UNIVERSIDADE FEDERAL DE SANTA MARIA
CAMPUS PALMEIRA DAS MISSÕES
PROGRAMA DE PÓS-GRADUAÇÃO EM AGRONEGÓCIOS

Sirineu José Sicheski

ESTUDO RETROSPECTIVO LONGITUDINAL SOBRE PRODUÇÃO E COMPOSIÇÃO DO LEITE NA MESORREGIÃO NOROESTE RIO-GRANDENSE

Palmeira das Missões, RS
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Dissertação apresentada ao Programa de Pós-Graduação em Agronegócios, da Universidade federal de Santa Maria, campus Palmeira das Missões (UFSM – PM), como requisito parcial para obtenção do título de **Mestre em Agronegócios**.

Orientador: Prof. Dr. João Pedro Velho

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2018

Sicheski, Sirineu José
Estudo retrospectivo longitudinal sobre produção e composição do leite na mesorregião noroeste rio-grandense / Sirineu José Sicheski.- 2018.
77 p.; 30 cm

Orientador: João Pedro Velho
Coorientador: Paulo Sérgio Gois Almeida
Tese (doutorado) - Universidade Federal de Santa Maria, Campus de Palmeira das Missões, Programa de Pós Graduação em Agronegócios, RS, 2018

1. Lactose 2. Produtores de leite 3. Preço do leite 4. Sistema de produção 5. Índice de temperatura-umidade I. Velho, João Pedro II. Almeida, Paulo Sérgio Gois III. Título.

Sistema de geração automática de ficha catalográfica da UFSM. Dados fornecidos pelo autor(a). Sob supervisão da Direção da Divisão de Processos Técnicos da Biblioteca Central. Bibliotecária responsável Paula Schoenfeldt Patta CRB 10/1728.

E-mail: sirineu.sicheski@iffarroupilha.edu.br

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Aprovado em 10 de agosto de 2018:

João Pedro Velho, Dr. (UFSM)
(Presidente/ Orientador)

Paulo Sérgio Gois Almeida, Dr. (UFSM)
(Coorientador)

Otoniel Geter Lauz Ferreira, Dr. (UFPel)

Ione Maria Pereira Haygert-Velho, Dra. (UFSM)

Palmeira das Missões, RS
2018

AGRADECIMENTOS

Agradeço a Deus pela força de vontade, ânimo e fé que norteiam meus dias e auxiliam na busca pelos meus objetivos.

Em nome da minha mãe, Virgilina, agradeço toda minha família, pelo amor, carinho, confiança e apoio.

À minha noiva e futura esposa, Fernanda, obrigado pela compreensão nos momentos de ausência e incentivo diário.

Ao meu professor, amigo e orientador, João Pedro Velho, muito obrigado pela confiança e troca de conhecimentos e experiências.

Ao Instituto Federal Farroupilha, pela oportunidade de cursar o mestrado, usufruindo o direito de afastamento total, para qualificação.

À Universidade Federal de Santa Maria – Campus Palmeira das Missões, por ter me recebido e proporcionado dias de grande aprendizagem.

À Escola Estadual Celeste Gobatto, propriedade que abriu as portas para que eu pudesse realizar o estudo.

Ao grupo de pesquisa INOVAZOOT, pelas experiências, geração de conhecimento e oportunidade de aprendizado.

Aos amigos, tenho um agradecimento muito especial porque acreditaram em mim desde o primeiro instante.

Agradeço todas as pessoas que de alguma forma contribuíram para que esse dia chegasse e transmitiram força e confiança.

