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Caracterização de propriedades leiteiras no noroeste do Rio Grande do Sul: fatores de risco associado a ocorrência de enfermidades em vacas

Rômulo Teles França

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“It is not the strongest of the species that survives, nor the most intelligent; it is the one most adaptable to change.” — Charles Darwin, British naturalist

Resumo

FRANÇA, Rômulo Teles. **Caracterização de propriedades leiteiras no noroeste do Rio Grande do Sul: fatores de risco associado a ocorrência de enfermidades em vacas.** 2023. 67f. Dissertação (Mestrado em Ciências) - Programa de Pós-Graduação em Veterinária, Faculdade de Veterinária, Universidade Federal de Pelotas, Pelotas, 2023.

O objetivo dessa dissertação foi caracterizar propriedades da microrregião de Sananduva, mesorregião Noroeste do Rio Grande do Sul, buscando os fatores de risco associado à ocorrência de enfermidades em vacas leiteiras. No primeiro estudo foram selecionadas 58 propriedades de mão de obra familiar com um total de 1636 animais em lactação, sendo que, dessas 58, 46 foram monitoradas por um período de 13 meses, avaliando a incidência de patologias durante a lactação. Foi realizado um questionário que detinha dados de manejos, produção e lactação, manejos pré e pós-parto da propriedade e desempenho reprodutivos. Os rebanhos em compostos em média de 28 animais em lactação com produção média de 24,78 ± 21,2 litros de leite/vaca/dia. Em relação aos sistemas de criações, o mais frequente foi o semi-extensivo com predominância de vacas da raça Holstein-Friesian. Já em relação ao manejo pré parto, se destaca o baixo fornecimento de dieta acidogênica, falta de conforto, baixa porcentagem de canzil e cobertura na linha de cocho, o que pode culminar em baixa eficiência da dieta pré-parto. Como resultado, a incidência de patologias foi relatada, analisadas entre os diferentes sistemas e de uma forma global. No segundo estudo foi realizado uma análise associativa entre variáveis de manejo de pré e pós-parto, manejo e de desempenho relacionando com a ocorrência de doenças. Para tanto foram selecionadas 7 propriedades rurais que apresentavam no mínimo 50 vacas em lactação, da raça holandesa e que era fornecida dieta acidogênica no período pré-parto, afim de determinar a incidência de enfermidades. Foram realizadas correlações entre os manejos e incidência de doenças uterinas. Observou-se que animais que tinham acesso ao cocho de água antes e depois da ordenha tiveram menores chances de apresentar retenção de placenta. Em relação ao manejo pré-parto, a utilização de canzil na linha de cocho foi benéfica para uma menor incidência de metrite. Ademais, quando se avalia sobra de alimentação no cocho no período pré e pós-parto, encontra-se uma menor incidência de endometrite. Em conclusão, o uso de tecnologias reduz as perdas.

Palavras-chave: sistemas de produção; bovinos; manejo; sanidade.

Abstract

FRANÇA, Rômulo Teles. **Characterization of dairy farms in northwest Rio Grande do Sul: risk factors associated with the occurrence of diseases in cows**. 2023. 67f. Dissertation (Master degree in Science) - Programa de Pós-Graduação em Veterinária, Faculdade de Veterinária, Universidade Federal de Pelotas, Pelotas, 2023.

The objective of this dissertation was to characterize properties of the microregion of Sananduva, Northwest mesoregion of Rio Grande do Sul, looking for risk factors associated with the occurrence of diseases in dairy cows. In the first study, 58 family farms were selected, with a total of 1636 animals in lactation, and, of these 58, 46 were monitored for a period of 13 months, evaluating the incidence of pathologies during lactation. A questionnaire was carried out with data on management, production and lactation, pre and postpartum management of the property and reproductive performance. Herds comprised an average of 28 lactating animals with an average production of 24.78±21.2 liters of milk/cow/day. Regarding the breeding systems, the most frequent was the semi-extensive with a predominance of cows of the Holstein-Friesian breed. In relation to pre-partum management, the low supply of acidogenic diet, lack of comfort, low percentage of kennels and coverage in the trough line stand out, which can culminate in low efficiency of the pre-partum diet. As a result, the incidence of pathologies was reported, analyzed across different systems and globally. In the second study, an associative analysis was carried out between variables of pre and postpartum management, management and performance related to the occurrence of diseases. For that, 7 rural properties were selected that had at least 50 lactating cows, of the Holstein breed and that were supplied with an acidogenic diet in the pre-partum period, in order to determine the incidence of diseases. Correlations were made between the managements and the incidence of uterine diseases. It was observed that animals that had access to the water trough before and after milking were less likely to have a retained placenta. Regarding pre-partum management, the use of a headlock in the trough line was beneficial for a lower incidence of metritis. In addition, when evaluating the surplus feed in the trough in the pre- and postpartum period, a lower incidence of endometritis is found. In conclusion, the use of technologies reduces losses.

Keywords: production systems; cattle; management; sanity.

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Lista de Abreviaturas e Siglas

%	Porcento
BCAD	Balanço Cátion Aniônico Dietético
BHB	Beta-hidroxibutirato
Ca	Cálcio
CCS	Contagem de Células Somáticas
CPP	Contagem Padrão em Placa
DEL	Dias em Lactação
DUT	Doenças Uterinas
ECC	Escore de Condição Corporal
FDA	Food and Drug Administration
g	Grama
GC/MS	Cromatografia Gasosa com espectro de massa
IEP	Intervalo Entre Partos
Kg	Quilograma
L	Litros
mEQ	mil equivalente
mL	Mililitro
MS	Materia Seca
PEV	Período de Espera Voluntário
pH	Potencial de Hidrogênio
PIB	Produto Interno Bruto
REF	Retenção dos Envoltórios Fetais
RS	Rio Grande do Sul
SisBi/UFPel	Sistema de Bibliotecas da Universidade Federal de Pelotas
TMR	Total Mixed Ration (Ração Total Misturada)
CEPAL	Comisión Económica para América Latina y Caribe

Sumário

1 Introdução

A bovinocultura leiteira apresenta um papel fundamental para a economia brasileira, gerando emprego e renda para um grande número de agricultores no país, principalmente em propriedades com mão de obra familiar (Travassos *et al.*, 2016). A produção brasileira de leite bovino sob inspeção foi de aproximadamente 25 bilhões de litros, no ano de 2021, sendo 2,19% menor que a do ano de 2020, demostrando um recuo da produção. Em contrapartida, no estado do Rio Grande do Sul ocorreu o inverso, elevando a produção em 0,8%, considerando o mesmo período (IBGE, 2022).

A queda da produção brasileira pode ser atribuída a diferentes razões, como fatores climáticos, desvalorização cambial e preços elevados dos insumos, além de desafios relacionados ao desempenho produtivo dos animais. Tem sido observado a saída de produtores e laticínios do setor, pelos fatores descritos acima, demostrando que há necessidade urgente de incrementos na gestão e adoção de tecnologias para se seguir na atividade. A bovinocultura leiteira tem se tornado cada vez mais seletiva, intensiva em capital e retorno sobre custo alimentar considerável (Carvalho *et al.*, 2022).

Os sistemas de produção de leite no Brasil são heterogêneos por todo o território nacional, destacando a mão de obra familiar, que representa aproximadamente 58% da produção, contribuindo significativamente para o setor agropecuário e receita das propriedades rurais (IBGE, 2017). Entretanto, segundo relatório do CEPAL (2014) (Comisión Económica para América Latina y Caribe), a pecuária leiteira baseada na mão de obra familiar ainda apresenta problemas relacionados a índices produtivos, gerando renda insuficiente para possíveis investimentos e garantia da permanência no setor.

Entre os estados brasileiros, o Rio Grande do Sul (RS) é o terceiro com maior produção de leite, com 12,1% da produção brasileira, tendo produzido aproximadamente 4,3 bilhões de litros no ano de 2020 (IBGE, 2020).

