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## Buffalo milk production system in the Arari region of the Marajó archipelago, Pará

### *Sistema de produção leiteiro de búfalas na região do Arari no arquipélago do Marajó, Pará*

**ABSTRACT:** The Marajó archipelago is known for buffalo farming, and has a large concentration of this species in the area. Thirty-eight percent of the buffalo in Brazil are located in the Marajó archipelago. The aim of this study was to examine the socioeconomic, productive, and technological aspects of the buffalo milk production system in the municipalities belonging to the region of Arari, Cachoeira do Arari, Soure, and Santa Cruz do Arari in the archipelago of Marajó, Pará. Forty questionnaires containing 25 questions each were distributed to buffalo milk-producing farms. We carried out a hierarchical grouping of producers in which we divided them into four groups. Seventy percent of the producers responded that they produce milk only for marketing purposes. Buffalo milk production in Marajó is concentrated in small properties. Sixty-seven percent of the interviewees responded that food is the main limitation for production. Eighty percent of producers produced milk during some months of the year, and 42% did not develop alternatives to improve their pastures. Most producers (75%) responded that they did not receive technical assistance on their properties. Thus, in this region, the production systems predominantly consist of family farmers without technical assistance and with low use of technology, which limits the growth of dairy activity in the Arari region of the Marajó archipelago. There is a need to develop public policies that improve access to credit and to technical assistance to strengthen production systems in the region.

**RESUMO:** O arquipélago do Marajó é conhecido nacionalmente pela exploração da bubalinocultura que é evidenciada principalmente pela grande concentração de animais dessa espécie, com 38% dos búfalos existentes no Brasil. Objetivou-se realizar um diagnóstico socioeconômico, produtivo e tecnológico do sistema de produção leiteiro de búfalas nos municípios pertencentes à região do Arari, Cachoeira do Arari, Soure e Santa Cruz do Arari no arquipélago do Marajó, Pará. Foram aplicados 40 questionários contendo 25 questões cada, em fazendas produtoras de leite de búfala. Foi realizado um agrupamento hierárquico dos produtores, onde estes foram divididos em quatro grupos. Foi observado que 70% dos produtores responderam que produzem leite somente para fins de comercialização. A base da produção do leite de búfala no Marajó concentra-se em pequenas propriedades. Observou-se que 67% dos entrevistados responderam que a alimentação é a principal limitação no desenvolvimento da atividade leiteira, 80% dos produtores produzem leite durante alguns meses do ano e 42% não desenvolvem alternativas para melhorar seus pastos. Quanto à assistência técnica, grande parte dos produtores (75%) respondeu que não recebem assistência técnica em suas propriedades. Sendo assim, nesta região os sistemas produtivos são predominantemente formados por agricultores familiares sem assistência técnica e com baixo nível tecnológico, o que limita o crescimento da atividade leiteira na região do Arari no arquipélago do Marajó. Existe a necessidade de se desenvolver políticas públicas de acesso ao crédito e principalmente de assistência técnica que fortaleça os sistemas de produção na região.

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## 1 Introduction

The current Brazilian buffalo population (*Bubalus bubalis*) is estimated at 1.5 million heads, with the northern region of the country accounting for 1 million animals. The state of Pará is the main producer, with 40% of the national herd, of which 65% is concentrated mainly in the Marajó archipelago, distributed in the municipalities of Soure, Cachoeira do Arari, Ponta de Pedras, Muaná, Chaves, Salvaterra, and Santa Arari's Cross (IBGE, 2020).

Given their representation in the northern region, buffalo farming is an important part of the production chain, as is the production and processing of buffalo milk. The Associação Paraense dos Criadores de Búfalos estimates that a dairy with a production of 1,000 liters of milk employs approximately 30 families, directly and indirectly. In the Marajó archipelago, 22 dairy products are registered, demonstrating the economic and social importance of buffalo farming. In this area, a kilo of milk sold for R\$2.00 to R\$2.50 in 2021 (Agência Pará, 2021).