RESUMO

ESTUDO RETROSPECTIVO LONGITUDINAL SOBRE PRODUÇÃO E COMPOSIÇÃO DO LEITE NA MESORREGIÃO NOROESTE RIO-GRANDENSE

AUTOR: Sirineu José Sicheski
ORIENTADOR: Dr. João Pedro Velho

A produção de alimentos de origem animal como carne, leite e seus derivados, deve ser intensificada em escala global e de forma sustentável. Aqui, nosso objetivo foi avaliar a produção de leite, composição química (extrato seco total, extrato seco desengordurado, gordura, proteína e lactose), contagem de células somáticas e contagem bacteriana total, em relação à estação (verão, outono, inverno e primavera) em uma propriedade rural no município de Palmeira das Missões, Rio Grande do Sul, entre janeiro de 2009 e dezembro de 2016. Este estudo de caso foi delineado como uma retrospectiva longitudinal. A principal variável analisada foi a produção de leite por hectare por mês, pois isso é de suma importância na avaliação de uma propriedade rural. O estudo retrospectivo longitudinal consecutivo ao longo de 8 anos serve para enfatizar que a execução organizada das atividades relacionadas à pecuária e produção de leite reduz os coeficientes de variação referentes à composição do leite. Em outras palavras, é mais fácil manter a qualidade do leite, além da geração de receita extra por meio do bônus de qualidade do leite. As instruções normativas dos números 51 e 62 do Ministério da Agricultura, Pecuária e Abastecimento servem como um guia para ajudar os produtores de leite a melhorar os sistemas de produção como um todo, já que a atividade é multifatorial por natureza.

Palavras-chave: Lactose. Produtores de leite. Preço do leite. Sistema de produção. Índice de temperatura-umidade.

ABSTRACT

LONGITUDINAL RETROSPECTIVE RURAL STUDY ON THE EFFECT OF SEASON ON MILK PRODUCTION AND MILK COMPOSITION IN MESOREGION NOROESTE RIO-GRANDENSE

AUTHOR: Sirineu José Sicheski
ADVISOR: Dr. João Pedro Velho

The production of foods of animal origin such as meat, milk, and their derivatives must be intensified on a global scale in a sustainable way. Here, our objective was to evaluate milk production, chemical composition (total dry extract, defatted dry extract, fat, protein, and lactose), somatic cell count, and total bacterial count, in relation to season (summer, fall, winter, and spring) on a rural property in the municipality of Palmeira das Missões, Rio Grande do Sul, Brazil between January 2009 and December 2016. This case study was delineated as a longitudinal retrospective. The main variable analyzed was the production of milk per hectare per month, as this is paramount in the evaluation of a rural property. The consecutive longitudinal retrospective study over the course of 8 years serves to emphasize that the organized execution of the activities related to animal husbandry and milk production reduces the coefficients of variation referring to the composition of the milk. In other words, it is easier to maintain milk quality, in addition to the generation of extra revenue by way of a bonus milk quality. The normative instructions from Nos. 51 and 62 of the Ministério da Agricultura, Pecuária e Abastecimento serve as a guide to help milk farmers to improve milk production systems as a whole, as the activity is multifactorial by nature.

Keywords: Lactose. Milk farmers. Milk prices. Production system. Temperature-humidity index.

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1 INTRODUÇÃO

O termo *agribusiness* (agronegócio) surgiu pela primeira vez em 1957, nos Estados Unidos, a partir das contribuições de John Davis e Ray Goldberg. Os estudiosos atrelaram o agronegócio a um conjunto de operações envolvidas na fabricação e distribuição de suprimentos agrícolas. Até o momento, agricultura e pecuária eram entendidas de forma isolada e independentes. E a partir dessa contribuição o agronegócio ficou entendido, como uma forma sistêmica e integrada de produção (BATALHA; SILVA, 2007).

Lopes e Neves et al., (2012) afirmam que "o agronegócio globalizado derrubou fronteiras, ultrapassou diferentes línguas e costumes, e criou um mundo inteiramente novo e diferente".

Em uma análise sobre o agronegócio, realizada por Rocha e Couto (2012), os autores constataram que em termos de produção, os brasileiros não enfrentam dificuldades. Todavia, no mercado internacional há quatro segmentos principais que merecem atenção: políticas agrícolas internacionais; exigências para comercialização; conjuntura de preços; e a dependência de importações. Esses quatro fatores são responsáveis pela restrição do potencial produtivo e competitivo do agronegócio brasileiro no exterior.

