produce higher milk yields than extensive grazing systems, which are also influenced by socioeconomic factors and altitude. Other factors, such as animal health, lactation stage, and management practices, may also contribute to variations in milk yield. However, in smallholder systems, these factors are often not well documented due to limited record-keeping.

Variability of Milk Production in Smallholder Systems

Milk production in dairy cows is influenced by complex interactions among physiological, nutritional, environmental, genetic, and management factors. Physiologically, the availability of glucose and amino acids is critical for sustaining milk yield, especially during early lactation when feed intake is low, and body reserves are heavily mobilized, creating a negative energy balance that limits nutrient supply to the mammary gland (Brady et al., 2021). Amino acids such as methionine and lysine play key roles not only as building blocks for milk protein synthesis but also in regulating immune function and metabolic pathways during the transition period (Cardoso, 2023). Genetic factors affect milk yield dynamics throughout lactation, with certain genes, such as DGAT1, influencing production after peak lactation, and casein genes exerting larger effects early on. Environmental stressors, such as heat, can impair milk synthesis by disrupting signaling pathways, including mTOR, in mammary epithelial cells, which are also regulated by nutrient availability (Li et al., 2023). Nutritional management strategies, including tailored total mixed rations during early lactation, improve metabolic status, reduce body condition loss, and enhance milk output compared to pasture-only feeding (Brady et al., 2021). Integrating genetics with nutrition through understanding molecular mechanisms and rumen microbial interactions holds promise for optimizing dairy cow performance sustainably (Qin et al., 2025).

Milk Production in Bukidnon Context

Milk production in Bukidnon, Philippines, is primarily driven by smallholder and backyard dairy farms, which face challenges such as limited technology, infrastructure bottlenecks, and capacity constraints that affect productivity and product quality. A technological assessment of a social enterprise in Bukidnon revealed severe overutilization of dairy processing equipment, recommending investments in refrigeration, milking machines, and facility upgrades to improve operational efficiency and milk quality (Tabal et al., 2025). Government-supported projects have enhanced small-scale dairy production skills among agrarian reform beneficiaries in Bukidnon's upland areas, resulting in increased calf production and additional income from local milk sales. Despite the growth potential, the Philippine dairy industry remains underdeveloped, with low self-sufficiency and a heavy reliance on imports; smallholders dominate but require improved breeding, nutrition, capacity building, and technology adoption to boost milk yields (Turaja et al.,

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2024). Findings from Aquino et al. (2024) from other Philippine regions indicate that feeding strategies using home-grown forages combined with complete nutrient diets can significantly increase milk production and farmer income, suggesting that similar approaches could benefit Bukidnon's smallholders. Most available data on dairy production in Bukidnon and the Philippines focus on regional or cooperative levels, with limited farm-level information, making it difficult to assess individual farm productivity and variability accurately. Studies show that smallholder farms, which dominate the sector, often face inefficiencies due to limited technology, poor breeding management, and undernutrition, all of which contribute to lower milk yields and reproductive challenges (Tabal et al., 2025). Efficiency analyses using farm-level data reveal that many smallholder farms operate below optimal technical and economic efficiency, suggesting significant room for improvement through better input use and management practices. Technological assessments recommend investments in milking equipment, refrigeration, and facility upgrades to reduce bottlenecks and improve milk quality at the farm level. Capacity-building projects have demonstrated success in improving farmers' skills and incomes, but remain limited in scale and scope, underscoring the need for more targeted interventions based on detailed farm-level data.

Furthermore, existing literature highlights that multiple interacting factors, including genetics, nutrition, environment, and management practices, influence milk production in dairy cattle. While global studies provide extensive insights into improving milk yield and efficiency, there is limited empirical evidence focusing on smallholder and backyard dairy systems in developing countries such as the Philippines. In particular, few studies have systematically described milk production performance at the farm level using simple but essential statistical measures. This lack of localized, farm-specific data creates a gap in understanding the variability and consistency of milk production in backyard systems, a gap this study aims to address.