In the state of Pará, interest in the manufacture of buffalo cheese has increased considerably in recent years; thus, the region is nationally known for Marajoara cheese (Bittencourt *et al.*, 2013). This identity is associated with the botanical diversity of the native pastures present in Marajó, as the nutritional composition of milk and its derivatives can be altered by the cows' diet.

There is an intimate relationship between the floristic diversity and aromatic richness of the forage and the milk and cheese produced, which is possible due to the considerable conversion capacity of buffaloes to transform the nutrients obtained from forage into high-quality milk. In addition, this important characteristic allows a higher yield in the elaboration of dairy products as buffalo milk has high levels of protein, fat, total solids, calcium, and phosphorus (Cavali & Pereira, 2020; Manousidis *et al.*, 2018; Shingfield *et al.*, 2013).

The buffalo production system in this region is based on four distinct pasture ecosystems: the estuary's floodable areas; flooded areas in the Lower Amazon mesoregion; terra firme; and cultivated dry land. In these environments, the production of buffalo milk is still limited by the lack of proper management throughout the production system, which frequently leads to the prohibition of commercial product sale due to lacking adherence to the legislation of the Agricultural Defense Agency.

Therefore, the socioeconomic importance of buffalo milk and cheese production in the Marajó region makes it essential to understand the current state of the production system. Based on this knowledge, researchers will be able to propose solutions for the community, direct new research, and encourage public policies that improve access to credit, contributing to the growth of dairy production in the Marajó region. The aim of this study was to carry out a socioeconomic, productive, and technological diagnosis of the buffalo milk production system in the municipalities of Cachoeira do Arari,

Soure, and Santa Cruz do Arari in the Marajó archipelago, Pará.

## 2 Materials and Methods

No Animal Use Ethics Committee approval was obtained for this study because no animals were used. In addition, according to article 1, sole paragraph of "Resolution 510/16 Conselho Nacional de Saúde" of the Ministry of Health, it is not necessary to submit the project to the Ethics Committee when the interviewees are not identified and the research is accessible to the public.

The present study was carried out in the municipalities of Soure (latitude 00° 43' 00" S and longitude 48° 31' 24" W, 10 m altitude), Santa Cruz do Arari (latitude 00° 39' 48" S and longitude 49° 10' 30" W, 5 m altitude) and Cachoeira do Arari (latitude 01° 00' 41" S and longitude 48° 57' 48" W, 20 m altitude), belonging to the Arari micro-region of the Marajó Archipelago in the state of Pará. The region has an Af climate, according to the Köppen classification (Alvares *et al.*, 2013), with a humid tropical climate and average precipitation exceeding or equal to 60 mm in the driest month.

A questionnaire was provided to 40 farms that produced milk, distributed in three municipalities of the archipelago, from November 2014 to January 2015. Questionnaires containing 25 structured questions were used as the main data collection tool, and administration of the questionnaires was carried out during visits to production areas by a zootechnician and an agronomist. Data were collected from 6, 7, and 27 properties in the municipalities of Cachoeira do Arari, Soure, and Santa Cruz do Arari, respectively.

The 25 questions characterized the size of the property, producer's time in the dairy activity, labor used, main purpose of milk production, total number of animals on the property, buffalo breeds used on the property, number of lactating cows, number of dry cows, milking method, contribution of dairy activity to income, production derived from buffalo milk, presence of technical assistance, property limitations linked to dairy production, daily milk production during the season (rainy season) and between seasons (dry season), lactation duration, milk production season, management techniques used to improve pasture areas, use of pasture rotation, division of pasture areas, main concern for dairy activity in the region, composition of buffalo diet, use or not of forage conservation, native forage species were present on the property, and use of forage species cultivated on the property.

A cluster analysis was performed that grouped the farms into similar (lower variance within groups) and different (higher variance between groups) categories using Ward's method and the shortest Euclidean distance. The groups were created by analyzing the following variables using statistical program R, version R-4.1.2. (R Development Core Team, 2021): daily milk production in the harvest and between harvests, milk production season, lactation duration, main concern in the dairy activity in

the region, composition of buffalo diet, improvement of the pasture area, pasture rotation, pasture division, native species present on the property, species cultivated on the property, and presence or absence of forage conservation.