A mesorregião Noroeste do RS, desponta como a maior produtora de leite bovino, com 2,90 bilhões de litros de leite ou cerca de 8,19% do leite produzido em todo território nacional. Um dos fatores que evidencia a produtividade na região sul do

Brasil é a produção por vaca/ano, que é de aproximadamente 3.437 litros (IBGE, 2020). Segundo Zoccal *et al.* (2006), a produção média da microrregião de Sananduva era de 2460 L/vaca/ano, sendo uma das maiores do país.

Um entrave para maximizar a produção leiteira é a saúde dos animais, sendo que o período de transição é a janela de maior desafio para as vacas leiteiras, decorrente de desordens metabólicas, imunológicas e hormonais, além de mudanças comportamentais e de manejo, sendo essas responsáveis por efeitos deletérios na saúde, produtividade e reprodução (Barletta *et al.*, 2017).

Segundo Grummer (1995), o período de transição é classificado como o intervalo entre as três semanas que antecedem o parto e as três semanas subsequentes ao parto. O período pré-parto é caracterizado por aumento da demanda energética, decorrente do desenvolvimento fetal e diminuição gradual do consumo de alimentos, sendo mais acentuada na semana final da gestação, chegando a um decréscimo de aproximadamente 30% na ingestão de matéria seca (MS) (Drackley, 1999; Ingvarstein & Andersen, 2000; Rabelo *et al.*, 2003). Também se observa disfunção imunológica que levam a um aumento a incidência de distúrbios metabólicos e patologias (Drackley, 1993; Mallard, 1998).

No período pós-parto também é observado baixo consumo de matéria seca, mas ao contrário do pré-parto, ocorre acréscimo gradual do consumo. Durante este período, existe uma alta demanda de nutrientes, devido, principalmente, ao aumento da demanda metabólica do tecido mamário, com maior captação de glicose requerida para síntese de lactose (Bell, 1995; Ingvarstein & Andersen, 2000).

Além do metabolismo energético, existe a súbita necessidade de cálcio (Ca) para a homeostasia (DeGaris & Lean, 2008) decorrente das necessidades de Ca para produção de colostro e do leite (Horst *et al.*, 2005). A demanda de Ca súbita muitas vezes é tão intensa e aguda que excede os mecanismos homeostáticos, podendo resultar em casos de hipocalcemia clínica ou subclínica (Horst *et al.*, 2005; Goff, 2008).

Segundo Goff (2014), o fornecimento de uma dieta acidogênica durante o periparto tem a finalidade de diminuir a incidência de casos de hipocalcemia, por ser uma dieta que estimula uma acidose metabólica compensada, com o objetivo de restaurar a sensibilidade dos tecidos a estimulação do paratormônio (PTH), aumentando a reabsorção óssea osteoclástica, elevando os níveis de Ca sanguíneo. Além disso, outra alternativa para minimização da hipocalcemia durante o período de transição, inclui a utilização de dietas com baixo teor de Ca, estimulando a reabsorção

óssea para compensar o baixo nível de Ca proveniente da dieta (Thilsing-Hansen *et al.*, 2002).

A homeostase de cálcio é fundamental para prevenção de doenças metabólicas e infecciosas¸ como hipocalcemia, cetose, lipidose hepática, retenção de placenta, metrite, mastite e deslocamento de abomaso (Goff & Horst, 1997; LeBlanc, 2010; Berge & Vertenten, 2014). Segundo LeBlanc (2006), cerca de 75% das patologias ocorrem até os trinta dias pós-parto e são previsivelmente associadas pelo curto espaço de tempo que se manifestam (Curtis *et al.*, 1985; Markusfeld, 1987; Gröhn *et al.*, 1989).

As doenças uterinas são altamente prevalentes nos rebanhos leiteiros e podem ser divididas em retenção dos envoltórios fetais (REF), metrite e endometrite. Segundo Sheldon *et al.* (2006), a REF ocorre depois das 24 primeiras horas do pós-parto, a metrite até os 21 dias e endometrite após 21 dias pós-parto. Essas doenças têm sido associadas à diminuição da taxa de concepção, aumento da taxa de descarte, maior período de serviço e elevadas perdas econômicas (Bartlett *et al.*, 1986; Sheldon e Dobson, 2004; Gilbert *et al.*, 2005). Dubuc *et al.* (2010) relatam incidência de 11,8% de REF, 17,6% de metrite e 14,6% de endometrite clínica. Entre as vacas com REF, 33,2% desenvolveram metrite e 32,5% das que desenvolveram metrite, desenvolveram endometrite clínica.

Dessa forma, o objetivo deste trabalho foi caracterizar propriedades leiteiras da mesorregião nordeste do Rio Grande do Sul, mais especificamente a microrregião de Sananduva e avaliar os fatores de risco associados a ocorrência de enfermidades em vacas leiteiras.

2 Revisão da Literatura

O período de transição, compreendido entre as três semanas que antecedem o parto até as três semanas posteriores, é considerado o período mais crítico para as vacas leiteiras, pois neste elas são submetidas a fatores estressantes causados pelo parto e por mudanças alimentares, maiores desafios metabólicos e inflamatório/infecciosos. O perfil metabólico é mais afetado neste período, onde a vaca passa de um período com baixa ingestão de energia, pois as dietas do período seco e pré-parto limitam este fator, com o intuito de fazer com que as vacas não elevem seu ECC. Além disso, nos dias que antecedem o parto, as vacas leiteiras tendem a suprimir o consumo, e então após o parto, são inseridas em uma dieta de alta demanda energética para produção de leite, e também objetivando a manutenção do ECC para que o retorno a ciclicidade seja breve (Pérez-Baez *et al.*, 2019).

Nos últimos 21 dias de gestação, as vacas devem ser alimentadas com dietas formuladas para diminuir os riscos de distúrbios metabólicos no pós-parto (Drackley, 1999; Drackley & Cardoso, 2014; Lean *et al.*, 2014). A duração do fornecimento de dietas com Balanço Cátion-Aniônico Dietético (BCAD) negativo deve ser de no mínimo 11 dias (Pizoni *et al.*, 2011), no entanto períodos maiores, de 21 a 25 dias são preconizados, tendo em vista a adaptação à dieta e antecipações de partos (Oetzel *et al.*, 1991; DeGaris *et al.*, 2008). Existem diversos fatores de manejo que contribuem para a saúde produtiva do animal durante o período de transição, incluindo o conforto do animal, minimização de fatores estressantes, monitoramento e diagnóstico de patologias e alimentação com dietas acidogênicas (Naydam *et al.*, 2017).

As dietas acidogênicas no período que antecede o parto, aumenta a produção de vacas multíparas (Lean *et al.*, 2014). Quando vacas multíparas são alimentadas com dietas com BCAD negativo, o organismo delas tende a passar por um processo de acidose metabólica, forçando assim, o animal a metabolizar cálcio ósseo e aumentar a absorção de cálcio intestinal aumentando a concentração do mineral no sangue no momento da colostrogênese e lactogênese. No geral, vacas suplementadas com sais aniônicos, na proporção de -15 mEQ/100 g/MS, tiveram níveis de cálcio plasmático maior e pH urinário mais baixo quando comparados aos

animais que não receberam a dieta (Conrado, 2010; Van Dijk & Lourens, 2001; Charbonneau *et al.*, 2006; Lean *et al.*, 2006).

A diminuição da IMS que ocorre no pós-parto, reduz a participação de precursores gliconeogênicos provenientes da dieta para produção hepática de glicose, sendo insuficientes para a síntese de lactose, e manutenção do estado fisiológico (Baumgard *et al.,* 2017), elevando a mobilização lipídica e aumento dos níveis de ácidos graxos não esterificados e beta-hidroxibutirato sanguíneo (Grummer *et al.*, 2004; French, 2006).

