Jurnal Sain Peternakan Indonesia
Available at https://ejournal.unib.ac.id/index.php/jspi
DOI: https://doi.org/10.31186/jspi.id.20.2.111-116

P-ISSN 1978-3000
E-ISSN 2528-7109
Volume 20 Issue 2 April-June 2025

Seasonal Adaptation in Feed Management: Assessing Forage and Feedstuff Variations in Small-Sized Dairy Farms in Boyolali, Central Java

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Revised: 2025-07-12, Accepted: 2025-07-27, Publish: 2025-07-29

ABSTRACT

Small dairy farms in tropical regions frequently encounter feed shortages and quality fluctuations between seasons, which can substantially affect milk production. This research aimed to evaluate the ability of small-scale dairy farms to adapt to and manage feed fluctuations in response to seasonal changes. The research employed an exploratory design, with samples collected using nested sampling methods. Three samples were collected according to the season, specifically during the dry season (August 2024) and the rainy season (January 2025), from the Cepogo and Selo Subdistricts in Boyolali. Feed samples collection was conducted in five stages: 1) desk study of the research area; 2) field visiting; 3) feed samples; 4) forage samples collection; and 5) feed analysis using proximate analysis (AOAC, 2005). The results showed differences in feeding management among farmers related to their dairy animal structures. The highest dry matter content in the forage was found in rice straw (60.4% DM), which dominated dry season use, while the highest crude protein content was observed in calliandra (23.5%) among the forages. Five coproducts have high dry matter content with varying crude protein and crude fibre levels. The research concluded that small-sized dairy farms can adapt and manage feed fluctuations based on seasonal changes by making forage and concentrate choices available.

Keywords: feedstuff, forage availability, nutrient quality, season changes, small-sized dairy farms

INTRODUCTION

Dairy farming has been one of the most significant branches of livestock production in Indonesia since the first dairy cows were imported in the late nineteenth century. The dairy farming sector has made a substantial contribution to food security and rural community development. Small-sized dairy farms (SSDFs), defined as those operating with fewer than 10 cows (Jahroh et al., 2020), are increasingly at risk due to a growing number of economic, environmental, and structural challenges that threaten their sustainability. However, there was little information available on how small dairy farms in Boyolali could adjust their feed strategies seasonally.

Feed supply for cows should be continuous and stable due to the animal's need for milk production, up to 10% of the cow's weight (Hedriyanto et al. 2021). Cow feed consists of concentrate and forage that may fluctuate, affecting the quality and quantity of milk, particularly due to seasonal changes between the rainy and dry seasons (Al Zahra et al., 2015). Furthermore, feed nutrition would affect reproduction performance, herd productivity, genetics, and health (Lanyasunya et al., 2005). Rahmana et al. (2018) reported that feed quality and availability could affect farm resilience and animal welfare. Thus, the research hypothesises that farmers who rely on low-quality crop residues during the dry season would reduce their milk yield.

The farm must manage dairy feed supply to maintain a sustainable business and farmer income. During the dry season, farmers rely on feed inputs from the surrounding area and purchase higher-priced feed to meet the cows' nutritional requirements (Kumalasari et al., 2019). Small farms may struggle to manage and survive independently, relying on off-farm income. The research goal was to evaluate the ability of small-scale dairy farms to adapt and manage feed fluctuations in response to seasonal changes. The findings will inform feed interventions aimed at stabilising milk production year-round.

MATERIALS AND METHODS

The research was conducted from July 2024 to January 2025 at Boyolali, Central Java. The feed samples were analysed in the Biotech Laboratory for proximate analyses using the AOAC method (2005) and in the Analytical

Laboratory, Department of Agroindustrial Technology, for starch analysis using the Indonesian National Standard (SNI) number 01-2891-1992.

Feed samples collection was conducted in five stages: 1) desk study of the research area; 2) field visiting and discussion with cooperative representatives; 3) feed samples collection from farmers; 4) forage samples collection; and 5) feed analysis.

The research employed an exploratory design, where a sample was collected using the nested sampling method. Three farms were randomly selected based on cooperative representation suggestions. The samples were collected according to the seasons, specifically during the dry season (August 2024) and the rainy season (January 2025), from Cepogo Subdistrict (-7.525248°S; 110.514722°E) and Selo Subdistrict (-7.50166°S; 110.463824°E). The feed and forage collection from each subdistrict was sampled in a composite of 2 kg/type of by-product feed and 5 kg/species. Nutrient analyses were conducted on the top 10 most usable forage and feedstuffs for concentrate. Data was analysed using descriptive methods that calculated the average and standard deviation to inform the variability.

RESULTS AND DISCUSSION

Boyolali Regency is located in the central-eastern part of Central Java Province, covering an area of 1,096.61 km². Geographically, Boyolali lies between 110°22' and 110°50' east longitude and 7°36' to 7°71' south latitude, with an altitude ranging from 75 to 1,564 meters above sea level. The average temperature is 29°C, and the annual rainfall reaches 2,000 mm, with the highest rainfall occurring in January and February. The livestock sector in Boyolali also shows significant potential. Many rural residents rear livestock, such as cattle, goats, and sheep, as a secondary source of income. In 2023, the dairy cattle population reached 85,520, producing a total of 51,388 tons of milk/year.