Differences between qualitative data were compared using Fisher's exact test with a significance level of 5% using R software version R-4.1.2. (R Development Core Team, 2021). Approaches were constructed based on analyses that allowed a follow-up of the transformations that occurred in the production systems, showing the dynamics that occurred in the communities and properties studied and/or activities explored.

### 3 Results and Discussion

After grouping the farms, Figure 1 shows the dendrogram with the formation of four distinct groups of producers, with a Euclidean distance of 12. Group 1 consisted mostly of farms having high production for the standards of the region and Group 4 consisted mostly of medium to large milk producers. These two groups represented 30% of the interviewed individuals. Group 2 mostly consisted of small milk producers and Group 3 of small and medium milk producers, which, in turn, represented 70% of the interviewed producers.

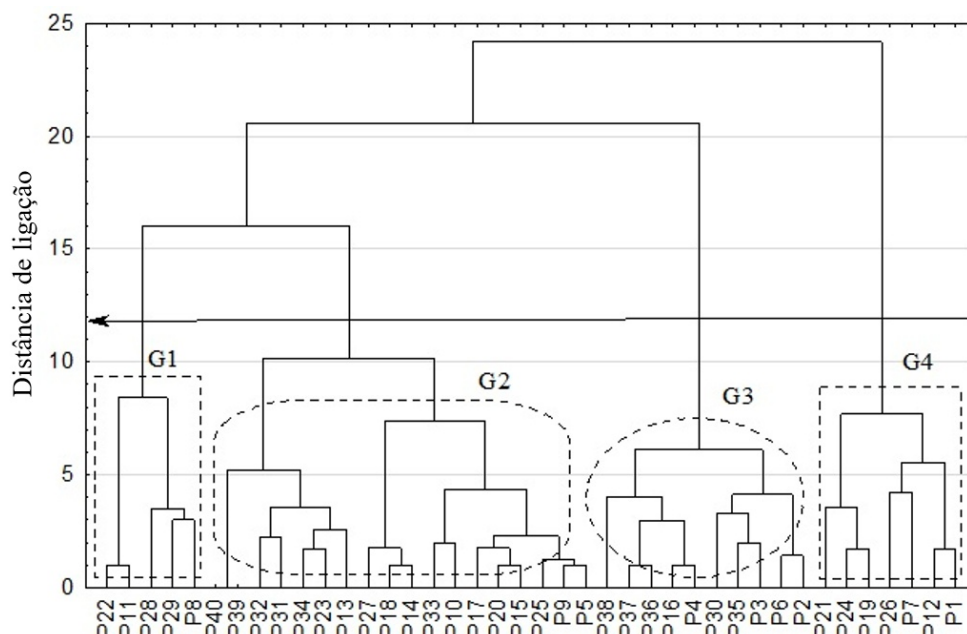
According to Table 1, most farms (47%) had an area of up to 100 ha, represented mostly by individuals from Groups 2 and 3, who owned 61% and 60% of the farms in this extract, respectively. Group 1 had the highest proportion of individuals with farms over 500 ha. At least 50% of the interviewed producers had been in activity for more than 20 years. The farms in Group 4 had the highest

proportion (71%) of owners who had been active for a longer period of time. In addition, only 22% of the properties had been in business for less than nine years. All farms in Group 1 used outsourced labor services, while Groups 2 and 3 mainly used family labor as a workforce.

When asked about the main purpose of the dairy activity, 70% of producers responded that they produce milk only for commercial purposes, and all producers in Group 1 had fully commercialized production. Groups 2 and 3 contained the most producers using part of the production for their own consumption. Thirty-five percent of the producers produced some type of milk derivatives, such as Marajó cream-type cheese or butter, dulce de leche, and buffalo butter. All producers in Group 1 answered that they did not produce dairy products and that they sold milk *in natura* (Table 1).