A variação de ECC entre o pré-parto e pós-parto contribui de forma negativa para retorno a ciclicidade, afeta a taxa de concepção das vacas, elevando assim os Dias Em Lactação (DEL) e o Intervalo Entre Partos (IEP), reduzindo a produção de leite (Butler *et al.*, 2003, Carvalho *et al.*, 2014, Middleton *et al.*, 2019, Pfeifer *et al.*, 2021). O balanço energético negativo tende a reduzir com o passar do tempo e o balanço de energético positivo inicia novamente entre 30 e 100 dias (Moallem *et al.*, 2000; Coffey *et al.*, 2002).

O perfil metabólico e mineral desse período, causa dificuldade de homeostase energética e de cálcio causando imunossupressão, em um aumento dos distúrbios metabólicos e doenças infecciosas, como hipocalcemia, cetose, esteatose hepática, retenção de placenta, deslocamento de abomaso, metrite e mastite (Goff & Horst, 1997; LeBlanc, 2010; Berge & Vertenten, 2014). Segundo Ribeiro (2015), aproximadamente um terço das vacas leiteiras têm pelo menos uma doença clínica nas primeiras 3 semanas de lactação, representando 60 a 80% de todos os casos clínicos das vacas em lactação.

As doenças uterinas afetam negativamente o período pós-parto das vacas lactantes, causando prejuízos na produção, reprodução e na saúde. As principais doenças uterinas são retenção dos envoltórios fetais, metrites e endometrites, sendo com prevalente em rebanhos leiteiros de alta lactação (Sheldon *et al.*, 2006). Existe grande correlação entre essas doenças, sendo que a hipocalcemia eleva os riscos de retenção de placenta, que por sua vez aumenta a chance do animal desenvolver metrite e, por fim, propicia casos de endometrite (Esnaola, 2014).

As funções imunitárias das vacas leiteiras passam por desafios no pós-parto, visto que as funções das células de defesa dependem do influxo de cálcio para seu pleno funcionamento. Tendo em vista que a hipocalcemia subclínica pode acometer cerca de 45 % do rebanho, e que o período de transição é considerado crítico para

infecções na glândula mamária e útero, a hipocalcemia subclínica eleva em 8 vezes as chances de desenvolvimento de mastite, e fisiologicamente, ocorre a contaminação uterina durante o parto (Weiller *et al.,* 2015; Koch, 2013).

Com isso, realizou-se dois artigos sobre saúde de vacas leiteiras no período de transição e até 100 DEL, com objetivo de encontrar variáveis de sistemas de criação e manejo que influenciam na manifestação de doenças, bem como resulta em incremento produtivo e reprodutivo.

3 Artigos

3.1 Artigo 1

Characterization of Dairy Properties in the Northwest of the State of Rio Grande do Sul Regarding Types of Farming Systems, Management Practices, and Disease Incidence

Rômulo França; Leonardo Marins; Tereza Caxias de Oliveira; Uriel Secco Londero; Vanessa da Silveira Pereira; Rutiele Silveira; Viviane Rohrig Rabassa; Thaís Casarin da Silva; Francisco Augusto Burkert Del Pino; Marcio Nunes Corrêa.

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Characterization of Dairy Properties in the Northwest of the State of Rio Grande do Sul Regarding Types of Farming Systems, Management Practices, and Disease Incidence

Caracterização de Propriedades Leiteiras no Noroeste do estado do Rio Grande do Sul quanto aos tipos de sistema de criação, manejos e incidência de doenças

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ABSTRACT

Dairy farming stands out as one of the main activities on rural properties in the Sananduva microregion, in the northwest of Rio Grande do Sul, Brazil. Considering the importance of this sector to the region, this study aimed to describe the properties in terms of types of farming systems, pre- and post-partum management practices, animal performance, and incidence of diseases up to 100 days in milk (DIM). A total of 58 properties of up to 80 hectares, employing family labor, were characterized. The herds averaged 28 lactating cows per property, with an average daily production of around 24 liters of milk per cow. It was observed 43% of the properties adopted a semi-intensive system, with the predominant breed Holstein-Friesian

(81%). Regarding pre-partum management, it was identified that 84% of the properties realized this management, where 29% had with canzil feeding areas and 36% had feeders coverage. The quality of milk was observed (SCC 435.0 ± 288.0 cells/mL and SPC 59.4 ± 84.0 CFU/mL), along with reproductive management metrics (DIM 186.0 days ± 34.3 and IEP 13.6 days ± 1.0). The overall incidence of uterine and non-uterine diseases was 17.1% and 6.39%, respectively, with an index of discard of 13.34% and abortion rates reaching 5.07%. It is concluded that despite the productive capacity, the northwest region lacks a more effective use of available technologies.

Keywords: Production systems; Management; Dairy cattle; Holstein; Health.

INTRODUCTION

Brazil is the third largest milk producer in the world, with an annual production of 34 billion liters. This production occurs in 98% of Brazilian municipalities, predominantly in small and medium-sized farms, employing approximately four million people (MAPA, 2022). The country's industrial sector is mainly supplied by small family farms, which are typically operated by family labor and have up to four fiscal modules, corresponding to between 80 and 400 hectares. These properties account for 81.2% of dairy farms in Brazil, contributing 64.2% of the total milk production (IBGE, 2019).

Rio Grande do Sul is the third largest milk-producing state, responsible for 12.42% of national production (EMBRAPA, 2023). According to IBGE research in 2021, the northwest mesoregion of the state produced approximately 2.97 billion liters, corresponding to 8.4% of the milk produced in the country. However, dairy properties have significant diversity regarding

the systems and pre- and post-partum management practices that impact animal performance and health.

A low-cost production system offers security against fluctuations in input prices and periods of low milk value. Nevertheless, despite the system adopted, technical guidance and rigorous cost monitoring are crucial to optimize production factors and making rural properties efficient and profitable (FACTORI et al., 2010).

Dairy cows raised in extensive and semi-extensive systems generally have lower milk yield compared to intensive systems (OLSZENSVSKI et al., 2011). However, these systems may provide greater animal welfare due to access to pasture (HENNESSY et al., 2020). In intensive systems, animals typically receive a balanced diet with all the necessary nutrients for maintenance and milk yield, which can be an advantage. However, according to BROOM & FRASER (2007), cited by SALVADOR (2018) and PINHEIRO (2021), there may be a higher occurrence of diseases.

In addition to care regarding the adopted system, there are phases of the production period that are more challenging than others, such as the beginning of lactation. According to ESTEVÃO (2019), one-third of cows present at least one clinically evident disease (metritis, mastitis, digestive, respiratory, or hoof problems) in the first three months of lactation. Furthermore, this period is also characterized by a high culling rate, with approximately one-third of animals being culled 100 days postpartum (GODDEN et al., 2003).

Thus, technical and management guidelines are necessary to maximize animal performance and for this, it is essential to better know the existing properties Therefore, the objective of this study was to characterize the properties in terms of farming systems, breed of animals, pre- and post-partum management, property management, animal performance, and the incidence of diseases up to 100 days in milk (DIM).

MATERIALS AND METHODS

The present study was conducted in the northwest region of Rio Grande do Sul, Brazil, from August 2021 to August 2022. Over the course of a year, 58 properties of up to 80 hectares that employed family labor were characterized, located in the Northwest Mesoregion, Sananduva Microrregion of RS (Cacique Doble: n=24, São José do Ouro: n=15, Santo Expedito do Sul: n=7, Baracão: n=4, Tupanci do Sul: n=3, São João da Urtiga: n=2, Machadinho: n=1, Maximiliano de Almeida: n=1, Paim Filho: n=1).

To characterize the properties in the region and to verify the incidence of diseases affecting herds at the beginning of lactation, a questionnaire was developed for data collection on each property. Consideration was given to the system in which the animals were kept (Compost barn, Free-stall, Semi-extensive, and Extensive), the structure for diet provision (with or without cover and pen), the waiting area for milking (with or without shade and misting), and the frequency of diet provision and assessment of diet leftovers.

The presence of maternity pens, provision of drench, evaluation of urine pH during the pre-partum period, availability of water before and after milking, duration of the voluntary waiting period (VWP), and dry period were also evaluated. Milk yield, somatic cell count (SCC), standard plate count (SPC), milk protein and fat, days in milk (DIM), and interval between calvings (IBC) were also included in this characterization.