In summary, the reviewed literature indicates that complex interactions among nutritional, genetic, environmental, and management factors influence milk production in dairy cattle. Studies consistently emphasize the importance of balanced feeding systems, improved forage quality, and effective farm management in enhancing milk yield and production efficiency. However, in smallholder and backyard dairy systems, particularly in developing countries, production remains highly variable due to inconsistent feeding practices, limited resource availability, and environmental constraints. While global and regional studies provide substantial insights into factors affecting dairy production, there remains a significant lack of farm-level analyses that describe milk production performance using simple but essential statistical indicators such as mean, range, and standard deviation. In the Philippine context, particularly in Bukidnon, most existing studies focus on regional or cooperative-level data, with limited attention given to variability among individual farms and animals. This gap underscores the need for localized, farm-specific studies to provide a clearer understanding of milk production patterns in smallholder systems. Addressing this gap is essential to developing targeted management strategies, improving productivity, and supporting sustainable, resilient dairy production systems.

Theoretical Framework

This study is anchored in the Smallholder Dairy Production Systems Framework, which emphasizes that the interactions among feeding practices, animal management, and resource availability influence dairy productivity in small-scale farming. This framework highlights the importance of evaluating production performance using measurable indicators, such as milk yield and variability, to assess system efficiency. In smallholder systems, where inputs and management practices vary widely, descriptive statistics serve as a practical tool for assessing productivity and identifying performance gaps.

Conceptual Framework

The study's conceptual framework follows an Input–Process–Output (IPO) model to describe milk production performance of dairy cattle in selected backyard dairy farms in Bukidnon. The input consists of dairy cattle and collected milk yield data, measured in liters per cow per day. These data serve as the basis for analysis. The process involves systematically collecting and organizing milk yield data, followed by the application of descriptive statistical tools, including the computation of the mean, minimum, maximum, and standard deviation. These statistical measures are used to summarize and analyze the level and variation of milk production among the cows. The study's output is the overall milk production performance of dairy cattle, including average daily milk yield, the range of milk yield (minimum to maximum), and milk production variability. This framework illustrates how raw data are transformed through statistical analysis into meaningful information that describes productivity in backyard dairy farming systems.

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Scientific Significance and Contribution

This study contributes to the understanding of milk production performance in smallholder dairy systems by providing farm-level empirical evidence from backyard dairy farms in Bukidnon, Philippines. Although the study is descriptive, its significance lies in generating localized baseline data on milk yield variability, which is often lacking in the existing literature focused on regional or aggregated dairy statistics.

From a scientific perspective, the study adds value by documenting production performance using standard descriptive measures (mean, range, and standard deviation), which can serve as reference indicators for future dairy production assessments in similar smallholder systems. The findings also contribute to the broader understanding of how feeding practices and management variability influence milk yield consistency in tropical dairy environments.

In terms of practical application, the results provide useful insights for farmers by highlighting the importance of consistent feeding strategies and balanced Total Mixed Ration (TMR) formulation in improving milk yield stability. Dairy farmers and cooperatives may use these findings to improve farm management practices, particularly in feed formulation and resource use.

For extension services and agricultural development programs, the study provides evidence to support targeted training interventions to improve feeding systems and reduce production variability among backyard dairy farms. Policymakers may also use the results as a baseline for designing programs to strengthen smallholder dairy productivity, food security, and rural livelihood development.

The study bridges the gap between scientific description and practical application by providing locally relevant data to guide improvements in management, extension planning, and future research in smallholder dairy production systems.