More than half of the interviewed producers (55%) had 0 to 100 animals, and the largest representations in this extract were from producers in Groups 2 and 3 (72% and 50%, respectively). The producers in Group 1 had the highest proportion of producers with more than 400 head of buffalo. Sixty percent of all producers used Murrah × Mediterranean crossbred animals.

Of the producers interviewed, 97% used manual milking. All producers in Groups 2, 3, and 4 used the manual system, while Group 1 (20%) was the only group with producers using mechanized milking. Dairy activity contributed to a family income of 92% of the interviewed producers. Only producers in Groups 2 and 3 answered that dairy activity contributed more than 75% of the family income on the property.



**Figure 1.** Hierarchical ascending groupings of buffalo milk-producing farms (P) in the Arari region of Marajó, Pará.

**Figura 1.** Agrupamentos ascendentes hierárquicos de fazendas (P) produtoras de leite de búfala na região do Arari no Marajó, Pará.

**Table 1.** Productive characteristics linked to the dairy activity of the farms studied in the Arari region of the Marajó archipelago, Pará.**Tabela 1.** Características produtivas ligadas a atividade leiteira das fazendas estudadas na região do Arari no arquipélago do Marajó, Pará.

Characteristics	Groups					p-value
	General	1	2	3	4	
Property size (ha)						0.897
0–100	47.5	40.0	61.1	60.0	42.8	
100–500	27.5	20.0	38.9	30.0	28.6	
> 500	7.5	40.0	0.0	10.0	28.6	
Production time (years)						0.208
0–4	15.0	40.0	16.7	0.0	14.3	
5–9	7.5	20.0	5.6	10.0	0.0	
10–19	27.5	0.0	33.3	40.0	14.3	
20 years or more	50.0	40.0	44.4	50.0	71.4	
Labor type						0.028
Family labor	52.5	0.0	72.2	50.0	42.9	
Hired labor	42.5	100.0	27.8	30.0	57.1	
Both	5.0	0.0	0.0	20.0	0.0	
Main purpose						0.888
Consumption	10.0	0.0	11.1	10.0	14.3	
Sale	70.0	100.0	66.7	60.0	71.4	
Consumption and sale	20.0	0.0	22.2	30.0	14.3	
Total animals						0.515
0–100	55.0	40.0	72.2	50.0	28.6	
101–400	37.5	40.0	22.2	50.0	57.1	
> 400	7.5	20.0	5.6	0.0	14.3	
Races						0.111
Murrah	27.5	40.0	27.8	20.0	28.6	
Mediterranean	5.0	0.0	5.6	0.0	14.3	
Crossbred	60.0	40.0	66.7	60.0	57.1	
All of the above	7.5	20.0	0.0	20.0	0.0	
Lactating cows						0.771
0–20	50.0	40.0	61.1	50.0	28.6	
21–40	25.0	20.0	27.8	20.0	28.6	
41–60	15.0	20.0	5.6	20.0	28.6	
>60	10.0	20.0	5.6	10.0	14.3	
Dry cows						0.967
None	10.0	20.0	5.6	10.0	14.3	
0–50	80.0	60.0	88.9	80.0	71.4	
51–100	5.0	20.0	0.0	0.0	14.3	
>100	5.0	0.0	5.6	10.0	0.0	
Milking						0.411
Manual	97.5	80.0	100.0	100.0	100.0	
Mechanical	2.5	20.0	0.0	0.0	0.0	
Contribution of activity to income						0.643
None	7.5	0.0	11.1	0.0	14.3	
Up to 25%	40.0	60.0	38.9	40.0	28.6	
25%–50%	32.5	40.0	27.8	20.0	57.1	
50%–75%	5.0	0.0	11.1	0.0	0.0	
>75%	15.0	0.0	11.1	40.0	0.0	
Milk derivatives						0.749
Yes	35.0	0.0	33.3	50.0	42.9	
No	65.0	100.0	66.7	50.0	57.1	
Technical assistance						0.580
Yes	25.0	40.0	16.7	40.0	14.3	
No	75.0	60.0	83.3	60.0	85.7	
Property limitation						0.288
Pasture	67.5	80.0	77.8	60.0	42.9	
Genetics	15.0	0.0	11.1	30.0	14.3	
Technical assistance	5.0	0.0	0.0	0.0	28.6	
Others	12.5	20	11.1	10	14.3	