Producers were guided by technicians to identify common diseases in the region, and when there were suspicions of any pathology, they would call veterinarians, who would reach a diagnosis through clinical evaluation, some complementary tests, and the animal's history.

The criteria for identifying reproductive diseases were based on the evaluation of vaginal mucus, collected using a Metricheck. If a cow presented purulent mucus with a brownish color and a foul odor, as described by SHELDON et al. (2006), possible postpartum reproductive pathologies such as metritis, endometritis, and retained placenta were diagnosed.

Most diseases were diagnosed through clinical examination, using the following signs as criteria: Retained Placenta: fetal membranes visible at the vulva 24 hours after calving; Clinical Hypocalcemia: animal presenting one or more of the following signs: muscle tremors, incoordination, difficulty standing, up to 72 hours postpartum, sternal or lateral recumbency, with clinical improvement after intravenous calcium administration; Ketosis: nervous signs, loss of appetite, difficulty walking, reduced production, and measurement with abnormal ketone bodies levels; Abomasal Displacement: auscultation of a metallic sound (ping) in the upper right or left flank; Bovine Parasitic Sadness Complex (BPS): fever, apathy, decreased feed intake, anemia or jaundice, tachycardia, hemoglobinuria, nervous signs; Grade 3 Mastitis: fever, alterations in milk and mammary gland, apathy, anorexia, and prostration.

For confirmation of diseases (Ketosis and Parasitic Sadness), in addition to clinical examination, complementary tests were performed using equipment such as Ketovet (ECO Diagnóstica, Nova Lima, BR), which evaluated Beta-Hydroxybutyrate blood levels and Hemovet (ECO Diagnóstica, Nova Lima, BR) for evaluating hematocrit levels in suspected cases of BPS.

Statistical Analyses

All analyses were performed using R software, version 4.2.2 (RStudio Team, RStudio: Integrated Development for R. RStudio, PBC, Boston, 2020). The variables were divided into three blocks according to their nature: pre- and post-partum management, general management, and productive and reproductive performance variables. The first block included the following variables: pre-partum diet provision (yes or no), diet provided in pen (yes or no), presence of cover over the diet provision area (yes or no), diet leftover assessment (yes or no), urine pH evaluation during the pre-partum period (yes or no), presence of maternity pen (yes or no),

provision of drench in the immediate postpartum period (yes or no), and assessment of metabolic diseases (yes or no).

In the second block, the general management variables were divided into: cooling method in the waiting area (only shade or presence of misting system), diet offerings (1 to 2, 3 to 4, or more than 4), duration of the pre-partum period (0, 21, or 25 days), duration of the dry period (50, 60, or 70 days), duration of the VWP (30 to 40, 45, or 50 to 65 days), and availability of water pre- and post-milking (no provision, only before, only after, or provision at both times).

Finally, the third block included the following variables: milk production (kg), somatic cell count (SCC), standard plate count (SPC), milk protein, milk fat, days in milk (DIM), and interval between calvings (IBC). For data analysis, a table with exploratory performance analyses, property management, and pre- and post-partum management was developed. The exploratory analysis described the municipality of the property, farming system, and breed of animals.

The properties were divided according to the production system: compost barn, free-stall, semi-extensive, and extensive. Subsequently, frequency counts for pre- and post-partum management and general management were performed for all properties (n=58) and for each production system. For performance variables, means and standard deviations were calculated. Additionally, during the study, the occurrence of diseases, abortions, and culls was recorded, and the incidence for each disease was calculated from these records.

RESULTS AND DISCUSSION

The predominant breed on the properties was Holstein (81%), followed by Jersey (12%), Girolando (3.5%), and other breeds (3.5%). The dominant production systems among the evaluated properties were semi-extensive (43%) and extensive (40%) systems (Fig. 1). Similar

to the study by DE ASSIS et al. (2005), the semi-extensive and extensive systems were present in the majority of dairy farms in the country.

Regarding the dry period, 95% of the properties scheduled a dry period of 60 days. The provision of anionic diets varied between 21- and 25-days pre-partum. According to BERWAL et al. (2020), the use of anionic products during the pre-partum period for dairy cows not only helps prevent hypocalcemia but also positively influences milk production, physiological responses, and animal health. In this study, the percentage of properties providing anionic diets in the pre-partum period was 100% in intensive systems, while in semi-extensive and extensive systems, it was 43% and 76%, respectively (Tab. 1).

To control the effectiveness of the anionic diet, urinary pH should be analyzed, aiming for a range between 5.8 and 6.8 (GOFF et al., 2014). On average, 67% of the properties used the diet during the pre-partum period, and only 7% evaluated urinary pH (Tab. 1).

During the pre-partum period, it is recommended that animals remain in a clean and well-ventilated environment, with maternity pens to facilitate monitoring of calving and to provide assistance if necessary (JENSEN & TOLSTRUP, 2021). However, in our study, only 5% of the properties had maternity pens, differing from the study by ASKEL (2020) in the Campos Gerais region of Paraná, where 53.33% of farms had maternity pens.

In terms of milk production, in 2021, the Northwest region of Rio Grande do Sul produced 2.97 billion liters of milk, which represents 8.41% of the national production (IBGE, 2021). The farms evaluated in this study had an average production of 24.8 liters of milk per cow per day. The Compost Barn and Free-stall systems showed the highest average production compared to the other systems evaluated (Table 2). This result may be associated with the provision of concentrate, which increases milk production.

Additionally, this result may be related to greater comfort and reduced energy expenditure for movement when compared to animals kept in semi-extensive and extensive

systems. In semi-extensive and extensive systems, animals consume less energy and exhibit higher activity due to grazing, which increases their energy expenditure (MEE & BOYLE, 2020). Comparative studies of milk yield in the Compost Barn and extensive systems showed a mean increase of 2.6 liters when cows were allocated to the Compost Barn system (SANCHES, 2020).

Regarding milk quality, according to Article 7 of the Normative Instruction No. 76 from the Ministry of Agriculture, the SCC (Somatic Cell Count) must be at maximum of 500,000 cells/mL. In this study, it was observed that the SCC was elevated only in the farms with extensive systems (Table 2), possibly associated with challenges that animals face, such as climatic changes, movement between the milking location and the grazing area, lack of shade, and increased susceptibility to heat stress (OKUYUCU et al., 2023). Other factors, such as the type of milking installation (non-automated), breed, season of the year, older animals, and higher DIM (days in milk) may also contribute to the increase in SCC (STOCCO et al., 2023). In intensive systems, the increase in SCC may be related to bedding moisture. Therefore, it is evident that, in addition to evaluating the best farming system option, correct management practices must be adopted in order to maximize the yield and effectiveness provided by the production systems (JAMAS, 2018).

Regarding milk composition, it was expected that cows from semi-extensive and extensive systems would have higher levels of fat and protein due to the pasture-based diet (HENNESSY et al., 2020). It is known that cows in semi-extensive systems generally have access to fiber-rich pastures, which promote ruminal fermentation and the production of acetate, an essential precursor for milk fat synthesis (ELGERSMA, 2015). However, in this study, the average levels of protein, fat, and IBC (Table 2) were similar across the different production systems.

Evaluating feed leftovers in the troughs is also important, with expectation of observing 3 to 5% leftovers (NRC, 2001). Additionally, offering the diet in a covered location helps prevent spoilage and fermentation due to environmental factors such as rain and direct sunlight exposure. The presence of *canzil* areas minimizes the dominance effect of cows, allowing animals to feed more adequately and uniformly (LEBLANC et al., 2005). In this study, a greater number of properties with covered troughs, *canzil*, and evaluation of diet leftovers was observed in the Compost Barn and Free-stall systems, suggesting that infrastructure can play a crucial role in the effectiveness of the production system (Tab. 3).

Another factor that can interfere with productive performance is the frequency of diet provision, as it is believed to stimulate animal intake (LUCIO et al., 2009). In properties with intensive production systems, the number of feedings per day was higher than in semi-extensive and extensive systems, with 71% of the properties using Compost Barn offering more than four feedings per day and 67% of the properties using Free-stall providing three to four feedings per day (Tab. 3).