Statement of the Problem

Milk production in smallholder and backyard dairy systems in the Philippines remains low and inconsistent, limiting its contribution to food security, rural livelihoods, and sustainable agricultural development. In Bukidnon, where dairy farming is an important agricultural activity, variations in feeding practices, resource availability, and farm management result in uneven milk production among dairy cattle. This inconsistency reduces farm productivity and constrains the efficiency and sustainability of small-scale dairy operations. Despite the importance of dairy production in supporting local food systems, there is a lack of farm-level studies that systematically describe milk production performance in backyard dairy farms using basic statistical indicators such as mean, range, and standard deviation. Most existing research focuses on regional or cooperative-level data, with limited attention to variability among individual farms and cows. This absence of detailed farm-level analysis represents a critical research gap, as it limits understanding of production patterns and restricts the development of targeted interventions, extension programs, and management strategies to improve productivity, sustainability, and food security in smallholder dairy systems.

General Objective

To describe the milk production performance of dairy cattle in selected backyard dairy farms in Bukidnon, Philippines.

Specific Objectives

1. To determine the average daily milk yield (L/cow/day) of dairy cattle in the selected farms.
2. To identify the minimum and maximum milk yield recorded among the cows.
3. To evaluate the variability of milk production using standard deviation.

Research Questions

1. What is the average daily milk yield (L/cow/day) of dairy cattle in the selected farms?
2. What is the minimum and maximum milk yield recorded among the cows?
3. What is the variability of milk production using standard deviation?

METHODS

Research Design

This study employed a descriptive research design to analyze the milk production performance of dairy cattle in selected backyard dairy farms in Bukidnon, Philippines. This design was appropriate because it allows systematic description and summarization of existing farm-level production data without manipulating variables. In agricultural research, particularly in smallholder systems, descriptive approaches are essential for generating baseline information

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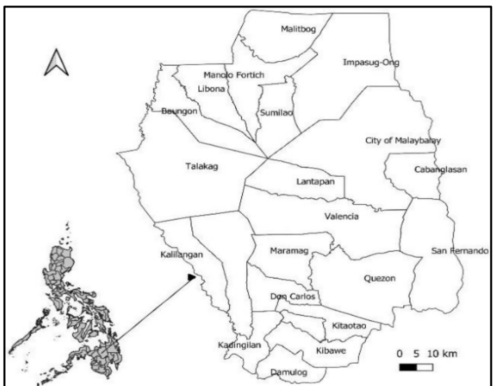
where experimental control is not feasible. The study did not employ experimental or comparative designs because it relied on existing farm records.

Locale of the Study

The study was conducted from June to October 2025 in selected backyard dairy farms in Bukidnon, Philippines. The province is characterized by a tropical climate with relatively high rainfall and moderate to high temperatures, which influences forage availability and dairy production systems.

A total of four (4) backyard dairy farms with nine (9) lactating dairy cows were included in the study. Farms were selected using purposive sampling based on the following criteria: (1) presence of at least two lactating dairy cows, (2) availability of consistent milk production records, and (3) willingness of farm owners to participate. All farms operated under normal management conditions without experimental intervention.



(Paquit et al., 2022)
Figure 1: Map of Bukidnon, Philippines.

Scope and Limitation of the Study

This study focused on the descriptive analysis of milk production data collected from selected backyard dairy farms in Bukidnon, where dairy cattle were raised under farm-based total mixed ration (TMR) feeding systems. The analysis was limited to evaluating milk yield, expressed in liters per cow per day, based on available farm production records. The scope of the study was limited to the presentation of milk yield data from the selected farms, using descriptive statistical methods. Other factors that may influence milk production, such as breed composition, nutritional management, animal health status, stage of lactation, and farm management practices, were not included in the analysis due to the limited availability of detailed farm records. Furthermore, the study did not attempt to establish causal relationships between feeding practices and milk production. The study's findings, therefore, provide only a descriptive overview of milk production performance on the selected farms and may not be generalized to all dairy farms in the province.