Most producers (75%) responded that they did not receive technical assistance on their properties, with the largest representative groups being 2 and 4. When asked about the main limitations on the properties, the majority of producers (67%), mainly from Groups 1 and 2, responded that management and lack of pasture are the main limiting factors in the production environment, followed by animal genetics, technical assistance, and others (transport and infrastructure).

Regarding the time of production of buffalo milk in Marajó (Table 2), 92% of producers produced milk in the rainy season of the year, while in the inter-harvest, the proportion that produced milk decreased to 62%. All groups except Group 1 contained producers who did not produce milk between harvests.

Regarding the duration of lactation, 65% of properties had animals with a lactation duration of 5 to 9 months, and 25% had animals with a lactation duration of more than nine months.

Observing the groups separately, Groups 2 and 3 had 78% and 70%, respectively, of farms that had animals with an average lactation duration of 5 to 9 months. Twenty percent of producers managed to produce buffalo milk throughout the year and most producers (80%) only produced for a few months. Group 2, represented by small producers, was the group with the highest proportion of producers who produced milk during some months of the year (83%).

When asked about the actions used to improve pasture production conditions on the properties, 42% of the interviewed producers answered that they did not take any action. Most producers (57%) responded that they carried out some management to improve the conditions of pastures on their properties. Groups 1 and 4 had the highest proportion of producers who responded that they had improved their pastures. Producers were asked two questions about improving management, the first referring to the use of rotation between pasture areas, and the second about the intention to divide new areas.

The vast majority (60%) of the producers answered that they use the continuous stocking system on their properties and that they do not carry out any type of rotation of the animals in the areas; Groups 2 and 3 had the highest proportion of individuals who did not rotate. When asked about the intention to divide the pasture areas, most producers (67%) answered that they intended to divide the pastures.

When asked about the main concerns regarding the buffalo milk production system, the majority (80%) responded that herd feeding was the main barrier. The producers were asked about the forms of feeding used in the herd, and the vast majority (85%) responded that the animals were kept exclusively on pasture, with emphasis on Groups 3 and 4, in which all individuals used pasture exclusively for animal feed. Some of the producers (15%) responded that, in addition to pasture, the animals received supplementation with concentrate or forage (grass) during part of the year. Only 2.0% of producers (found only in Group 1) used forage conservation in their dairy production system.

Regarding the native forage species present on the farm, 32% of the producers did not know which species were present on the property. The species *Echinochloa polystachya*, commonly known as Canarana grass, was the native forage most cited by respondents; 35% responded that they observed the species on their properties. When asked about the use of cultivated forages, 35.0% answered that they did not use them. Of the cultivated species, *Brachiaria humidicola* was the most cited cultivated forage (55%), followed by *Brachiaria brizantha* cv. Marandu (7.5%), and *Pennisetum purpureum* cv. Napier (2.5%).

In the surveyed municipalities, the predominance of small- and medium-sized (Groups 1 and 2) properties was remarkable. This production base followed the trends and production models observed in Brazil, both in dairy cattle and in buffalo production developed in this and other regions of the country, that is, heterogeneity among producers (Cruz *et al.*, 2020; Rodrigues *et al.*, 2008).

Buffalo milk production systems can be developed on small, medium, and large areas of land, and most small and medium milk producers in Marajó have been active for more than 20 years using family labor. This relationship probably reduces the rural exodus in the studied region, maintains family labor in the countryside, and provides employment (Menezes, 2011).

The main purpose of dairy activity in the Marajó region is the direct commercialization of the product in the local consumer market, with a diversity of interests among small, medium, and large milk producers in the region. In general, large producers are interested in selling their entire milk production without any processing, as they do not work with dairy products. Small and medium producers use milk for consumption, but also manufacture Marajoara cream-type cheese and/or butter, constituting a source of income for families; these results corroborate the results found in this region that highlight the predominance of family work and the traditional method of cheese production (Cruz *et al.*, 2020).

