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RESEARCH ARTICLE

Availability, Utilization and Nutrient Contribution of Feed Resources to Livestock of Dairy Farmers in Batangas and Cavite, Philippines

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ABSTRACT

The dairy buffalo production in Region 4A faces significant challenges due to the limited availability and quality of feed resources. This study aimed to assess the feed resources available to dairy farmers, their utilization, and nutrient contributions to livestock production. Additionally, it aimed to identify the perceived constraints and potential interventions to address feed-related issues. Twelve dairy farmers from Rosario Livestock and Agriculture Farming Cooperative in Batangas and General Trias Dairy Raisers Multi-Purpose Cooperative in Cavite, were randomly selected for the study, respectively. Data was collected through focus group discussions, individual interviews, key informant interviews, secondary sources, and personal observations. The data was analyzed using the Feed Assessment Tool (FEAST version 2.21). The findings revealed that crop-livestock integration and tethering are common in Batangas and Cavite, respectively. Key feed resources included purchased feeds, natural pastures, crop residues, and some agro-industrial by-products. Purchased feeds contributed over 30%, while natural grazing provided more than 60% of the nutrient requirements for dairy buffalo in Batangas and Cavite, respectively. Major constraints identified were high commercial feed costs, seasonal feed shortages, limited land, and some health issues. Proposed interventions include research-based least-cost ration, feed quality enhancements, use of government land for forage production.

INTRODUCTION

Livestock production faces several constraints, including feeding, genetics, and health, as well as limitations related to knowledge in husbandry practices, market access, infrastructure, and credit access (Duncan, 2021). Despite these challenges, resource-poor farmers continue to raise livestock animals for various reasons such as food, income, manure, draught power, strategic asset, and social status (Randolph et al., 2007). In the Philippines, the livestock industry is an essential component of the agricultural sector and provides a livelihood for the rural population (Ortega et al., 2021). Ruminant livestock are generally raised by smallholder farmers in crop-based farming systems (Domingo et al., 2022), fed with available feed resources consisting of grassland, weeds, crop residues, grasses in land under coconut plantation, and agro-industrial by-products (Moog, 2005). However, livestock productivity remains low, particularly at the smallholder level, due to the insufficient quantity of good quality feed.

Buffaloes are known to be highly efficient ruminant livestock that can utilize fibrous crop residue because of the diverse microbial population present in their rumen (Wanapat and Rowlinson, 2007). This makes them a suitable option for rice-based agricultural systems. In the Philippines, 99% of these ruminants are owned by smallholder rice farmers, who have lower income, limited resources, and little access to economic opportunities (Moog, 2005; Borghese, 2005). They play a significant role in providing draft power in agricultural operations and in supplying valuable products such as meat, milk, and hide for human consumption. The Philippine Carabao Center (PCC) has been making

continuous efforts to genetically transform traditional draught buffalo into milk producers, which has had a significant impact on smallholder farming families venturing into dairy production enterprises (Cruz, 2010). However, insufficient supply of high-quality forage grass continue to limit animal productivity in this industry (Lantican et al., 2017), resulting in inadequate nutrient supply. Such could be associated with lower milk production, poor reproductive performance, and growth rate in buffaloes (Sarwar et al., 2009). Thus, feed availability and efficiency are crucial factors in improving animal performance (Devendra and Leng, 2011).

Livestock performance and productivity can vary significantly between farms and locations due to variations in roughage availability and feeding strategies implemented by farmers to ensure a consistent supply of feed resources throughout the year (Moog, 2005). Feed resources remain a crucial factor in animal production, with feed typically being the most expensive component (Devendra and Sevilla, 2002). As a significant determinant of milk prices and yield (Hemme and Otte, 2010), high feed costs can negatively impact the financial viability of dairy buffalo enterprise. Therefore, addressing feed constraints could have a positive impact on the financial sustainability of the dairy buffalo industry. By evaluating the availability of feed resources and estimating their potential contribution to animal nutrition, farmers can make informed decisions about the number of animals they can sustainably raise while maintaining optimal health and productivity levels. With the increased herd size of dairy farmers engaging in milk production, the requirement, competition, and pressure to sustain the availability of local feed resources is becoming a major challenge. Effective utilization of feed resources is therefore crucial to improve animal nutrition and productivity. To achieve this, a site-specific approach in evaluating feed resources is necessary for the proper diagnosis of feed-related problems and the development of effective interventions. Hence this study was conducted.

MATERIALS AND METHODS

Description of the Study Area

This research was conducted in two areas, namely Rosario, Batangas, and General Trias, Cavite, both of which have a high buffalo population and are located in Region 4A CALABARZON in South Luzon, Philippines. The Philippine Carabao Center is actively involved in developing and promoting improved dairy buffaloes and associated technologies to enhance farm productivity and increase smallholder income. Their efforts are focused on selected areas through dairy cooperatives such as the Rosario Livestock and Agriculture Farming Cooperative (TRLAFCO) in Rosario, Batangas, and the General Trias Dairy Raisers Multi-Purpose Cooperative (GTDRMPC) in General Trias, Cavite.. In addition, these dairy cooperatives were selected considering their good record of dairy production, better linkage to milk markets, and accessibility. Rosario, Batangas is a first-class Municipality in the 4th district of Batangas Province, covering a land area of 226.88km2 and consisting of 48 barangays/villages with a population of 128,352 people according to the 2020 census. It is considered the "Rice Granary" of the province, located approximately 93 kilometres southeast of Metro Manila, at 13°41'7" N and 13°52'31" N latitude and 121°9'54" E and 121°21'50" E longitude, with an elevation of 143.6 meters above sea level. It has an annual mean temperature of 27.56^{o}C and precipitation of 141.44mm (5.57 inches). General Trias, on the other hand, is a first-class city in the province of Cavite with 33 barangays and a population of 590,371 according to the 2023 census. The city has a land area of 90.01 km^2, which accounts for 5.90% of the total area of Cavite, and comprises of agricultural, Forest Park, agro-industrial, and idle or vacant lands. The town is located in the northern part of Cavite province, at 14°23′ latitude and 121°53′ longitude, 35 km from southwest of Manila. Its terrain is characterized by a flat northern portion, while the southern portion is hilly and rolling, with a slope ranging from 3 to 40%. Steep waterways occupy the remaining portion of the area. It has an annual average temperature of 30^{o} degrees and precipitation of 42.56mm (1.68 inch).