Data Source and Collection

Secondary data on milk production were obtained from the milk production records maintained by the participating farms. The collected data consisted of daily milk yield records expressed in liters per cow per day. These records were reviewed and compiled to assess dairy cattle's milk production performance during the data collection period. Data were encoded and organized using Microsoft Excel, which was also used for data processing and statistical analysis. To ensure data reliability, only farms with consistent and complete records were included. The data recording format was reviewed to ensure uniformity in measurement units and recording intervals across farms.

Parameters Measured

Milk production performance was evaluated using the following parameters

1. Average daily milk yield (L/cow/day)
2. Minimum milk yield
3. Maximum milk yield
4. Standard deviation (SD)

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These parameters were used to describe both the level and variability of milk production among dairy cattle.

Statistical Analysis

Descriptive statistics, including mean, minimum, maximum, and standard deviation, were computed to summarize milk yield per cow across farms. Mean values per cow were used to avoid pseudo-replication arising from repeated daily measurements. All results were expressed as mean ± standard deviation (SD). Data analysis was performed using Microsoft Excel.

Ethical Considerations

The study utilized secondary data obtained from participating dairy farms with the informed consent of farm owners. All data were treated with confidentiality and used solely for research purposes. No experimental manipulation or harm was imposed on animals. Where applicable, the study adhered to institutional guidelines for ethical research involving agricultural data and ensured that all data were used with proper authorization from farm owners.

RESULTS and DISCUSSION

This section presents the results and discussion of the milk production performance of dairy cattle in selected backyard dairy farms in Bukidnon. It focuses on key production indicators, including average daily milk yield, minimum and maximum milk yields, and milk production variability, as measured by standard deviation. The findings provide an overview of milk yield productivity and consistency among dairy cattle on the selected farms. Furthermore, this section discusses observed differences in production performance. It highlights possible factors contributing to variation among cows and farms, thereby providing a clearer understanding of milk production in backyard dairy systems.

1. Composition and Inclusion Levels (%) of Feed Ingredients Used in Selected Backyard Dairy Farms in Bukidnon

The Total Mixed Ration (TMR) formulations across the selected farms showed variation in ingredient composition and inclusion levels, reflecting differences in locally available feed resources and farmer management strategies. These variations are important because ration formulation directly influences nutrient intake, rumen efficiency, and milk productivity. Across farms, locally available forages and agro-industrial by-products were commonly utilized, which is typical in smallholder dairy systems aiming to reduce feed costs while sustaining production. However, differences in nutrient balancing were evident among farms, which likely contributed to variation in milk yield performance. Farm A utilized a diversified forage base composed of Napier (30%), Mombasa (25%), and Mulato (20%) grasses, supplemented with rice bran (20%) and salt (5%). The inclusion of multiple forage species increases fiber diversity, thereby enhancing rumen microbial activity and fermentation stability. Rice bran provides an additional energy source that supports milk synthesis. This claim aligns with Gul et al. (2025) and Ashagrie et al. (2023), who emphasized that combining energy-dense by-products with diverse forage sources improves nutrient utilization and milk production efficiency in smallholder systems.

Farm B relied heavily on corn silage (70%), supplemented with pineapple pulp (25%) and dairy concentrates (5%). Corn silage is a highly digestible energy source that supports efficient fermentation and milk synthesis. The inclusion of pineapple pulp improves palatability and feed intake by providing fermentable carbohydrates. According to Idayanti et al. (2022), such agro-industrial by-products can effectively substitute commercial concentrates while maintaining energy supply for lactating cows. Farm C adopted a simpler ration dominated by Napier grass (70%), with corn bran (25%) and salt (5%). While Napier grass is widely used in tropical systems, its low crude protein and metabolizable energy content may limit milk production unless properly supplemented. Islam et al. (2024) emphasized that reliance on low-quality forage without adequate supplementation constrains productivity due to insufficient nutrient supply. Farm D utilized Napier (40%) and Mombasa (40%) grasses with rice bran (30%). This formulation provides a balance between structural fiber and energy density, supporting rumen health and moderate milk production levels.