De acordo com o Centro de Estudos Avançados em Economia Aplicada (CEPEA – ESALQ, 2018), o agronegócio movimentou R$ 1,41 trilhões no ano de 2017, ou seja, 21,59% do Produto Interno Bruto (PIB) total brasileiro, e a pecuária apresentou participação de R$433,5 bilhões, equivalente a 6,61% do total. O Ministério da Agricultura, Pecuária e Abastecimento (MAPA), em estudo sobre as projeções do agronegócio (2013) para os próximos dez anos elenca o grão de soja e o leite entre os produtos com maior potencial de crescimento, produção e dinamicidade do agronegócio brasileiro.

Com alta representatividade no agronegócio, a cadeia produtiva do leite constitui uma das mais importantes do setor (GONÇALVES et al., 2009). Segundo Zuge et al. (2008), a disponibilidade de áreas agricultáveis aliadas à abundância de água doce são fatores determinantes para colocar o Brasil como destaque na exportação de lácteos.

Conforme Auad (2010), o cenário mundial indica o agronegócio como sendo o carro-chefe para o desenvolvimento comercial e industrial. Da mesma forma, Jorge (2011), afirma que muitos analistas internacionais, indicam que o Brasil será, dentro de alguns anos, o maior produtor mundial de alimentos, em decorrência de suas vantagens competitivas.

Figueiredo (2016) afirma, que "agropecuária brasileira tem pagado as contas da nação". Mesmo que algumas cadeias produtivas apresentem produções de nicho e de subsistência com pequena representação econômica, a agropecuária possui grande significado social em todas as regiões brasileiras.

Conforme Pacheco et al., (2012), o agronegócio do leite e de seus derivados ocupa um papel relevante no suprimento de alimentos e na geração de emprego e renda para a população. De acordo com dados do Instituto Brasileiro de Geografia e Estatística (IBGE, 2016), o Rio Grande do Sul é o segundo maior produtor de leite do país, com uma produtividade anual que corresponde a aproximadamente a 12% da produção nacional. Esse dado ressalta a importância da atividade leiteira para a economia gaúcha e mostra que o produtor deve estar atento ao sistema agroindustrial do leite, nos níveis internacional, nacional, estadual e regional.

A produção leiteira como atividade econômica e social é fomento para o desenvolvimento do país, tanto sob o ponto de vista produtivo como para as relações políticas e sociais que se estabelecem na construção da cidadania (DALCIN; TROIAN; OLIVEIRA, 2008).

Fraga et al., (2016) contextualizam a produção leiteira como uma das bases da agricultura regional, extremamente importante para a manutenção de muitas famílias no campo, contribuindo para a economia local. Existe uma grande necessidade de aumentar a produtividade leiteira, baseada na produção com baixo custo, melhorando a eficácia dos sistemas de produção. Conforme Neves e Conejero (2007), cada vez mais as atividades serão focadas para estratégias de produção com foco em sistemas interligados, segundo os autores, esse será o agronegócio mundial.

Desta forma, nosso objetivo foi avaliar a produção de leite, composição química, contagem de células somáticas e contagem bacteriana total do leite em relação às estações do ano de uma propriedade rural de Palmeira das Missões, Rio Grande do Sul, Brasil, entre janeiro de 2009 e dezembro de 2016. O estudo está estruturado em cinco partes, a primeira parte inicia com o capítulo introdutório com referencial teórico composto por uma contextualização geral do assunto; o segundo capítulo traz o artigo submetido ao periódico *Journal of Rural Studies*; na sequência, o capítulo três estão as considerações finais e sugestões para futuros estudos na área.