Selection of Participants and Sampling Procedure

The participants were obtained from a farmer- member of TRLAFCO in Rosario, Batangas and GTDRMPC in General Trias, Cavite, respectively. Dairy producers from this cooperative were randomly selected to participate in focus group discussion (FGD) and individual interview. Following the recommendation of FEAST, twelve (12) dairy farmer-member from each cooperative were randomly selected as representatives to participate in group discussions using the participatory rural

appraisal (PRA).After the FGD, nine (9) farmers from each cooperative were chosen using a stratified random sampling technique to participate in individual interview. Based on the land holdings stated during the FGD, the participants were classified into three groups: small, medium, and large farmer. Each group had three farmer representatives. Focus group discussions and individual farmer interviews were conducted separately in the two communities. The number of respondent and participant were based on the requirements set by Feed Assessment Tool.

Data Collection Procedures and Tools

The Feed Assessment Tool, developed by the team of Duncan et al., (2012) at the International Livestock Research Institute (ILRI) were used in this study to gather qualitative and quantitative data on feed resources. Specifically, focus group discussion guide questions and individual farmer interview questionnaire were obtain from International Livestock Research Institute (2019). FEAST is a farmer-centered diagnostic tool that systematically assesses the availability and utilization of local feed resources in the community to develop site-specific interventions that help improve and maximize feed supply. To ensure the suitability of the tool, the FEAST guide questions were pre-tested with four dairy buffalo farmers who are not involved in the research. This pre-test evaluate the farmers' understanding of the questions, validate the translation of technical terms, and estimate the time required to complete the interview. Appropriate changes, corrections, and revisions were made as necessary to refine the questionnaire and improve its structure before the final interview.

A semi-structured and structured questionnaire were used to collect data during focus group discussions and individual farmer interviews. Following the FEAST guidelines, the participatory rural appraisal approach were used to elicit participants' consensus opinion about various feed-related issues, including overview of farming system, labor availability, land availability, rainfall patterns, and the utilization of livestock feeds. Also to identify current challenges affecting livestock production, primarily concerning feed resource availability, and to discuss potential solutions. On the other hand, individual farmer interviews were conducted to gather quantitative data on feed resources, nutrient availability, and feeding practices used by dairy farmers. During the FGD and individual farmer interview, the researcher ask questions in Tagalog, the local language, for ease of communication with the farmer.

To ensure the accuracy and validity of the data gathered from the focus groups and individual farmer interviews, several methods were employed. These include key informant interviews with the dairy cooperative manager, a field technician, and an elder dairy farmer who possess knowledge about the study area. On-site observations were also conducted to evaluate and corroborate information about feed utilization. Furthermore, secondary data from Philippine Carabao Center at University of the Philippines Los Banos, dairy cooperatives, and published literature were used to supplement and enhance the gathered information.

Evaluation of Available Feed Resources

Quantitative data on feed resources' availability and nutrient quality were collected through in-depth interviews with farmers. Mean values of key feeding variables, such as diet composition and availability of nutrients like dry matter (DM), metabolizable energy (ME), and crude protein (CP), were calculated using the reported contribution of feed resources such as purchased feeds, crop residues, pasture/grazing, collected fodder, and cultivated fodder on the diet of dairy buffalo. The FEAST software provide standard feed values for DM, ME, and CP, ensuring accuracy and consistency in the calculations.

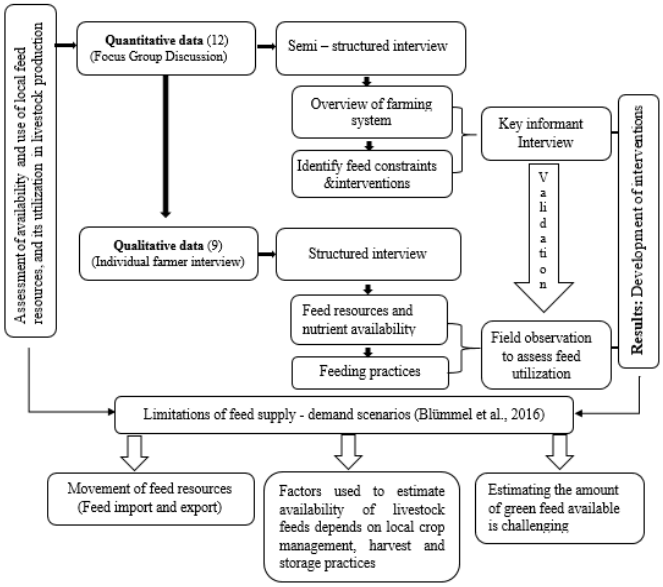

Figure 1. Methodological framework of the study and its limitations.

Data Analysis

Data from focus groups and individual interviews were processed with FEAST software version 2.21. Results were presented using various tools including; tables, figures, graphs, bar charts, and pie charts, to provide a comprehensive view of the research findings. Mean values and percentages were used to summarize the data and facilitate a clear understanding of the results.