In terms of milking, providing thermal comfort to animals through the availability of shade and cooling systems, such as ventilation and misting in the waiting area, promotes the welfare of dairy cows and can favor an increase in milk production (ALMEIDA et al., 2010). In this study, approximately 83% of the properties had waiting areas with shade, while only 17% had cooling systems in these areas (Tab. 2).

Another important factor to consider is the water supply before and after milking. Animals with limited access to water, whether due to competition or inadequate provision, may experience reduced milk yield. Furthermore, they are prone to heat stress, which significantly impacts feed intake and leads to greater production losses (MCDONALD et al., 2020). In this study, 43% of the properties with a Compost Barn system, 20% with a semi-extensive system, and 35% with an extensive system did not provide water before or after milking. In contrast, all

properties with a Free-stall system offered water at the time of milking, before (67%) and after (33%). The amount of water cows consume depends on several factors such as dry matter intake, climatic conditions, diet composition, and lactation phase (FIENGA, 2021), with recommendations for water provision before and after milking (MARTINEZ, 2017).

All these evaluated variables can influence the prevalence of postpartum diseases. In this study, the most prevalent diseases were related to the reproductive system, with 7.76% being metritis, 5.38% retained placenta, and 3.96% endometritis (Tab. 4). It is known that there can be an association between these diseases, as retained placenta can delay uterine involution, increasing the risk of metritis due to secondary infections (LEAL, 2010). When evaluating the four production systems, a higher prevalence of endometritis was observed in the Free-stall system and retained placenta in the Compost Barn system, compared to the other systems. Metritis had a similar prevalence across the systems (Tab. 4).

According to RIBEIRO and CARVALHO (2017), about one-third of dairy cows experience at least one clinical disease in the first 3 weeks of lactation. It is estimated that 40 to 60% of dairy cows are affected by one or more health disorders within the first 60 days in milk (DEL) (SANTOS et al., 2010), accounting for 60 to 80% of all clinical cases in lactating cows. Reproductive diseases, followed by mastitis and hoof disorders, are the most prevalent and can lead to culling during lactation (DALLAMO et al., 2021). Additionally, 100 cases of abortion were recorded, with the highest occurrence in semi-extensive systems (6.68%) (Table 5).

SHELDON et al. (2019) report that, over the past 50 years, the incidence of uterine diseases in postpartum cows has increased from being a rare occurrence to around 40%. This rise may be related to the intensification of dairy cattle management systems and the increase in milk production. Therefore, intensive farming models, combined with genetic improvement

aimed at high productivity, seem to further exacerbate the challenges faced by these animals during the transition period.

Data from COCKCROFT (2015) indicate that the average annual culling rate for cows should be around 24%. CERQUEIRA (2023) highlighted that the main causes of early culling in dairy cows include mastitis (35%), followed by lameness (28%). In this study, 263 culling cases were recorded, with the highest occurrences in compost barn systems (16.63%) and free-stall systems (15.14%).

CONCLUSIONS

Regarding the characterization of the properties in the Sananduva microregion of Rio Grande do Sul, Brasil, evaluated in this study, it is concluded that the predominant systems in the region are primarily semi-extensive (43%) and extensive (40%), with an average of 28 cows in lactation, an average milk production of 24L/day, and the predominant breed being Holstein-Friesian (81%). Regarding the adoption of pre-partum lots, a predominance of 84% was observed; however, in the feeding system, only 29% had individual stalls, and 36% had coverage along the feed line. The diseases with the highest incidence were uterine diseases, at 17.1%. It is concluded that the studied region has considerable productive potential, but the implementation of more effective technologies and management practices is crucial to optimize herd health and milk production.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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Figure 1. Characterization of the production systems of 58 properties of up to 80 hectares, located in the Northwest Mesoregion, Sananduva Microrregion of Rio Grande do Sul.

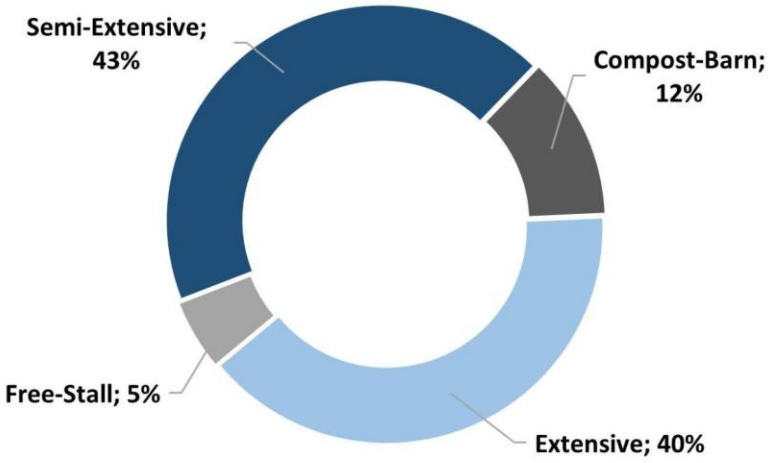

Table 1. Pre- and post-partum management practices according to the production system of 58 properties of up to 80 hectares, located in the Northwest Mesoregion, Sananduva Microregion of Rio Grande do Sul; Brazil.

Management Variables	***Compost Barn (n=7)***		***Free-stall* (n=3)**		**Semi-Extensive (n=25)**		**Extensive (n=23)**		**Total (n=58)**	
Prepartum Diets	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
pH Evaluation	7	100	3	100	19	76	10	43	39	67
	4	57	0	0	0	0	0	0	4	7

Table 2. Productive and reproductive performance variables according to the production system of 58 properties of up to 80 hectares, located in the Northwest Mesoregion, Sananduva Microregion of Rio Grande do Sul, Brazil.

Management Variables	***Compost Barn* *(n=7)***		***Free-stall* *(n=3)***		**Semi-Extensive (n=25)**		**Extensive (n=23)**		**Total (n=58)**	
	Mean	SD*	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Milk yeld (Litres)	35,4	4,6	31,9	6,9	24,8	5,1	20,6	4,1	24,8	6,7
SCC[1] (Cells/mL)	385,0	103,0	391,0	122,0	505,0	358,0	380,0	246,0	435,0	288,0
SPC[2] (CFU/mL)	30,3	31,6	32,3	36,5	94,4	145,0	80,6	123,0	78	124
Protein (g/100g)	3,3	0,1	3,4	0,3	3,3	0,2	3,4	0,2	3,3	0,2
Fat (g/100g)	3,6	0,3	4,0	0,4	3,7	0,3	3,9	0,3	3,7	0,3
CI (Days)[3]	13,6	0,8	13,1	0,9	13,6	1,2	13,6	1,0	13,6	1,0
DIM (Days)[4]	185,0	36,9	171,0	7,8	189,0	31,9	185,0	38,9	186,0	34,3

*SD= Standard deviation

1 SCC = Somatic cell count (cells x10³/mL); 2 SPC = Standard Plate Count (UFC/mL).

3 CI = Calving interval; 4 DIM = Days in milk.

Table 3. Infrastructure and management practices according to the production system of 58 properties of up to 80 hectares, located in the Northwest Mesoregion, Sananduva Microrregion of Rio Grande do Sul, Brazil.

Variables	***Compost Barn* (n=7)**		***Free-stall* (n=3)**		**Semi-Extensive (n=25)**		**Extensive (n=23)**		**Total (n=58)**	
System	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Canzil	3	43	1	33	7	28	6	26	17	29
Covered	7	100	2	67	9	36	3	13	21	36
Evaluation of fee leftovers	4	57	1	33	0	0	0	0	5	9
Number of Feedings										
1 or 2	0	0	0	0	19	76	23	100	42	72
3 or 4	2	29	2	67	6	24	0	0	10	17
>4	5	71	1	33	0	0	0	0	6	10
Waiting Room										
Shade	2	29	3	100	23	92	20	87	48	83
Sprinkling	5	71	0	0	2	8	3	13	10	17
Water before and after milking										
None	3	43	0	0	5	20	8	35	16	28
Before	1	14	2	67	8	32	13	57	24	41
After	2	29	1	33	9	36	1	4	13	22
Before and After	1	14	0	0	3	12	1	4	5	9

Table 4. Incidence of diseases in dairy cows according to the production system of 58 properties of up to 80 hectares, located in the Northwest Mesoregion, Sananduva Microrregion of Rio Grande do Sul.