The maintenance of herds with dual-purpose animals, such as Murrah × Mediterranean crossbreeds, mainly by small dairy farmers, is probably part of the strategy of diversifying the composition of income by complementing the regular marketing of milk and cheese with the sale of calves to beef cattle producers. This limits greater specialization and, consequently, impacts animal productivity (Ferreira *et al.*, 2020; Sena *et al.*, 2012).

There was little uniformity in the distribution of the number of lactating and dry cows. Despite the territorial extensions that small producers use to manage their herds, the number of dry cows exceeded those in lactation. This characterizes the lack of property management in the production system.

**Table 2.** Characteristics of buffalo milk production season and forage production on farms in the Arari region of the Marajó archipelago, Pará.**Tabela 2.** Características da época de produção do leite de búfala e da produção forrageira nas fazendas da região do Arari no arquipélago do Marajó, Pará.

Characteristics	Groups					p-value
	General	1	2	3	4	
Harvest production (L)						0.046
No harvest production	7.5	0.0	11.1	10.0	0.0	
0–50	50.0	0.0	66.7	40.0	57.1	
51–100	17.5	0.0	11.1	30.0	28.6	
101–150	12.5	20.0	11.1	20.0	0.0	
> 150	12.5	80.0	0.0	0.0	14.3	
Off-season production (L)						0.0796
No off-season production	37.5	0.0	44.4	30.0	57.1	
0–50	42.5	40.0	50.0	40.0	50.0	
51–100	15.0	40.0	5.6	30.0	0.0	
> 150	5.0	20.0	0.0	0.0	14.3	
Lactation duration						0.170
0–4	10.0	0.0	11.1	10.0	14.3	
5–9	65.0	40.0	77.8	70.0	42.9	
>9	25.0	60.0	11.1	20.0	42.9	
Production season						0.470
Whole year	20.0	40.0	16.7	90.0	28.6	
Some months	80.0	60.0	83.3	10.0	71.4	
Improve pastures						0.908
Yes	57.5	80.0	50.0	40.0	57.1	
No	42.5	20.0	50.0	60.0	42.9	
Pasture rotation						0.109
Yes	40.0	80.0	33.3	20.0	57.1	
No	60.0	20.0	66.7	80.0	42.9	
Division of pastures						0.177
Yes	67.5	80.0	72.2	50.0	71.4	
No	32.5	20.0	27.8	50.0	28.6	
Main concern						0.285
Sanity	10.0	0.0	16.7	10.0	0.0	
Feeding	80.0	80.0	83.3	80.0	71.4	
Genetic enhancement	5.0	0.0	0.0	10.0	14.3	
All and Others	5.0	20.0	0.0	0.0	14.3	
Feeding						0.206
Pasture	85.0	60.0	77.8	100.0	100.0	
Concentrated supplementation	7.5	20.0	11.1	0.0	0.0	
Cut and carry system	7.5	20.0	11.1	0.0	0.0	
Forage conservation						0.125
Yes	2.5	20.0	0.0	0.0	0.0	
No	97.5	80.0	100.0	100.0	100.0	
Native forage species						0.115
Do not know	32.5	20.0	61.1	0.0	14.3	
<i>Echinochloa polystachya</i>	35.0	80.0	38.9	30.0	0.0	
Andrequice	17.5	0.0	0.0	70.0	0.0	
Taboquinha	15.0	0.0	0.0	0.0	85.7	
Cultivated species						0.670
None	35.0	40.0	33.0	40.0	28.6	
<i>Brachiaria humidicola</i>	55.0	40.0	61.1	50.0	57.1	
<i>Brachiaria brizantha</i> cv. Marandu	7.5	20.0	5.6	0.0	14.3	
<i>Pennisetum purpureum</i> cv. Napier	2.5	0.0	0.0	10.0	0.0	

The practice of manual milking in Marajó highlights the need for a study related to the efficiency of this type of milking in the region, especially the correct handling and hygiene practices needed to obtain a quality product. The low use of mechanized systems in the region can be explained by the fact that credit is available mainly to medium and large producers, as this system is only viable in farms where the number of cows for milking is high, as mechanized milking is generally associated with the highest production cost (Linhares *et al.*, 2021).