RESULTS AND DISCUSSION

Overview of the Farming System

The results of the survey show that dairy buffalo farmers in Rosario, Batangas, and General Trias, Cavite have distinct farming system. In Rosario, farmers have developed a mixed crop-livestock production, with rice being a significant crop. This strategy focuses on both grain and crop residue production, serving as a vital coping mechanism to address the inadequate supply of forage in the area, particularly during the dry season. Victorio and Badayos (2006) emphasize that ruminant production in the area regularly faces serious limitations in roughage supply, particularly during the dry season. In addition, Cammayo & Padilla (2019) noted that dry season poses a significant challenge for dairy farmers, as they face a scarcity of quality feed resources for their animals. During this period crop residues such as corn stover and rice straw which are high in fiber and low in nutrients serve as a feed supplement and filler to the daily diets of dairy buffalos. The integration of buffalo production with cropping systems in Rosario is a key aspect of this approach. The buffalo production complements the cropping systems by utilizing the weeds associated with the cropping system and the crop residues. This integration is beneficial not only for the dairy farmers but also for the environment. As noted by Reddy (2016) integrated crop-livestock farming systems in the Philippines can enhance sustainability, productivity, and environmental benefits through mutual benefits of crop residues as feed and animal manure for soil improvement.

In contrast, dairy farmers in General Trias, Cavite, commonly engage in vegetable production and other off-farm activities. They cultivate vegetables like Pechay, Tomato, eggplant, and bitter gourd to diversify income sources. Specifically, dairy farmers in General Trias plant vegetables for daily earnings, indicating a focus on short-term income generation. Availability of land for farming is a significant constraint in the areas, with the majority of dairy buffalo farmers in General Trias categorize as landless. Farmers used idle land for grazing their animals, indicating the dependence of dairy buffalo production on land availability. As mentioned by Vargas (2003), rural farmer communities in the Philippines often cultivate land owned by the state and wealthy landlords. The rapid expansion of housing and urbanization in General Trias has led to a decrease in land area available for farming. As more land is converted for housing and industrial development, there is less available land for the dairy farmers to grow forage crops to feed their buffaloes. In other words, rapid

conversion of agricultural lands to housing and industrial uses is threatening the sustainability of dairy buffalo farming in General Trias. Farmers noted that besides land, the availability of green fodder for animals is also a constraint during the summer months (February to May). Such difference in farming system of dairy buffalo farmers emphasize the importance of understanding the local conditions and resource availability in each area, as well as the impact of land availability on dairy buffalo production practices.

Land Ownership and Utilization

The distribution of land area utilized by dairy farmers in Rosario and General Trias is presented in Figures 2 and 3, respectively. Results of the survey indicate different characteristics in land ownership and utilization between Rosario and General Trias, shedding light on the challenges faced by dairy farmers in these areas. In Rosario, a significant portion of households are smallholder farmers, with 45% owning 0-1 hectare of land, while 25% are large landholding farmers with over 2 hectares. Conversely, in General Trias, only 10% of farmers are classified as "large" landholders, owning 1 hectare, with approximately half (50%) being landless farmers. These differences extend to land use practices. Dairy farmers in Rosario integrate crop-livestock systems, utilizing resources like weeds from rice paddies and crop residues such as rice straw to feed their buffalo. Conversely, farmers in General Trias rely on idle land for tethered grazing to meet nutrient requirement of their animals. Argañosa and Bato (1991) noted that ruminants primarily subsist on vegetation from open grasslands, forested areas, agro-industrial by-products, crop residues, and weeds from idle or vacant lands. These contrasting approaches emphasize the importance of land availability and utilization strategies in sustaining dairy production. In General Trias, the rapid urbanization and expansion of housing have placed mounting pressure on agricultural land, emphasizing the urgency for comprehensive land use planning to support the long-term viability of dairy buffalo production in the area. With a significant portion of farmers in Rosario and General Trias being landless or having limited land ownership, the availability of suitable land for grazing and forage production becomes a major constraint for dairy production. By recognizing these dynamics and challenges faced by dairy farmers in Rosario and General Trias, stakeholders can work towards implementing strategies that promote sustainable dairy farming practices and address land use issues. This may involve exploring alternative feed sources, such as the utilization of agro-industrial by-products and the development of efficient forage production systems on limited land. Additionally, stakeholders can collaborate with local authorities to ensure that land use planning considers the needs of dairy farmers and preserves agricultural land for dairy production. Furthermore, the resilience of the agricultural sector in both Rosario and General Trias can be enhanced through the promotion of sustainable dairy production practices. This may include the adoption of integrated crop-livestock systems, as seen in Rosario, which optimize resource utilization and enhance agricultural sustainability. By sharing best practices and knowledge between the two areas, dairy farmers can learn from each other's experiences and adapt successful strategies to their local contexts.

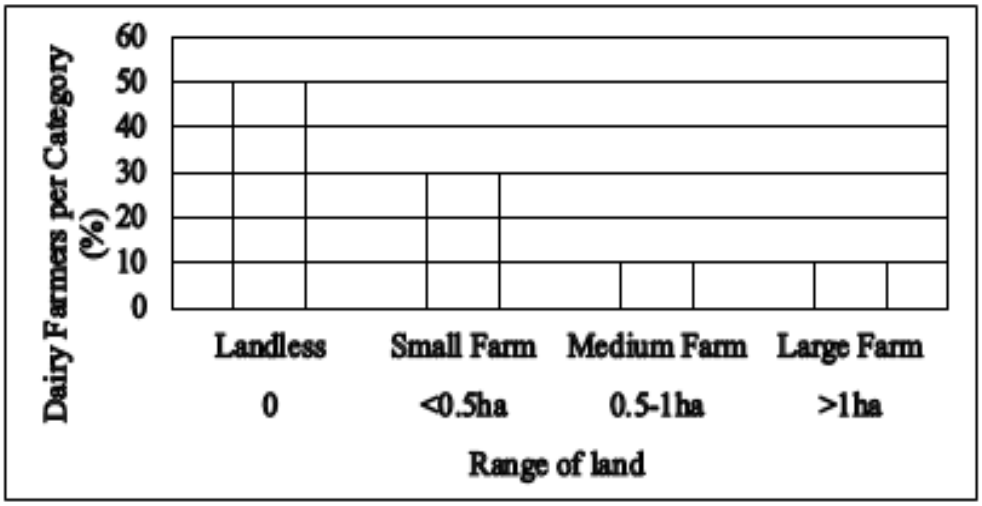

Figure 2. Distribution of land area cultivated by dairy farmers in different categories in Rosario, Batangas