Diseases	***Compost Barn (n=475)***		***Free-stall (n=284)***		**Semi-extensive (n=687)**		**Extensive (n=525)**		**Total (n=1971)**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Acidosis	4	0,84	3	1,06	4	0,58	0	0,00	9	0,46
Ketosis	5	0,84	3	1,06	13	1,89	6	1,14	27	1,37
Abomasal displacement	4	0,84	4	1,41	16	2,33	2	0,38	26	1,32
Abomasal displacement	17	3,58	20	7,04	26	3,78	15	2,86	78	3,96
Hypocalcaemia	0	0,00	1	0,35	6	0,87	5	0,95	12	0,61
Mastitis	4	0,84	7	2,46	15	218	16	3,05	42	2,13
Metritis	39	8,21	21	7,39	51	7,42	42	8,00	153	7,76
Pneumonia	4	0,84	2	0,70	2	0,29	1	0,19	9	0,46
Retained placenta	36	7,58	14	4,93	36	5,24	20	3,81	106	5,38
Parasitic sadness	3	0,63	0	0,00	13	1,89	3	0,57	19	0,96

Table 5. Abortion and culling rates according to the production system of 58 properties of up to 80 hectares, located in the Northwest Mesoregion, Sananduva Microrregion of Rio Grande do Sul.

Variáble	***Compost Barn* (n=475)**		***Free-stall* (n=284)**		**Semi-extensive (n=687)**		**Extensive (n=525)**		**Total (n=1971)**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Abortion	24	5,05	13	4,58	47	6,84	16	3,05	100	5,07
Discard	79	16,63	43	15,14	82	11,94	59	11,24	263	13,34

3. Artigos

3.2 Artigo 2

Environmental and Management Factors Associated with Metritis Occurrence in Small Dairy Farms

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Environmental and Management Factors Associated with Metritis Occurrence in Small Dairy Farms

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Abstract

Metritis is a highly prevalent disease in dairy herds, which negatively impacts reproductive performance and generates economic losses for dairy farms. Small producers are even more severely affected due to the low availability of resources for investments. Thus, the present study aimed to investigate possible risk factors for the occurrence of metritis related to the environment and management practices in small dairy farms. The study was conducted between August 2021 and August 2022 and included 46 farms and 1436 lactating cows. A logistic regression analysis was performed including the variables: presence of self-locking feed stanchion (yes or no), presence of feed bunk in a covered area (yes or no), evaluation of leftovers in the feed bunk (yes or no), evaluation of urine pH (yes or no), presence of a maternity pen (yes or no), administration of drench in early postpartum (yes or no), access of water in milking (absent; before; after; before and after), cooling method in the holding pen (shade; shade and sprinkling; shade, sprinkling, and ventilation). During the evaluation period, 141 episodes of metritis were identified, resulting in an incidence of 9.8%. The final logistic regression model included the variables cooling method in the holding pen, access to water in milking, feed bunk leftovers evaluation, and urine pH evaluation. Animals from farms that employed cooling methods such as ventilation and sprinkling had a lower chance of developing metritis compared to those from farms with only shade available. Animals from farms that evaluated leftovers in the feed bunk were 2.17 times less likely to develop metritis. Another factor impacting the probability of metritis was the access to water before and after milking. Identifying risk factors for the occurrence of metritis is essential for developing strategies to prevent this disease and reduce its impact on dairy farms.

Keywords: acidogenic diet, heat stress, uterine disease, reproduction

1. Introduction

Uterine diseases are among the most prevalent in dairy herds, alongside mastitis and lameness (Várhidi et al., 2024). Among uterine disorders, metritis has the highest incidence, affecting about 8 to 50% of cows in the postpartum period (Galvão, 2012; Molinari et al., 2022; Pérez-Báez et al., 2021). Uterine diseases have serious negative impacts, such as reduced milk production, decreased reproductive performance, and increased likelihood of early culling. Additionally, they lead to longer intervals for the return of ovarian cyclicity, impaired embryonic development, resulting in lower fertility and consequently, increased calving-to-conception intervals and reduced conception and pregnancy rates (Wittrock et al., 2011).

The negative impacts caused by uterine diseases are directly and indirectly reflected in economic losses for dairy farms. Previous studies have estimated the cost of metritis to be up to US$884.00 per episode, due to the costs of antimicrobial treatment and the impacts on milk production, fertility, and early culling (Giuliodori et al., 2013; Lima et al., 2019; Pérez-Báez et al., 2021). Sheldon et al. (2009) estimated that metritis generates annual losses reaching €1.4 billion in the European Union and US$650 million in the USA.

Metritis can be defined as the inflammation of all layers of the uterus (endometrium, myometrium, and perimetrium), occurring within the first 21 days postpartum (Molinari et al., 2022; Várhidi et al., 2024). This disease can be caused by the persistence of pathogenic bacteria in the uterine lumen, such as *Trueperella pyogenes*, *Fusobacterium necrophorum*, *Prevotella* spp., and *Escherichia coli* (Sheldon et al., 2020). Metritis can be diagnosed by an abnormally enlarged uterus and presence of fetid red-brown watery uterine discharge, often accompanied by systemic signs such as pyrexia, lethargy, and anorexia, classified as puerperal metritis, which occurs more frequently within the first 10 days postpartum (de Lima, 2020; Sheldon et al., 2006).

Previous studies have investigated various risk factors related to the occurrence of metritis. Parity, obesity, stress, shorter gestation length, abnormalities at parturition (dystocia, stillbirth,

and vulvar lacerations), twin births, male offspring, prolapsed uterus, abortion, and retained placenta are known factors that increase the risk of metritis (Giuliodori et al., 2013; Hossein-Zadeh & Ardalan, 2011; Machado et al., 2020; Mahnani et al., 2021; Sheldon et al., 2020; Várhidi et al., 2024; Vieira-Neto et al., 2016). Additionally, heat stress and metabolic disorders, mainly occurring during the peripartum period, such as ketosis and hypocalcemia, have also been associated with a higher risk of animals developing uterine diseases (Benzaquen et al., 2007; Rodríguez et al., 2017; Sumi et al., 2022).

However, studies that relate environmental factors and management strategies to the development of metritis are still scarce. These factors are even more important in small dairy farms that rely on family labor and have low potential for investment in technologies. Knowledge of risk factors for the occurrence of metritis can aid in the development of prevention strategies for this disease, leading to gains in reproductive performance and financial returns. Thus, the objective of the present study was to investigate risk factors for the occurrence of metritis related to the environment conditions and management practices in small dairy farms.

2. Materials and Methods

2.1 Dairy farms description

The present study was conducted between August 2021 and August 2022, on 46 dairy farms located in the municipalities of Barracão (n=3), Cacique Doble (n=23), Machadinho (n=1), Paim Filho (n=1), Santo Expedito do Sul (n=5), São José do Ouro (n=10), and Tupanci do Sul (n=3), situated in the Northwest mesoregion of the state of Rio Grande do Sul (Lisbinski et al., 2020), Brazil (Figure 1).