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Table 1
Composition and Inclusion Levels (%) of Feed Ingredients Used in Selected Backyard Dairy Farms in Bukidnon

Farm	Ingredients	Inclusion (%)
Farm A	Napier	30
	Mombasa	25
	Mulato	20
	Rice Bran	20
	Salt	5
Farm B	Corn Silage	70
	Pineapple Pulp	25
	Dairy Concentrates	5
Farm C	Napier	70
	Corn Bran	25
	Salt	5
Farm D	Napier	40
	Mombasa	30
	Rice Bran	30

2. Average Daily Milk Production of Dairy Cows Fed Farm-Based TMR in Selected Backyard Farms (June–October)

Milk yield values represent the average daily milk production per cow, computed from repeated monthly observations collected from June to October to standardize comparisons among farms. The average daily milk production of dairy cows fed with farm-based Total Mixed Rations (TMR) in selected backyard farms is presented in Table 2. The results show variation in milk yield across farms, indicating differences in productivity among dairy cattle. Among the farms, Farm B recorded the highest average milk yield at 10.38 L/cow/day, suggesting better production performance compared to the other farms. This result may be attributed to differences in feeding practices, feed quality, or overall management. According to Leduc et al. (2021), the quality and composition of feed, especially fiber content and energy balance, significantly influence milk production and composition in dairy cattle. Magan et al. (2021) show that different feeding strategies, such as pasture-based versus concentrate-based diets, affect milk's macronutrient profile and fatty acid composition, which in turn impact milk yield and quality. Feeding multispecies pastures with varied nutrient profiles can increase milk fat and protein yields compared to monoculture ryegrass pastures, highlighting the role of diet diversity in enhancing milk components (Kostovska et al., 2024). Feed-to-yield systems demonstrate that increasing dry matter intake through concentrates improves milk yield but may reduce fat and protein concentration, indicating a complex relationship between diet energy density and milk composition (Craig et al., 2022). Moreover, Lucy (2005) highlighted that properly formulated rations significantly improve milk yield and overall animal performance by ensuring adequate nutrient supply tailored to the cows' needs.

In contrast, Farms A and C had relatively lower average milk yields of 6.15 and 6.67 L/cow/day, respectively, indicating moderate production levels. These differences may be associated with variations in nutrient intake, forage quality, and feeding systems. As noted by Hassen et al. (2022), inconsistencies in diet formulation and feed availability can lead to reduced milk production and inefficiencies in nutrient utilization. Farm D had an average milk yield of 8.75 L/cow/day, which is higher than Farms A and C but lower than Farm B. However, it recorded the highest standard deviation (2.47), indicating greater variability in milk production among cows within the farm. This result suggests inconsistency in individual cow performance, which may be influenced by factors such as differences in lactation stage, health condition, or feed intake. According to Collier et al. (2017), variability in milk yield within a herd is often linked to differences in management practices and animal-related factors, including genetics and physiological status. Genetic factors account for about 25% of milk yield differences, with the remaining 75% attributed to environmental and management conditions, including nutrition, milking frequency, and housing.

On the other hand, Farms A and B had lower standard deviation values (0.92 and 0.96, respectively), indicating more consistent milk production among their cows, which may reflect more uniform feeding and management practices. Furthermore, the mean milk yield across all farms was 8.12 L/cow/day, reflecting the overall milk production level in the selected backyard dairy farms. This level of production is typical of smallholder or backyard dairy systems, where management and feeding practices are often less intensive. As reported by Hailemariam et al. (2022), milk production

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on small-scale dairy farms tends to be lower and more variable than in commercial operations due to limitations in nutrition, management, and resources.