2 REFERENCIAL TEÓRICO

2.1 DIAGNÓSTICO DA PRODUÇÃO DE LEITE NO RIO GRANDE DO SUL, BRASIL, 2015 E 2017

Nesta seção do artigo são apresentadas e abordadas algumas características da Cadeia Produtiva do Leite (CPL) no Estado do Rio Grande do Sul. O Instituto Gaúcho do Leite (IGL), Associação Riograndense de Empreendimentos de Assistência Técnica e Extensão Rural (EMATER/RS) e Associação Sulina de Crédito e Assistência Rural (ASCAR) em 2015 realizaram pesquisa nos 497 municípios (100%) do Estado do Rio Grande do Sul. Utilizando metodologia semelhante no ano de 2017 (491 municípios – 99%) a EMATER/RS e ASCAR repetiram a pesquisa, de modo que a combinação de ambos os resultados permite avaliar a dinâmica da CPL no Rio Grande do Sul nesse curto espaço de tempo.

Um dos números que mais atraem atenção do leitor nos referidos relatórios é a variação do número de famílias de produtores rurais que reduziu de 198.467 para 173.706, ou seja, houve um decréscimo de 24.761 (-12.5%) famílias que tinham algum vínculo com a produção de leite. Considerando somente as propriedades rurais que vendem leite para as indústrias, cooperativas ou queijarias (Tabela 1) a redução foi 18.959 (-22,58%), repercutindo sobre os demais parâmetros avaliados.

Tabela 1 – Parâmetros avaliados em produtores que vendem leite para indústrias, cooperativas ou queijarias no Rio Grande do Sul, Brasil

Parâmetros avaliados	Ano de 2015	Ano de 2017
Número de produtores que vendem leite para indústrias, cooperativas ou queijarias	83.975	65.016
Área média das propriedades dos produtores de leite no Rio Grande do Sul, Brasil (Hectare)	19,0	19,1
Números de vacas leiteiras no Rio Grande do Sul	1.170.181	1.068.577
Produtividade por vaca (Leite/vaca/ano)	3.576,3	3.839,0
Produção diária média por vaca (Litro)	11,7	12,6
Produção de leite anual média por propriedade (Litro)	49.835,9	63.097,0
Produção de leite mensal média por propriedade (Litro)	4.153	5.258,1
Produção de leite diária média por propriedade (Litro)	138,4	172,9
Produção diária média no Rio Grande do Sul (Litros)	11.539.811,3	11.309.937,5
Produção de leite anual no Rio Grande do Sul (Litros)	4.184.972.183	4.102.315.774

Fonte: Elaborado pelos autores com base nos Relatórios Socioeconômicos da Cadeia Produtiva do Leite no Rio Grande do Sul de 2015 publicado pelo IGL, EMATER/RS, ASCAR e de 2017 publicado pela EMATER/RS e ASCAR.

A área média das propriedades rurais praticamente manteve-se constante, aumentando em apenas 0,1 hectares. O número de vacas reduziu 8,68%, mas observa-se que houve melhora no rendimento por vaca e por propriedade. Provavelmente, os aumentos da produção de leite por vaca são explicados pela composição dos rebanhos que, somando vacas das raças Holandês e Jersey, ultrapassam 74% na média do rebanho do Rio Grande do Sul nos dois anos avaliados (2015 e 2017).

A especialização do rebanho é de fundamental importância, mas se considerarmos que a maior parte da nossa genética é proveniente da América do Norte, principalmente dos Estados Unidos da América (EUA) percebe-se que há como aumentar consideravelmente a produção por meio de melhorias ambientais que são representadas sobre tudo por alimentação e nutrição do rebanho.

Na Tabela 2 verificam-se alterações na estratificação dos produtores de leite, em função, do volume diário. Em 2015 os três primeiros estratos somavam 61,2% do total. Enquanto que em 2017 os mesmos estratos representam 54,9%, demonstrando que há tendência de aumentar a produção de leite por propriedade rural, uma vez que geralmente o lucro por litro de leite produzido é pequeno, mínimo e até mesmo ausente, de modo que é necessário ter escala para aumentar a rentabilidade da propriedade rural.