Three cooperatives in Boyolali serve dairy farmers, i.e. KUD Musuk, KUD Cepogo, and KUD Mojosongo. These cooperatives provide support by offering concentrated feed and accepting milk to supply dairy companies. KUD supplies concentrate feed, including rice bran, pollard bran, tofu dregs, and commercial feed, directly from the manufacturer. The selected farmers from these cooperatives, with the highest milk intake in Boyolali, include KUD Musuk, which receives 600,000 litres per month, and KUD Cepogo, which receives 279 tons per month. The milk price in the KUD varied depending on the management system in place. At KUD Musuk, the cost could reach IDR 7,500 per litre, while at KUD Cepogo, the price was only IDR 7,000 per litre.

There are differences in feeding management among farmers related to the animal dairy structure (Table 1). The farmer supplying KUD Musuk has four cows with a dairy feeding schedule that includes three forage feedings per day, at morning, mid-day, and afternoon, with concentrate feedings scheduled for the morning and afternoon. The farmer who supplies KUD Cepogo has a pattern of feeding times, where twice the time for forage feeding is allocated in the morning and afternoon, while concentrate is given in the morning and midday. Milk production on each farm decreased by 24.44% in the dry season compared to the rainy season, due to a reduction in the number of lactating cows.

Table 1. Dairy farm profile at Boyolali in the dry and rainy season

Dairy Profile		Dry season	Rainy season
Animal dairy structure	Lactating cows	2±0	3±1.41
	Dry cows	1±1.41	3.5±2.12
	Heifer	1±0	0±0
	Calves	1±0	2.5±3.5
	Bull	3±2.83	1±1.4
Milk production	Each farm (kg/farm/d)	34±5.66	45±15.56
	Each animal (kg/animal/d)	17±2.83	15.5±2.12
Feeding management for lactating cows	Forage (kg/d/head)	31.5±19.09	27±25.45
	Concentrate feed (kg/d/head)	11.5±3.53	13.25±5.01

The milk yield decreased during the rainy season in Boyolali, consistent with previous research that reported the rainy season results in the lowest production (Azimi et al., 2022). However, the result contrasts with Mudavadi et al. (2020), who found that research in Africa showed that cows decreased milk production in the dry season due to heat stress. The milk production in Boyolali, where the average milk yield reached 16.25 kg/animal/day, was higher than in Bogor, i.e., 11.01 kg/animal/day (Despal et al., 2022), due to the difference in farm elevation and feed diversity. In Indonesia, feeding management in smallholder dairy farming is specified for each farmer, who typically uses the cut-and-carry method of local forage to ensure sufficient feed (Kumalasari et al., 2022). Feeding management is crucial for good dairy farming practices (GDFP) to ensure animal welfare, particularly by preventing animals from experiencing thirst, hunger, or malnutrition, and reducing animal discomfort (Susilorini et al., 2022). At Boyolali, the feeding management was influenced by the animal dairy structure, as the animal body size had a significant effect on the food intake required for the animals (Sunyigono et al., 2024).

The farmer in Boyolali uses 31 feeds, which consist of 5 forages, three feed rations, one agricultural by-product, and 13 coproducts during the dry season. In contrast, during the rainy season, the feed mix consists of four forages, three feed rations, and one coproduct (Table 2). The most common forage was Napier grasses with several varieties, i.e. elephant grass (*Pennisetum purpureum*), pakchong grass (*Pennisetum purpureum* cv. Taiwan), and odot grasses (*Pennisetum purpureum* cv. Mott).

Table 2. Dairy feed profile at Boyolali in the dry and rainy season

Common Name	Feed Group	Plant part
Dry Season		
Concentrate sf-11	Feed ration	n/a
Pellet concentrate sh-1351	Feed ration	n/a
Pellet concentrate	Feed ration	n/a
Elephant grass	Grass	Whole Plant
Pakchong grass	Grass	Whole Plant
Dwarf elephant grass	Grass	Whole Plant
Rice straw	Agriculture Byproduct	Whole Plant
Calliandra	Legume	Leaves
Albizia leaves	Legume	Leaves
Dry distiller grains	Coproducts	n/a
Corn gluten feed	Coproducts	n/a
Cassava waste	Coproducts	n/a
Rice bran	Coproducts	n/a
Coconut meal	Coproducts	n/a
Soybean meal	Coproducts	n/a
Palm kernel meal	Coproducts	n/a
Coffee husk	Coproducts	n/a
Molasses	Coproducts	n/a
Pollard	Coproducts	n/a
Cassava	Coproducts	n/a
Tofu dregs	Coproducts	n/a
Poultry litter	Tubers	n/a
Rainy Season		
Concentrate sf-11	Feed ration	n/a
Pellet concentrate sh-1351	Feed ration	n/a
Pellet concentrate	Feed ration	n/a
Elephant grass	Grass	Whole Plant
Pakchong grass	Grass	Whole Plant
Corn forage	Grass	Whole Plant
Calliandra	Legume	Leaves
Pollard	Coproducts	n/a

The farmer cultivated the forage on their land or communal land provided by the village government. In the dry season, forage production declined, so farmers bought forage and used agricultural by-products and co-products. There were forage traders who supplied rice straw in the dry season and young maize whole plants in the rainy season. Therefore, the forage quality was relatively low, and farmers need to concentrate on compensating for the dairy nutrients required. On the other hand, farmers prefer using local forage resources that grow well with sufficient water during the rainy season and have lower costs.