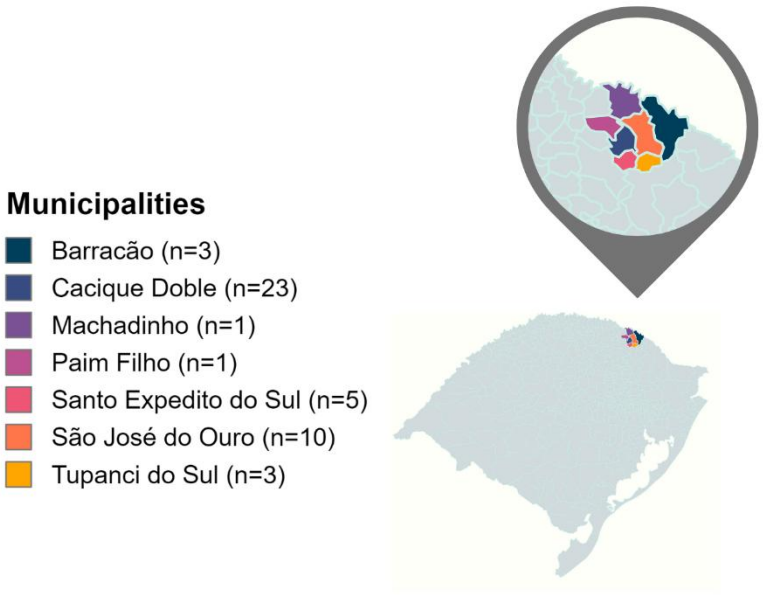

Figure 1. Municipalities situated in the Northwest mesoregion of the state of Rio Grande do Sul, where the 46 small dairy farms included in the study are located.

The dairy farms included in the study were classified as small properties, possessing up to 4 fiscal modules and mainly relying on family labor. A fiscal module represents a unit of area measurement, in hectares, varying among states and municipalities according to regional characteristics related to land use. In the studied region, a fiscal module is defined as an area of 20 hectares (Landau et al., 2012).

These farms received technical assistance from veterinarians and had an average of 31 lactating cows, ranging from 12 to 110. The farms adopted different production systems, which could be extensive (n=17), semi-extensive (n=19), or intensive, such as Free-Stall (n=3) or Compost-bedded pack barn (n=7). Data related to milk production, somatic cell count (SCC), milk composition, and other herd indicators are summarized in Table 1.

Table 1. Descriptive data related to milk yield, milk composition and herd indicators of 46 small dairy farms located in the Noerthwest mesoregion of the state of Rio Grande do Sul, Brazil.

Item	Minimum	Mean	Standard Deviation	Maximum
Milk Yield (l/day)	11.0	25.3	6.8	42.0
SCC[1] (x1000 cels/ml)	94.0	458.7	288.6	1257.0
Milk Protein (%)	2.7	3.3	0.2	3.8
Milk Fat (%)	3.0	3.7	0.3	4.9
Calving Interval (months)	11.5	13.6	1.1	18.0
BSC[2] prepartum	2.5	3.2	0.4	3.7
BSC[2] postpartum	3.0	3.6	0.6	4.0

[1]Somatic Cells Count
[2]Body score condition (scale from 1 to 5)

2.2 Data collection

Before the start of the study, all properties were visited by researchers to gather information related to the environment and management practices. A total of 8 variables were evaluated, four related to feeding an acidogenic diet during the prepartum period: presence of self-locking feed stanchion, presence of feed bunk in a covered area, evaluation of leftovers in the feed bunk, and evaluation of urine pH. The other four variables were the presence of a maternity pen, access of water before and/or after milking, cooling method for cows in the holding pen, and administration of drench in early postpartum.

Cases of metritis were characterized by the presence of fetid red-brown watery uterine discharge, occurring within 21 days postpartum (Sheldon et al., 2006). Diagnosis was performed through clinical examination and a specific genital tract examination using a Metricheck device by the veterinarians attending the properties (McDougall et al., 2007). Only data from animals that calved after the start of the study and completed 21 days postpartum before the end of the study were included.

All obtained data was recorded in an Excel spreadsheet (Microsoft Office®) created by the researchers. This spreadsheet contained data related to lactating animals, such as animal

identification, last drying off date, last calving date, and disease history. The researchers conducted periodic visits to the studied properties, which could be weekly, biweekly, or monthly.

2.3 Statistical Analysis

Statistical analyses were conducted using R Software version 4.2.2 (R Core Team, 2023, Vienna, Austria). A logistic regression model (function GLM, family = binomial) was constructed using a backward stepwise approach, until only variables with P-values < 0.05 remained in the model. The categorical variables included were presence of self-locking feed stanchion (yes or no), presence of feed bunk in a covered area (yes or no), evaluation of leftovers in the feed bunk (yes or no), evaluation of urine pH (yes or no), presence of a maternity pen (yes or no), administration of drench in early postpartum (yes or no), access of water in milking (absent; before; after; before and after), cooling method in the holding pen (shade; shade and sprinkling; shade, sprinkling, and ventilation). The models were evaluated using the Bayesian Information Criterion (BIC). The final logistic regression model included the variables: cooling method for cows in the holding pen, access of water in milking, evaluation of leftovers in the feed bunk, and evaluation of urine pH. Odds ratios (OR) and 95% confidence intervals (CI) were calculated for the variables included in the final model.

3. Results

In total, data from 1436 lactating cows from the 46 evaluated properties were included. A total of 141 cases of metritis were identified, resulting in an incidence rate of 9.8%. The property with the highest incidence reached 29.4%, while the property with the lowest incidence did not present any episodes of metritis during the evaluated period. Table 2 presents the frequency of animals that developed metritis in relation to all evaluated variables.

Table 2. Frequency of animals with and without metritis according to environment and management variables in 46 small dairy farms located in the Noerthwest mesoregion of the state of Rio Grande do Sul, Brazil.

Variable	Metritis			
	No		Yes	
	n*	%	n*	%
Presence of self-locking feed stanchion				
No	913	89.8%	104	10.2%
Yes	382	91.2%	37	8.8%
Presence of feed bunk in a covered area				
No	695	89.3%	83	10.7%
Yes	600	91.2%	58	8.8%
Feed bunk leftovers evaluation				
No	1034	90.1%	113	9.9%
Yes	261	90.3%	28	9.7%
Urine pH evaluation				
No	1089	90.5%	114	9.5%
Yes	206	88.4%	27	11.6%
Presence of a maternity pen				
No	1163	90.7%	119	9.3%
Yes	132	85.7%	22	14.3%
Drench administration in early postpartum				
No	928	91.2%	90	8.8%
Yes	367	87.8%	51	12.2%
Access to water in milking				
Absent	311	89.6%	36	10.4%
Before	536	89.3%	64	10.7%
After	329	91.1%	32	8.9%
Before and after	119	93.0%	9	7.0%
Cooling strategy in the holding pen				
Shade	987	90.2%	107	9.8%
Shade and sprinkling	51	92.7%	4	7.3%
Shade, sprinkling, and ventilation	257	89.5%	30	10.5%

*Number of animals

The final logistic regression model included the variables cooling method for cows in the holding pen, access of water in milking, evaluation of leftovers in the feed bunk, and evaluation of urine pH (Table 3). Animals on properties that had cooling methods in the holding area, such as shade and sprinkling, had 82% less chance of developing metritis, while those with shade, sprinkling, and ventilation had a 58% less chance compared to

animals on properties with only shade. Access to water was also a significant factor. Animals that had access to water immediately after milking or before and after milking had a 54% and 62% lower chance, respectively, of developing metritis compared to animals without access to water at these times.

Additionally, on properties where leftovers in the feed bunk were evaluated, animals had a 2.17 times less chance of developing metritis compared to those from properties where there was no evaluation of leftovers. Regarding the evaluation of urine pH, the chance of developing metritis was higher in animals from properties that conducted this analysis. The presence of self-locking feed stanchion, presence of feed bunk in a covered area, presence of a maternity pen, and administration of drench in early postpartum had no effect on the risk of metritis.

Table 3. Final multivariable logistic regression model of association between environment and management variables and metritis in 46 small dairy farms located in the Northwest mesoregion of the state of Rio Grande do Sul, Brazil.