Table 2
Average Daily Milk Production of Dairy Cows Fed Farm-Based TMR in Selected Backyard Farms (June–October)

Farm	No. of Cows (n)	Milk Yield (L/cow/day)*	SD
Farm A	2	6.15	0.92
Farm B	2	10.38	0.96
Farm C	3	6.67	1.62
Farm D	2	8.75	2.47
Overall Mean		8.12	

3. Overall summary of milk yield

The overall summary of milk yield shows that dairy cows on the selected backyard farms produced a mean milk yield of 7.84 L/cow/day, ranging from 4.80 L/cow/day to 11.06 L/cow/day. This milk yield indicates a moderate level of production, typical of smallholder or backyard dairy systems. According to Mukasafari et al. (2025), milk yield on small-scale dairy farms is generally lower than on commercial farms due to limitations in feeding, management, and the genetic potential of the animals. The wide range between the minimum and maximum milk yield reflects considerable variation in individual cow performance. This variation may be attributed to differences in factors such as nutrition, lactation stage, health status, and management practices. As emphasized by Carroll et al. (2024), milk production is strongly influenced by nutrient intake and ration quality, and inconsistent feeding can lead to differences in milk yield among animals.

Furthermore, the standard deviation of 2.10 indicates moderate variability in milk production within the population. This standard deviation suggests that while some cows perform close to the average, others deviate significantly, either producing much lower or much higher milk yields. The results suggest that although the average milk yield is within an acceptable range for backyard dairy systems, the observed variability underscores the need for improved, more consistent feeding and management practices to enhance productivity and reduce performance gaps among dairy cattle. The findings of this study have important implications for smallholder dairy farmers and agricultural stakeholders. The observed variability in milk production highlights the need for improved feeding strategies, particularly the adoption of balanced Total Mixed Ration (TMR) formulations tailored to locally available resources. In addition, strengthening extension services and farmer training programs can help improve management practices and reduce inconsistencies in milk production. For policymakers, the results provide baseline data to support the design of targeted interventions to enhance dairy productivity and sustainability in rural communities. The observed variability in milk production also has important implications for sustainability in smallholder dairy systems. Inconsistent feeding practices and inefficient use of locally available feed resources may increase production costs and reduce system resilience. Improving feed management by using balanced, locally adapted Total Mixed Ration (TMR) formulations can enhance nutrient use efficiency while minimizing waste. Furthermore, using climate-resilient feed resources, such as drought-tolerant forages and agricultural by-products, may help stabilize milk production under changing environmental conditions. These strategies are essential for promoting sustainable and resilient dairy production systems in tropical smallholder settings.

Table 3
Overall Summary of Milk Yield

Parameter	Value
Mean milk yield	7.84
Minimum	4.80
Maximum	11.06
Standard deviation	2.10

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Conclusions

Based on the study's findings, milk production performance among backyard dairy farms in Bukidnon is highly variable, suggesting inconsistencies in feeding practices and farm management. While the average milk yield reflects moderate productivity typical of smallholder systems, the wide range and variability suggest significant opportunities for improvement. These findings provide important baseline data for understanding production patterns in backyard dairy farming. The study contributes to agricultural research by highlighting the need for standardized management practices to improve milk yield, thereby supporting sustainable dairy production and enhancing food security in rural communities.

Recommendations

Based on the results and conclusions of the study, the following recommendations are proposed:

1. Dairy farmers may improve record-keeping practices by including detailed production data such as feeding regimes, lactation stage, and animal health status to support better decision-making and productivity analysis.
2. Future researchers may expand the scope of the study by including larger sample sizes and additional variables such as breed, nutrition, and management practices to better explain variations in milk production.
3. Local agricultural agencies and dairy cooperatives may utilize the findings as baseline data for designing targeted extension programs and interventions to improve dairy productivity in Bukidnon.
4. Future studies may consider longitudinal data collection to assess trends and seasonal variations in milk production over time.
5. Agricultural agencies may promote farmer training programs on balanced TMR formulation, sustainable feeding strategies, and efficient farm management practices to improve milk yield consistency and support sustainable dairy production systems.

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