Elephant grass is the most common forage crop cultivated in Indonesia, particularly among dairy farmers (Kumalasari et al. 2019). In the dry season, local forage production decreases; thus, the forage type and the number of coproducts used increase to fulfil the animals' needs, similar to those in the rainy season (Lestari et al., 2011). The forage trader offers several forage, such as rice straw, elephant grass, pakchong grass, and dwarf elephant grass, from other areas to supply the dairy farm. Abdelghany et al. (2022) reported that different feeding management strategies result in varying milk production for each animal (Table 1). In the dry season, legume trees such as calliandra and albizia can preserve their production and contain higher nutrient quality, which improves dairy cattle performance (Myint and Muang, 2020). Farmers added concentrate that was bought from the cooperatives or formulated based on their experiences and available feedstuff (Rahardjo and Wadjdi, 2014)

The five forages and five coproducts that are commonly used as dairy feed in Boyolali were analysed for their nutrient content through proximate and starch analyses (Table 3). The highest dry matter content in forage was rice straw, followed by calliandra, corn stover, elephant grass, and the lowest was dwarf elephant grass. Rice straw contained the third highest crude fibre content but had the highest ash content. The highest crude protein content in forage was found in calliandra, followed by corn stover, elephant grass, rice straw, and dwarf elephant grass. Five coproducts have high dry matter with varied crude protein and crude fibre; however, all of them were pretty similar in starch content.

The quality of rice straw in this research was lower than that in previous studies, with crude protein at around 7.49% and crude fibre up to 20%, due to differences in harvest age (Syafiyullah et al. 2019). The higher ash content in rice straw increases the fibre density and compressive strength, which reduces the forage digestibility compared to other forages (Onugba et al. 2024). The crude fibre content in the coproduct is relatively low, except for rice bran, which has a content of 40.64%, significantly higher than previous research, which reported values ranging from 11.26% to 36.10% (Dewi et al., 2021). The differences in crude fibre content across studies may be attributed to variations in rice varieties (Singh et al., 2020), milling processes, the presence of contaminants, or the addition of other mixing materials (Ridla et al., 2023). Calliandra has been shown to improve milk production in smallholder dairy farms, in line with Makau et al. (2020), who reported an increase of at least 1 litre/cow/day for each kilogram fed.

Table 3. Nutrient content of feed in smallholder dairy farming at Boyolali

Common name	Moisture	DM	Ash	CP	EE	CF	NFE	Starch
	----------%----------							
Elephant grass	85.05	14.94	12.75	8.76[a]	1.65	29.57	n/a	7.16
Dwarf elephant grass	89.41	10.58	n/a	7.23-11.93[bc]	1.39	23.19	n/a	5.86
Corn stover	72.32	27.67	10.98	10.74	1.32	27.75	49.19	9.13
Rice straw	39.55	60.44	22.03	7.38	2.14	26.96	41.46	7.58
Calliandra	66.54	33.45	6.44	23.50	1.20	18.16	50.68	5.94
Rice bran	6.55	93.45	n/a	4.55	0.80	40.64	n/a	6.61
Corn gluten feed	9.91	90.09	5.86	25.40	2.34	11.99	54.39	7.34
Coconut meal	10.53	89.47	9.09	24.86	2.79	8.39	54.84	7.62
Soybean meal	10.93	89.07	9.04	60.92	0.53	3.24	26.23	6.09
Palm kernel meal	4.86	95.14	4.50	17.63	6.04	15.03	56.77	8.92

Source: [a]Hakim et al. (2023), [b]Rajab et al. (2020), [c]Sarwanto et al. (2019)
DM = dry matter, CP = crude protein, EE = ether extract, CF = crude fiber, NFE = nitrogen-free extract, n/a = not analysed

CONCLUSION

This study demonstrates that small-scale dairy farms in Boyolali adapt to seasonal feed fluctuations by adjusting their forage and concentrate use, with calliandra (23.5% crude protein) serving as a key dry-season protein source, while rice straw (60.4% dry matter, DM) compensates for bulk. However, relying on low-quality crop residues during the dry season risks nutrient gaps, highlighting the need for interventions such as promoting drought-tolerant forage or affordable concentrate alternatives. Future research should evaluate the long-term impacts of these adaptive strategies on milk yield and farm economics.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the support from the UC Davis University of California for the research collaboration in Global Methane Hub Development of Feed Formulation Tool for Dairy Sector from February 2024 - February 2025

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