Tabela 2 – Estratificação dos produtores de leite em função do volume diário de produção no Rio Grande do Sul, Brasil, para os anos de 2015 e 2017 referentes aos produtores que vendem leite para indústrias, cooperativas ou queijarias ou que processam a produção em agroindústria própria legalizada

Estratos	2015		2017	
	Total	Percentual	Total	Percentual
Até 50 litros por dia	20.089	23,9	11.657	17,9
Entre 51 e 100 litros por dia	17.881	21,2	12.975	19,9
Entre 101 e 150 litros por dia	13.632	16,2	11.170	17,1
Entre 151 e 200 litros por dia	10.383	12,3	8.982	13,8
Entre 201 e 300 litros por dia	9.504	11,3	8.587	13,2
Entre 301 e 500 litros por dia	7.118	8,5	6.720	10,3
Entre 501 e 1.000 litros por dia	4.195	5,0	3.923	6,0
Entre 1.0001 e 2.500 litros por dia	1.055	1,3	1.018	1,6
Mais de 2.500 litros por dia	322	0,4	170	0,3
Total	84.179	100,0	65.202	100,0

Fonte: Relatórios Socioeconômicos da Cadeia Produtiva do Leite no Rio Grande do Sul de 2015 publicado pelo IGL, EMATER/RS, ASCAR e de 2017 publicado pela EMATER/RS e ASCAR.

Na Tabela 3 verifica-se que as pastagens são a principal fonte de alimentação dos rebanhos. No relatório de 2017 também foram determinados os sistemas de produção, chegando-se aos seguintes números: à base de pasto 62.331 (95,6%) sistema onde os animais permanecem livres durante todo o dia, com acesso à pastagem, embora possam receber alimentação em algum tipo de instalação, após as ordenhas; semiconfinamento 2.175 (3,3%) sistema no qual os animais permanecem presos por mais de seis horas por dia, mas são soltos por algumas horas quando têm acesso à pastagem; e confinamento total 696 (1,1%) sistema no qual os animais permanecem presos durante todo o dia, em algum tipo de galpão (*Tie Stall*, *Free Stall* ou *Compost Bedded Pack Dairy Barn*), recebendo 100% da alimentação no cocho.