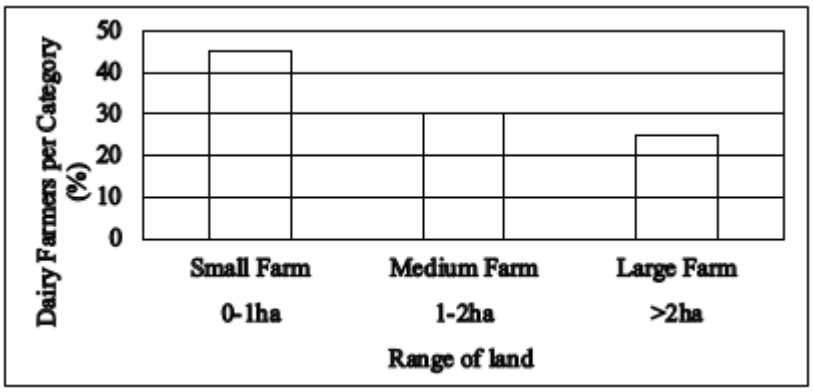

Figure 3. Distribution of land area cultivated by dairy farmers in different categories in General Trias, Cavite

Sources of Household Income

The data on the contribution of livelihood activities to household income of dairy farmers in Rosario, Batangas, and General Trias, Cavite is presented in Figure 4. In Rosario, the primary sources of income for dairy farmers are livestock production (dairying) (70%), crop production (rice) (15%), business (13%), and others (2%). This suggests that dairy farmers in Rosario rely heavily on livestock production, particularly dairy buffalo production, as their primary source of income. Additionally, they also engage in crop production, business ventures, and other activities to supplement their income. In contrast, dairy farmers in General Trias have a different income structure. Livestock production (dairy) accounts for 57% of their household income, while crop production (vegetable) contributes 27%. This corroborates with the result of De Guia., (2010) which states that 99% of farmer-respondents they surveyed in General Trias considered dairying as their major source of income. The remaining 14% comes from other activities, and only 2% from business ventures. This indicates that dairy farmers in General Trias also rely on livestock production, but to a lesser extent than those in Rosario. They also engage in crop production, but to a greater extent than in Rosario. According to Escarcha et al. (2020), shifting from cash crops to dairy buffalo has emerged as an adaptive response by farmers, primarily aimed at achieving income security. In addition, Tsuji (2021) noted that modern dairy farming of Murrah buffalo is becoming increasingly popular in farming communities near the Philippine Carabao Center which indicates a significant transformation in dairy culture, evolving from a minor, conventional regional system into a major industrial farming and business model that sustains the livelihoods of local small-scale farmers.

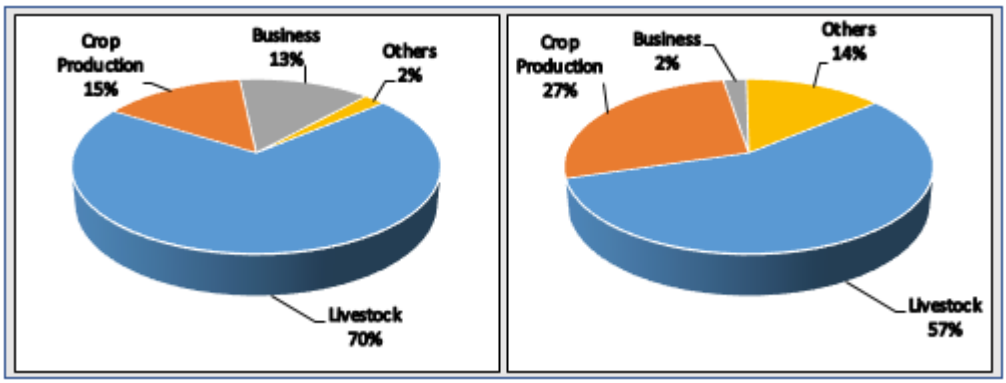

Figure 4. Contribution of livelihood activities to household income of dairy farmers in (a) Rosario, Batangas and (b) General Trias, Cavite

Livestock Holding and Species Composition

Table 1 presents a comparative analysis of average livestock holdings per household of dairy buffalo farmers in two study areas: Rosario, Batangas, and General Trias, Cavite, measured in Tropical Livestock Units (TLU). Notably, among the farmers included in the sample improved buffalo emerged

as the most significant livestock species in both areas, with households in Rosario holding an average of 14.55 TLU, compared to 10.75 TLU in General Trias. This substantial difference emphasize the prominence of buffalo production in Rosario, potentially due to favorable feeding management. Following improved buffalo, cattle were the second most common livestock, with an average holding of 2.56 TLU in Rosario and a markedly lower average of 1.15 TLU in General Trias. This disparity may reflect differences in economic factors influencing livestock production in the two areas. Dairy farmers in Rosario has a history of fattening cattle for meat production, influenced by their proximity to the Padre Garcia livestock auction market, which boosts market demand for this commodity. Pigs also showed a significant variation, with Rosario households averaging 4.55 TLU, while General Trias reported only 0.07 TLU. This contrast indicates that pig production is significantly more prevalent and potentially more economically viable in Rosario, driven by high market demand for pork, the widespread practice of the paiwi system, and proximity to local feed mills. In terms of goats, both areas reported minimal holdings, with Rosario at 0.03 TLU and General Trias slightly higher at 0.05 TLU. This indicates that goats are not a primary livestock choice in either area, which may be attributed to market demand or farming practices that favor other species. Poultry holdings were also low, with commercial poultry averaging 0.08 TLU in Rosario and absent in General Trias. Native poultry animals were similarly low, with 0.05 Tropical Livestock Units (TLU) in Rosario and 0.03 TLU in General Trias.