Variáveis	n*	Estimate	EP	OR (95% IC)	*P-value*
Intercept		-3.80	0.77		
Cooling method in the holding pen					0.04
Shade	1094			Reference	
Shade and sprinkling	55	-1.73	0.78	0.18 (0.04-0.81)	
Shade, sprinkling, and ventilation	287	-0.86	0.42	0.42 (0.19-0.95)	
Access to water in milking					0.01
Absent	347			Reference	
Before	600	0.08	0.23	1.09 (0.70-1.70)	
After	361	-0.77	0.32	0.46 (0.25-0.87)	
Before and After	128	-0.96	0.50	0.38 (0.15-1.01)	
Feed bunk leftovers evaluation					0.04
No	1147			Reference	
Yes	289	-0.78	0.39	0.46 (0.21-0.98)	
Urine pH evaluation					<0.01
No	1023			Reference	
Yes	233	2.03	0.62	7.64 (2.28-25.59)	

*Number of animals

4. Discussion

Metritis causes various losses to dairy farming due to reduced milk production, decreased reproductive efficiency, and higher culling rates (Giuliodori et al., 2013; Machado et al., 2020). Several risk factors for its occurrence have been identified, which can be related to the animals, pathogenic agents, environment, and management practices. Sheldon et al. (2020) proposes that resilience against uterine infections is related to three mechanisms: avoiding, tolerating, and resisting pathogens. The adoption of certain management practices and environmental controls can help animals become resilient to these diseases. Few studies have been conducted on small dairy farms, which have limited resources, equipment, and infrastructure.

A recent literature review on uterine diseases identified that metritis could affect up to 40% of animals, with the highest frequency in the first 10 days postpartum (Várhidi et al., 2024). Other studies found varying incidence rates of metritis, such as 8% (Hossein-Zadeh & Ardalan, 2011), 20% (Galvão, 2012), and up to 50% in certain herds (Pérez-Báez et al., 2021). The incidence of metritis found in our study was 9.8%, reaching approximately 30% on the property with the highest incidence, in agreement with previous studies.

The peripartum period is marked by an increased demand for calcium due to fetal development and colostrum and milk production (Venjakob et al., 2019), leading to a deficit in serum calcium levels. When homeostasis mechanisms are insufficient to provide the required levels of this mineral, animals enter a state of hypocalcemia, which plays a crucial role in the development of uterine diseases such as metritis (Rodríguez et al., 2017).

Feeding cows during the prepartum period with acidogenic diet is a strategy to reduce the incidence of hypocalcemia (Santos et al., 2019). This diet causes a drop in blood pH, leading to mild metabolic acidosis, which in turn increases the sensitivity of parathyroid hormone receptors, promoting bone mobilization of calcium as well as greater reabsorption in the

kidneys and absorption in the intestine (Melendez & Chelikani, 2022). Another important factor to consider is the method of providing the acidogenic diet, as the absence of a stanchions can affect intake due to competition among animals (Couto Serrenho et al., 2022; Paudyal et al., 2023). This effect was not observed in the findings of the present study, which may be due to the uneven characteristics of structure in the dairy farms included in the study.

The evaluation of urine pH is a method used to verify whether the ingestion of the acidogenic diet is occurring adequately since blood acidification causes a drop in urine pH (Constable et al., 2019). Contrary to expectations, animals from properties that performed this technique had a higher chance of developing metritis compared to those from properties that did not check urine pH. This result may be because properties adopting this strategy already had a higher incidence of metritis previously. In a study conducted to investigate possible risk factors for the occurrence of mastitis in small farms located in the Southeast region of Brazil, the authors also found unexpected results, such as an increased risk of mastitis in animals from properties practicing dry cow management (A. C. Silva et al., 2021), reflecting the use of the technique due to the higher incidence of the disease.

One limitation of providing an acidogenic diet to reduce cases of hypocalcemia is the reduction in dry matter intake observed in animals receiving this diet. The lower palatability of anionic salts and the acidified ruminal environment could be associated with this intake reduction. Evaluating leftovers in the feed bunk is an indirect way to measure feed intake and can help control the use of this strategy (de Paula et al., 2023). This evaluation can be done visually or by weighing the leftover feed. Although the method of evaluating leftovers may differ between the studied properties, the result obtained in the present study indicates that this management practice, when performed, allows for the adjustment of the acidogenic diet, which could reduce cases of hypocalcemia and, consequently, preventing uterine diseases.

The use of techniques to promote thermal comfort for animals in the holding pen is commonly associated with a reduction in the probability of developing metritis (Sumi et al., 2022). Heat stress occurs when there is an increase in body temperature above

physiological values due to the animals' inability to dissipate enough heat through homeostasis mechanisms to maintain thermal balance (Molinari et al., 2022). Animals under heat stress exhibit lower reproductive efficiency and are more susceptible to abortions, calving abnormalities, and retained placenta, which are known risk factors for uterine diseases such as metritis and endometritis (Giannone et al., 2023; Menta et al., 2022; Molinari et al., 2023; Sumi et al., 2022).

This study was conducted in a region with a subtropical climate, characterized by high temperatures during the summer months (Olalde & Haas, 2017). Additionally, small farms often lack the financial resources to invest in cooling systems. The results showed that employing cooling techniques in the holding pen, such as forced ventilation and water spray, positively impacted the uterine health of animals, reducing the chance of developing metritis compared to animals in farms with only shade available. Silva & Passini (2018) conducted a study comparing different holding area cooling systems and observed that environments with shade and sprinkling, as well as those with shade, sprinkling, and ventilation, promoted greater thermal comfort compared to environments with sun exposure and shade only.

Lastly, the availability of fresh water is essential for milk production, reproductive performance, thermoregulation, health, and welfare of dairy cows (Golher et al., 2020). Several factors affect water intake, such as weight, pregnancy, lactation stage, milk production, diet composition, and climatic conditions (Jensen & Vestergaard, 2021; Van Os, 2019). Animals under high temperature-humidity index (THI) conditions exhibit increased water intake, higher frequency of visits to water troughs, and competitive behavior around the water trough (McDonald et al., 2020). In this study, it was observed that animals with access to water before and after milking had a 62% lower chance of developing postpartum metritis compared to animals without access to water at these times.

Thus, identifying risk factors for metritis occurrence is crucial for preventing this disease. Management practices to mitigate deleterious effects of heat stress, access to water before

and after milking, and prepartum acidogenic diet intake evaluation can help reduce cases of metritis in small farms.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Statements and Declarations

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

All authors contributed to the study conception and design. Study design planning and resource raising were performed by Marcio Nunes Correa. Material preparation, data collection, and analysis were performed by Rômulo Teles França. Statistical Analysis were performed by Leonardo Marins. The manuscript revision was performed by Thaís Casarin, Uriel Secco Londero, Eliza Rossi Komninou, Viviane Rohrig Rabassa, Francisco Augusto Burkert Del Pino, and Marcio Nunes Corrêa. The first draft of the manuscript was written by Leonardo Marins and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data Availability

Data from the present study might be available upon request to the corresponding author.

4 Considerações Finais

Evidenciou-se no trabalho que as propriedades produtoras de leite da mesorregião noroeste, e microrregião de Sananduva – RS conta com mão de obra quase totalmente de origem familiar para a produção leiteira, contudo, destaca-se que a média da região é alta, comparada com níveis nacionais e estaduais, no entanto enfatiza-se que a mesma ainda possui baixo nível de tecnificação.

O advento de tecnologias produtivas como as dietas pré-parto, e de instalações como canzis ficaram aquém do esperado, observou-se que poucas propriedades realizavam o correto manejo das vacas leiteiras no período pré-parto, o que refletiu na lactação subsequente. Apesar do baixo nível tecnológico observado no trabalho, a produção leiteira ficou acima da média, o que sugere crescimento nos anos que virão.

Por conseguinte, observou-se que as propriedades que apresentaram melhores manejos e nível tecnológico mais acentuado tiveram menos problemas com doenças no até 100 DEL e menos doenças uterinas. A adoção de tecnologias nas propriedades leiteiras deve evoluir consideravelmente, no entanto seu uso deve ser seguido de maneira correta e de forma a tomar medidas de controle de qualidade, para verificar o perfeito funcionamento das mesmas.

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