The low percentage of producers using technical assistance may reflect the inefficiency of resource use on properties and the inadequacy of management techniques. Technical assistance improves zootechnical control and strategies for health, genetic improvement, and food use efficiency. Production planning and the use of appropriate technologies are essential for the financial success of buffalo milk production systems (Dadario *et al.*, 2018).

Producers in the Arari region are limited mainly by the lack of forage during periods of feed shortage. There is also a lack of research related to genetic improvement. Though such programs exist for cattle, no program exists for the genetic improvement of buffalo species in the region, and any existing initiatives are associated with the tenacity of a few researchers and breeders (Malhado *et al.*, 2007). Research allied to the management of dairy activity, which directly affects the proportion of income in the family, helps training producers to follow up on zootechnical and economic indices, and would decisively contribute to high production outcomes (Ferrazza *et al.*, 2015).

The low production of milk during and between harvest periods is directly linked to the effect of seasonality. In the dry period of the year, when pastures cannot be grazed, a drastic reduction in milk production occurs, which negatively affects native pasture productivity. The rational use of these areas can strategically contribute to reducing the cost of milk production by extending the grazing season during the dry period of the year, prolonging the grazing season at the end of the rains, and anticipating the beginning of the rainy season (Dadario *et al.* 2018; Queiroz *et al.*, 2012).

To obtain results that increase the lactation period of the animals and contribute to maintaining milk production throughout the year, small and medium producers in the region, who mostly do not seek alternatives to improve their pastures, use as a main method only the division of the pasture, in which the property is randomly divided. They do not define the number of paddocks depending on the period of occupation and rest or consider the existing animal category. In contrast, some of the large producers who had better responses during the lactation period maintained production throughout the year by diversifying their management and feeding methods.

Concern about food by producers is understandable in view of the limited forage resources in the Arari region during the dry season. For this reason, weeding, food supplementation, and forage conservation measures must be adopted during this period. A diversified and adequate

herd diet is one of the factors that directly influences the production and quality of milk (Manousidis *et al.*, 2018). Despite their economic and environmental importance, the preservation and use of these natural pastures have received little attention from the government (Nabinger & Carvalho, 2009).

Therefore, this region has a need for efficient alternatives during the critical period of forage production; for example, by implementing forage storage techniques through silage as a possible method to maintain production of good-quality forage throughout the year.

The use of native pastures in the buffalo production system in Marajó is remarkable in all the properties studied; however, the lack of knowledge, mainly of small producers, regarding which species are found on their property makes it difficult to choose and implement the best management strategy. Another factor to consider is that producers in general do not cultivate and produce forage, and when they do, they do not choose species with satisfactory nutritional value that are adapted to the region.

In the specific case of milk production, the success of pasture-based animal production depends on the use of forages with high nutritional value that are managed with the objective of ensuring high nutrient intake (Ribeiro *et al.*, 2009). It is also important to emphasize the value of management and the conservation of resources. According to Carvalho & Batello (2009), policies related to natural resources must be adjusted through initiatives oriented towards conservation, and in this case, production must be a reward, not a target.

## 4 Conclusion

It can be inferred from the data that buffalo milk producers in the Arari region are predominantly family farmers without technical assistance and with limited use of technology. These factors, together with structural limitations and logistical difficulties in this region, limit the growth of dairy activity in the Arari region of the Marajó archipelago.

Our study highlights the need to develop public policies that allow access to credit and technical assistance to strengthen production systems in the region. In addition, our study reveals the need to encourage the application of technologies that contribute to the growth and competitiveness of milk buffalo farming, reconciling animal productivity, economic, social, and environmental sustainability, as well as investments in infrastructure in the region.

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