Table 1. Average Livestock holding per household in the study areas (TLU)

Livestock Species	Rosario, Batangas	General Trias, Cavite
	Mean	Mean
Improved Buffalo	14.55	10.75
Cattle	2.56	1.15
Pig	4.55	0.07
Goat	0.03	0.05
Poultry - Commercial	0.08	-
Poultry – Village Condition	0.05	0.03

**TLU - Tropical Livestock Unite which is equivalent to a live weight of 250kg*

Feed Resources and Seasonal Availability

Figure 5 and 6 showed the composition of feedstuff available throughout the year in relation to the rainfall patterns in Rosario and General Trias, respectively. In Rosario, during the peak of the rainy season, livestock primarily rely on naturally occurring green forage resources, which are harvested and brought to the animals. To prevent damage to rice crops, farmers confine their animals during this time. Buffaloes are stall-fed with cut native forages and crop residues, such as rice straw, which are fed at about 5 to 10 kg per feeding, twice daily. Farmers reported that their animals' weights recover during this period due to the abundance of green fodder. Argañosa and Bato (1991) mentioned that the feed supply for ruminants is relatively adequate during the rainy season. As the rainy season transitions to the dry season, crop residues become the main feed resource in Rosario, coinciding with the rice harvest season. Crop residues are stored using the "***bayeboy"*** method for feeding during the dry season. According to farmer respondents, after every rice harvest, dairy farmers collect and stockpile rice straw outdoors. The conserved straw is normally used as animal fodder during the lean months of January to May or when the paddies are already planted with rice in July and August. This is supported by Aquino et al. (2020) who mentioned that livestock producers commonly haul and stack rice straw from their rice farms, forming reserved feed for their animals during lean months or when good-quality roughages are scarce. The extent of rice straw utilization as fodder is dictated by the availability of forage gardens and the number of animals being fed. Feed scarcity is often experienced from February to May during the dry season, with crop residues being more abundant than green forage and legumes. Therefore, crop residues are fed to animals first, while purchased feeds supplement lactating buffaloes to increase milk production. Aquino et al. (2020) mentioned that rice straw alone is not adequate for milk production. Feeding purchased feeds, composed of commercial concentrates and agro-industrial by-products such as brewer's spent grain, are another strategy farmers use to cope with feed scarcity during the dry season and sustain milk production. Tethering in rice stubbles or vacant rice fields also provides additional forage.

In contrast, tethered grazing is widely practiced by dairy farmers in General Trias, Cavite. This corroborates with the statement De Guia et al. (2010) who mentioned that 99% of the farmer-respondents they interviewed in General Trias practiced extensive rearing, allowing their animals to graze on idle land year-round. Available natural pasture is a major feed resource during both the wet and dry seasons in General Trias. Forage availability in natural pasture increases from June to December, coinciding with the rainy season, but declines as the dry season approaches (Jan. – May). Naturally occurring green fodder species identified include Napier grass, Cogon grass, Para grass, Gamba grass, Amorsiko, and Digitaria species. Sajise et al. (1975) noted that dry matter production from Cogon grass is low, about 0.088 tons per hectare per year, which can only support about 0.25 animal units per hectare per year. During the dry season, dairy farmers in General Trias cope by harvesting naturally occurring Napier grass from diversion canal. Other farmers opt to harvest rice straw from neighboring barangays to have reserved feed for their animals. Rice straw is usually obtained for free, but hiring a jeep for hauling requires payment. Ironically, while rice straw is abundant during the rainy season after rice harvest, it is not fed to buffaloes because farmer prefer fresh grasses from natural pastures. Farmers observe weight loss among buffaloes during the dry season and attribute this to the scarcity of green grasses in available pasture areas. According to Argañosa and Bato (1991), the bulk of the ruminant population is in the hands of smallholder raisers, with feeding primarily based on available fibrous crop residues, whatever grasses are available on the farm, and grazing on idle lands or communal pastures. Result emphasize that livestock feed accessibility and type vary seasonally. To cope with seasonal variations and rainfall patterns, dairy farmers in Rosario and General Trias, may diversify their feed resources. This can include using crop residues, such as rice straw, and non-conventional feeds, such as brewer's spent grain.

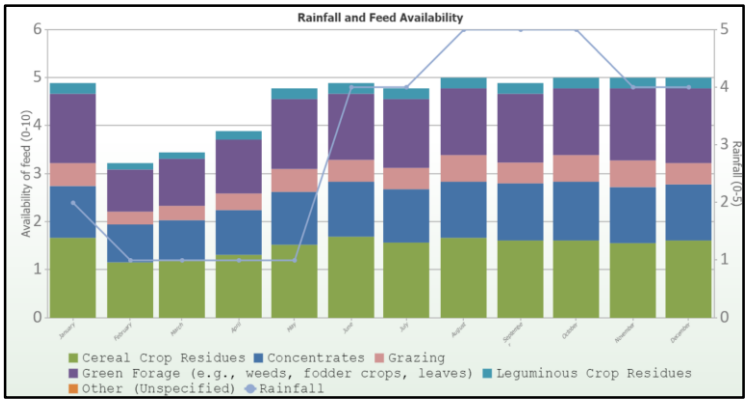

Figure 5: Composition of livestock feed throughout the year in relation to rainfall pattern in Rosario, Batangas

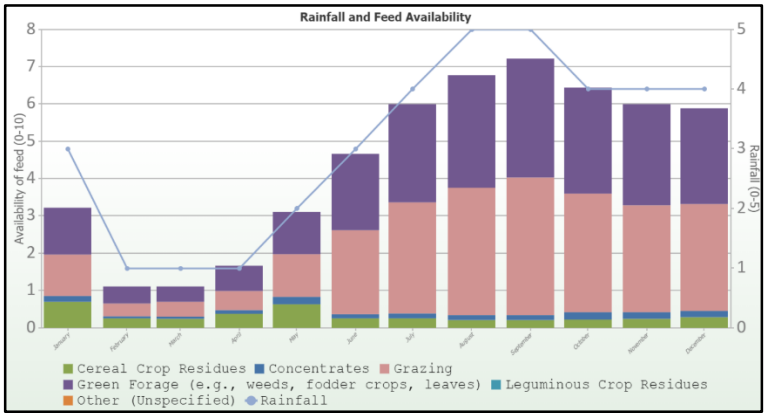

Figure 6: Composition of livestock feed throughout the year in relation to rainfall pattern in General Trias, Cavite

Raw Milk (Li/day) Received in Processing Plant across Dry and Rainy Season

Supplementary data for 2023 from the respective dairy cooperatives in Figure 7 highlights significant differences in milk production between the dry season (January to May) and the rainy season (June

to December) in General Trias, Cavite, and Rosario, Batangas. The data on milk production in General Trias, Cavite, reveals significant seasonal variations, particularly between the dry and rainy seasons. During the dry season, from January to May, milk production begins at 1,739 liters in January but declines steadily to 1,001 liters by May. This downward trend reflects the challenges faced by dairy farmers during these months, primarily due to limited forage availability and extreme heat, which adversely affect the milk production performance. Such decrease in production emphasizes the need for effective resource management and adaptive strategies to mitigate the impact of these environmental stressors. In contrast, the rainy season, spanning from June to December, marks a notable recovery in milk production. Starting at 1,061 liters in June, production peaks at 1,552 liters in December. This increase can be attributed to increase natural forage availability and enhanced pasture conditions that facilitate higher milk yields. The data clearly indicates that the rainy season consistently outperforms the dry season in terms of milk production, reflecting the beneficial effects of adequate rainfall on dairy buffalo production under grazing system of feeding.

Comparatively, the situation in Rosario, Batangas, presents a different scenario. During the dry season from January to May, milk production in Rosario, Batangas, begins at 383 liters in January, peaks at 406 liters in February, and then declines to 355 liters by May. This gradual decline suggests that dairy farmers in Rosario face similar challenges as those in General Trias, with limited forage supply impacting overall productivity. However, the rainy season in Rosario exhibits more variability. Milk production begins at 338 liters in June and continues to decline, reaching a low of 291 liters in September. Despite this initial downturn, production gradually recovers, ending the year at 377 liters in December. This pattern indicates that while the rainy season can initially hinder production due to excess moisture in forage, there is a recovery phase towards the end of the year. Notably, overall milk production levels during the rainy season in Rosario remain lower than those in the dry season, with December production not exceeding the levels recorded in the early dry season. These contrasting milk production patterns between General Trias and Rosario highlight the different challenges faced by dairy farmers in each region. The initial decline in output during the rainy season in Rosario may reflect the adverse effects of high humidity, which can reduce forage quality and increase moisture content in feed. These factors likely contribute to decreased milk production during this period. Conversely, the relatively higher production levels in General Trias during the rainy season suggest that farmers may be better equipped to manage their herds and resources effectively during these months. These seasonal dynamics highlight the importance of adaptive strategies in dairy buffalo production to maintain optimal output throughout the year, emphasizing the need for effective feed resource management during both the dry and rainy seasons.

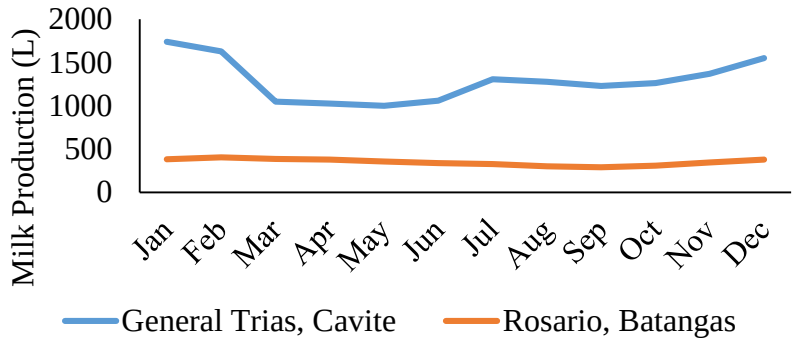

Figure 7. Mean Daily Raw Milk (Li/day) Delivered to Processing Plants by Dairy Buffalo Cooperatives in General Trias, Cavite, and Rosario, Batangas for 2023

Livestock Housing and Feeding Management System

The dairy buffalo management systems in Rosario and General Trias, Cavite, varies in terms of feeding practices and housing. In Rosario, a combination of indoor and outdoor feeding practices is employed. Animals are fed collected fodder, Napier grass, and purchased feeds such as lactating feeds and brewer's spent grains. The majority of farmers in Rosario have concrete sheds for their animals, providing a stable environment, while others only have milking parlors and allow their animals to stay in vacant areas under trees beside their houses. In contrast, dairy farmers in General Trias

primarily utilizes an extensive grazing system, allowing animals to graze from 3 PM to 9 AM for most of the year. During the rainy season, dairy farmers in Rosario keep their animals in sheds to prevent crop damage, whereas dairy farmers in General Trias use concrete shed and trees as shelters for their animals after grazing or even let the animals stay in the grazing area overnight to maximize feed intake. Feeding practices between the two areas also differ significantly. In Rosario, fixed amount of purchased feeds such as commercial lactating feeds, dairy cattle feed, and brewer's spent grains are often combined and mixed with water to enhance palatability and increase water intake. Farmers believe that this homemade feed mixture increases water intake, which they associate with increased milk production. However, Habib et al. (2007) noted that feeding concentrates at a flat rate without considering milk yield can result in overfeeding low producers and underfeeding high producers. In General Trias, natural pastures are the primary feed resource, with commonly harvested forage species including Napier grass, and Para grass. These forages are fed to buffaloes, especially during the rainy season when they are abundant. The reliance on natural pastures indicates a more traditional and extensive approach to buffalo production. The management of crop residues also varies between the two areas. In Rosario, crop residues are stockpiled to preserve rice straw for a longer duration. Some semi-commercial farmers in Rosario reported purchasing rice straw at PHP 3000 per hectare of rice field to ensure sufficient feed for emergencies. Conversely, in General Trias, crop residues are seldom harvested due to abundance of natural pastures in the area which supply feed requirement of the animals. Differences in management systems emphasize the importance of local conditions and resource availability in shaping dairy buffalo production practices. In Rosario, the use of concrete sheds, a mix of indoor and outdoor feeding, and the stockpiling of crop residues reflect a more intensive and resource-prepared approach. In General Trias, the emphasis on extensive grazing and reliance on natural pastures indicate a more traditional and extensive system, adapted to the availability of idle natural pastures.

Veterinary and Artificial Insemination (AI) Services

In Rosario, some farmers mentioned that veterinary services were not readily available, and in emergencies like dystocia or prolapse in dairy buffalo post-partum, they usually contact the Village-Based A.I Technician (VBAIT) for assistance. VBAIT technicians respond promptly to these calls, and the cost of service varies depending on the farmer's request. This limited access to veterinary services may have contributed to the increase incidence of animal mortality reported by farmers in the area. In contrast, General Trias dairy farmers benefits from active veterinary services. Government veterinarians in the area visit every quarter to administer vaccine, provide vitamins, and deworm the animals. This regular veterinary care may have contributed to the lower animal mortality rate reported by farmers in General Trias. On the other hand, breeding practices of dairy farmers in Rosario and General Trias also differ. In Rosario, 80% of farmers rely on artificial insemination, while 20% use bull service. In General Trias, farmers utilize both artificial insemination (30%) and bull service (70%). Farmers in both areas reported a high conception rate and reduced repeat breeding in cows bred using natural mating methods compared to artificial insemination. This indicate the financial capabilities of dairy farmers in both areas. Farmers with financial capability either purchase or keep bulls in their farm for breeding purposes.

Nutrient Contribution of Feed Resources

Table 2 presents the contribution of various feed resources to the dry matter (DM), metabolizable energy (ME), and crude protein (CP) contents of the total diet of dairy buffalo in Rosario, Batangas, and General Trias, Cavite. In Rosario, the majority of the DM (31.36%), ME (33.94%), and CP (51.76%) in the total diet of dairy buffalo comes from purchased feed, which includes brewer's spent grains, lactating feeds, rice bran, dairy cattle feed, and copra meal. This reliance on purchased feed is influenced by both the abundant availability of these resources in the area and the indoor feeding system commonly practiced. Crop residues and collected fodder also contribute significantly to the diet, with 25.08% and 24.48% of DM, respectively. The prevalence of rice-based farming in Rosario explains the abundance of crop residues. During the dry season, crop residues become a major feed resource due to their quantity and availability. On the other hand, dairy farmers in General Trias rely heavily on grazing as their primary source of feed, contributing 66.37% of DM, 67.11% of ME, and 68.71% of CP. Collected fodder and crop residues contribute 23.07% and 8.88% of DM, respectively. Sevilla et al. (2005) noted that the availability of grazing land and the feeding of soilage, or fresh,

succulent forage crops, are highly correlated with improved cattle productivity. This is due to the fact that these feeding practices allow the animals to access a diverse and nutrient-dense diet, which adequately meets their nutritional requirements. In contrast, purchased feed and cultivated fodder contribute minimally to the buffalo's diet, accounting for only 1.04% and 0.64% of DM, respectively. This lower contribution of purchased feeds could be due to their limited usage, which is typically reserved for times when the body condition of the animals requires additional supplementation, such as during prolonged dry seasons. The reliance on grazing, coupled with the utilization of collected fodder and crop residues, emphasize the importance of optimizing the availability and management of these feed resources to ensure the continued productivity and performance of the dairy herd in General Trias. Differences in feed resources between these regions are a reflection of the diverse local conditions and resource availability unique to each area. In Rosario, the accessibility of concentrate feeds, agro-industrial by-products, and the prevalence of crop residues and collected fodder influence the feeding practices of dairy farmers. Conversely, in General Trias, the abundance of available natural pastures and grazing area makes grazing the primary source of feed for dairy buffalo. The nutrient contribution of feed resources in Rosario and General Trias illustrates the adaptability of dairy farmers to local conditions. Dairy farmers in Rosario benefit from home – mixed feeds and crop residues, while General Trias farmers rely on natural pastures and grazing, demonstrating diverse strategies to achieve balanced and economical feeding for dairy buffalo.

Table 2. Contribution of various feed resources to the Dry Matter (DM), Metabolizable Energy (ME) and Crude Protein (CP) contents of total diet of Dairy Buffalo in Study Site

Feed Resources	Nutrient Contribution (%)		
	DM	ME	CP
Rosario, Batangas			
Purchased feed	31.36	33.94	51.76
Crop residue	25.08	15.05	9.54
Collected fodder	24.48	26.06	19.34
Cultivated fodder	17.29	23.24	17.96
Grazing	1.78	1.71	1.41
General Trias, Cavite			
Grazing	66.37	67.11	68.71
Collected fodder	23.07	25.91	23.88
Crop residue	8.88	5.63	4.43
Purchased feed	1.04	0.65	2.07
Cultivated fodder	0.64	0.71	0.91

Constraints of Dairy Production in the Area and Farmers Proposed Solution

Findings from focus group discussions, key informant interviews, and field observations showed that farmers in Rosario and General Trias face several similar constraints that significantly affect dairy production. These include high prices of commercial concentrates, feed shortages in terms of quantity and quality during dry season, limited land availability, and health issues (see Tables 3 and 4). Previous research has consistently highlighted feed shortages during the dry season as a major constraint to livestock production. A study by Duguma and Janssens (2016) in Ethiopia identified feed scarcity, especially during the dry season, as the most important constraint, primarily due to a lack of access to land. Another study by De Guia (2010) found that 95% of farmers in General Trias, Cavite experienced low milk yields from their livestock during the dry months, emphasizing the significant seasonal impact on productivity. According to Sarwar et al., (2009) such irregular and inadequate availability of quality feedstuffs can significantly hamper the performance of dairy

buffalo, stressing the critical necessity of a consistent supply of high-quality feed to maintain optimal livestock productivity.

Table 3. Major problems in order of importance identified by the dairy farmers in Rosario, Batangas and their suggested solutions

Identified Problems		Proposed Solutions by Farmers
	High cost of concentrate feeds	Research institutions particularly the Philippine Carabao Center provide them with least-cost feed formulation for their lactating buffalo
	Lack of area for fodder production	Allocate a portion of land from rice fields to be planted with improved forage
	Limited availability of green fodder during summer	Increase the amount of home-mixed feed *(Lactating feed, Brewer's spent grains, and Dairy cattle feed)* offered to animals to compensate for the shortage of feed intake Purchase and conserve rice straw as a supplementary feed source to mitigate the effects of limited green fodder availability.
	Repeat Breeding	Purchase or retain good quality sire for natural mating
	Prolapse	Adjust feed offered to pregnant buffalo based on Body Condition Score (BCS)

Table 4. Major problems in order of importance identified by the dairy farmers in General Trias, Cavite and their suggested solutions

Identified Problems		Proposed Solutions by Farmers
	Lack of land area for forage production	Collaborate with the Local Government Unit (LGU) to utilize vacant land for the production of improved forage.
	High price of concentrate feeds	Seek assistance from the Philippine Carabao Center to initiate research and development (R&D) efforts to develop least-cost lactating feed for dairy buffalo.
	Fluctuating and limited market outlet for milk and milk products	Milk product innovation Improve marketing strategies Partnering with nearby establishment such as hotels and restaurants.
	Middlemen offer lower price for injured or spent buffaloes	Establishment of meat processing facility for carabeef production
	Liver fluke infestation	Conduct regular deworming

Potential interventions derived from farmers proposed solutions

Based on the identified challenges, several potential intervention options have been proposed to address the prevailing problems in the study area. As mentioned by Umberger et al., (2022), it is imperative to undertake a prioritisation process with local stakeholders regarding what are high impact interventions and understand their intent to co-deliver these interventions in the future.

1. The Philippine Carabao Center can conduct research on locally available feed resources to develop least-cost feed formulations. These formulations can then be provided to dairy cooperatives for manufacturing of feeds for their members in collaboration with local feed mills. This approach could optimize the use of locally sourced ingredients while ensuring cost-effectiveness of feeds for farmers.
2. Partner with the LGU to utilize government land for improved forage production. By leveraging underutilized government land, the available area for forage cultivation can be expanded, helping to mitigate feed shortages.
3. Designate border areas or dikes within rice fields for the cultivation of improved forage species to minimize feed shortage. This strategy allows for the integration of forage production within existing rice farming systems, optimizing land use and enhancing feed availability.
4. Enhance the nutritional quality of locally available agro-industrial by-products, such as Brewer's spent grains and Soya pulp, through research. This intervention aims to compensate for the inadequate feed supply.
5. Empower dairy cooperative milk processors by providing comprehensive training on value-added milk product development and market access strategies. This capacity-building initiative will enhance their knowledge and skills, enabling them to increase competitiveness and build resilience against market fluctuations.
6. Train farmers on common animal disease diagnosis, prevention, and treatment. Equipping farmers with the necessary knowledge and skills can help them identify, manage, and prevent disease outbreaks, reducing economic losses and enhancing animal welfare.

CONCLUSION

Dairy farmers in Rosario rely on mixed crop-livestock production, while farmers in General Trias utilize natural pastures owned by banks and private individuals. In Rosario, the majority of buffalo's nutritional requirements are met by purchased feed, while in General Trias, available grazing areas are the primary feed source. During the dry season, crop residue and collected fodder from diversion canal become significant feed sources for farmers in Rosario and General Trias, respectively. Feed scarcity in both areas is attributed to the unavailability of land and poor natural pasture quality, prompting farmers to adopt coping strategies such as utilizing agro-industrial by-products, feeding commercial concentrate, and conserving rice straw. To address these challenges, potential interventions include: Providing dairy cooperatives with research-based least-cost ration formulations to reduce feed costs and improve feed quality through the utilization of locally available feed resources. Partnering with Local Government Units to utilize government land for enhanced forage production, which is crucial for mitigating feed shortages and promoting sustainable dairy production. Such could contribute to the growth and development of the dairy industry in both areas by optimizing feed resources, reducing costs, and promoting sustainable dairy production practices enabling growth and development in the dairy industry of both regions.

Recommendations

1. Develop Least-Cost Ration Formulations: Collaborate with the Philippine Carabao Center to create specific least-cost ration formulations that utilize locally available feed resources, including agro-industrial by-products, to lower feed expenses and enhance nutrition for dairy buffalo.
2. Enhance Forage Production: Work with Local Government Units (LGUs) to convert government-owned land into forage production sites. Establish demonstration plots and provide targeted training on effective forage management to ensure sufficient availability during the dry season.

3. Promote Use of Crop Residues and By-Products: Encourage the utilization of crop residues, such as rice straw, and agro-industrial by-products as alternative feed sources. Provide training focused on processing and storage techniques to improve their nutritional value.
4. Research Suitable Forage Species for Paddy Fields: Initiate research to identify and trial high-performing forage species that can thrive in rice paddies. Develop guidelines to assist farmers in balancing land use for rice and forage production based on economic viability, ensuring a consistent supply of forage throughout the year.

Authors' Contribution

ROR: Conceptualized the study, collected data, performed analyses, and contributed to the discussion of results.

AAA: Conceived the idea, refined the study's concept, enhanced the results and discussion sections, and assisted in formulating the study's conclusions.

ADB: Finalized the study design, contributed to the discussion of results, and suggested recommendations.

CSC: Assisted in writing the manuscript, providing valuable input in the results discussion and recommendations.

FCC: Contributed to the discussion of results, and the formulation of conclusions and recommendations.

All authors read and approved the final manuscript.

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