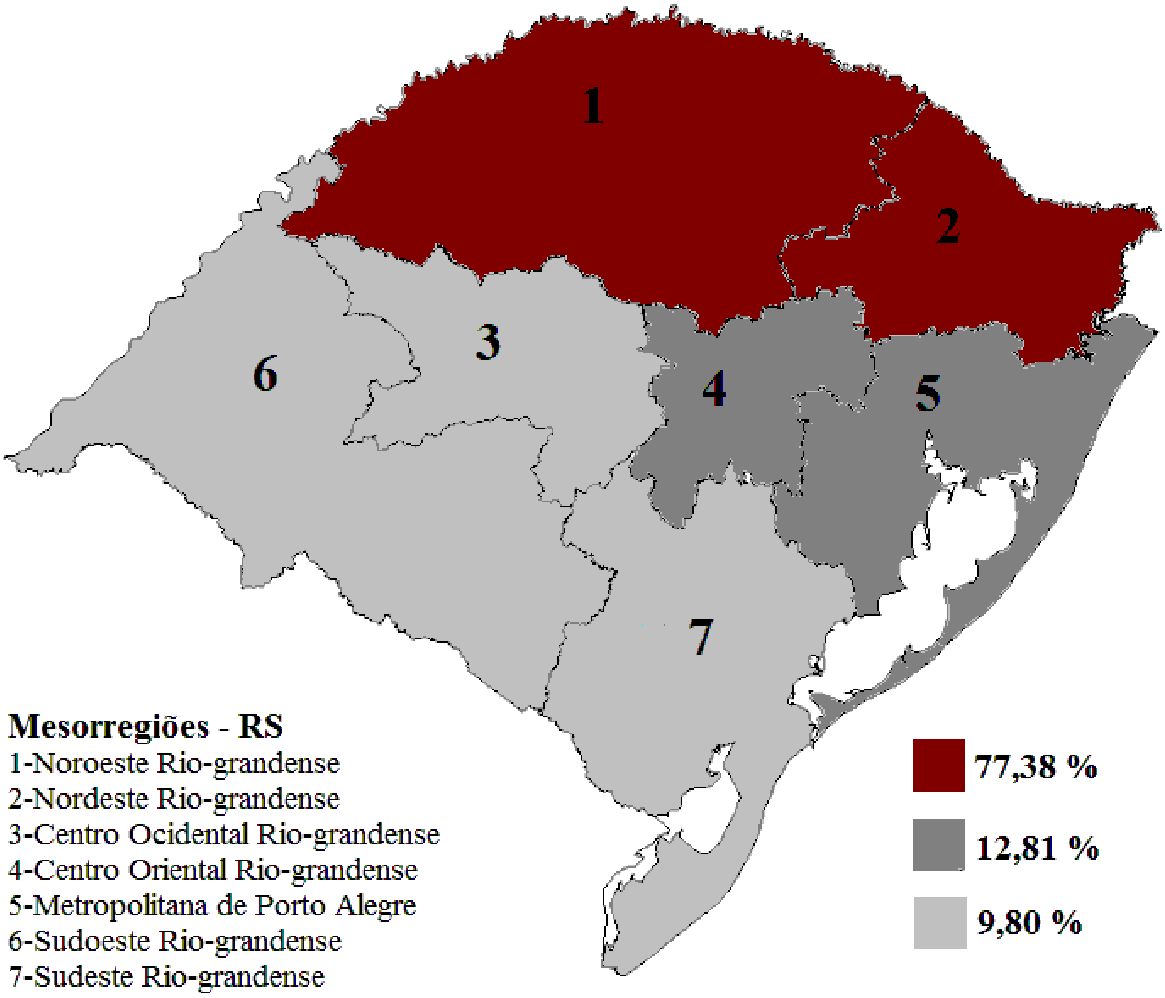
Tabela 3 – Tecnologias utilizadas no Rio Grande do Sul, Brasil, para os anos de 2015 e 2017 referentes aos produtores que vendem leite para indústrias, cooperativas ou queijarias ou que processam a produção em agroindústria própria legalizada

Estratos	2015		2017	
	Total	Percentual	Total	Percentual
Utilizam pastagem anual de inverno	79.554	94,5	62.761	96,3
Utilizam pastagem anual de verão	72.276	85,8	55.765	85,5
Utilizam silagem de verão ou inverno	67.396	80,0	55.104	94,5
Utilizam inseminação artificial (IA ou IATF)	64.891	77,1	52.703	80,8
Realizam pastoreio rotativo/rotacionado	52.056	61,8	45.263	69,4
Utilizam gramíneas perenes de verão	48.807	58,0	40.833	62,6
Fornecem ração conforme a produção da vaca	20.894	24,8	20.064	30,8
Fazem controle leiteiro por vaca, no mínimo mensal	11.415	13,6	11.321	17,4
Produzem leguminosas	6.932	8,2	5.290	8,1
Utilizam irrigação de pastagens	2.240	2,7	2.240	3,4
Total	84.179	100,0	65.202	100,0

Fonte: Relatórios Socioeconômicos da Cadeia Produtiva do Leite no Rio Grande do Sul de 2015 publicado pelo IGL, EMATER/RS, ASCAR e de 2017 publicado pela EMATER/RS e ASCAR.

Apesar dos baixos valores de semiconfinamento e confinamento a utilização do uso de silagem é bem significativa, demonstrando que mesmo os rebanhos que estão basicamente na pastagem ainda recebem suplementação com volumoso conservado.

Figura 1 – Produção de leite em percentual pelas mesorregiões no Rio Grande do Sul em 2016



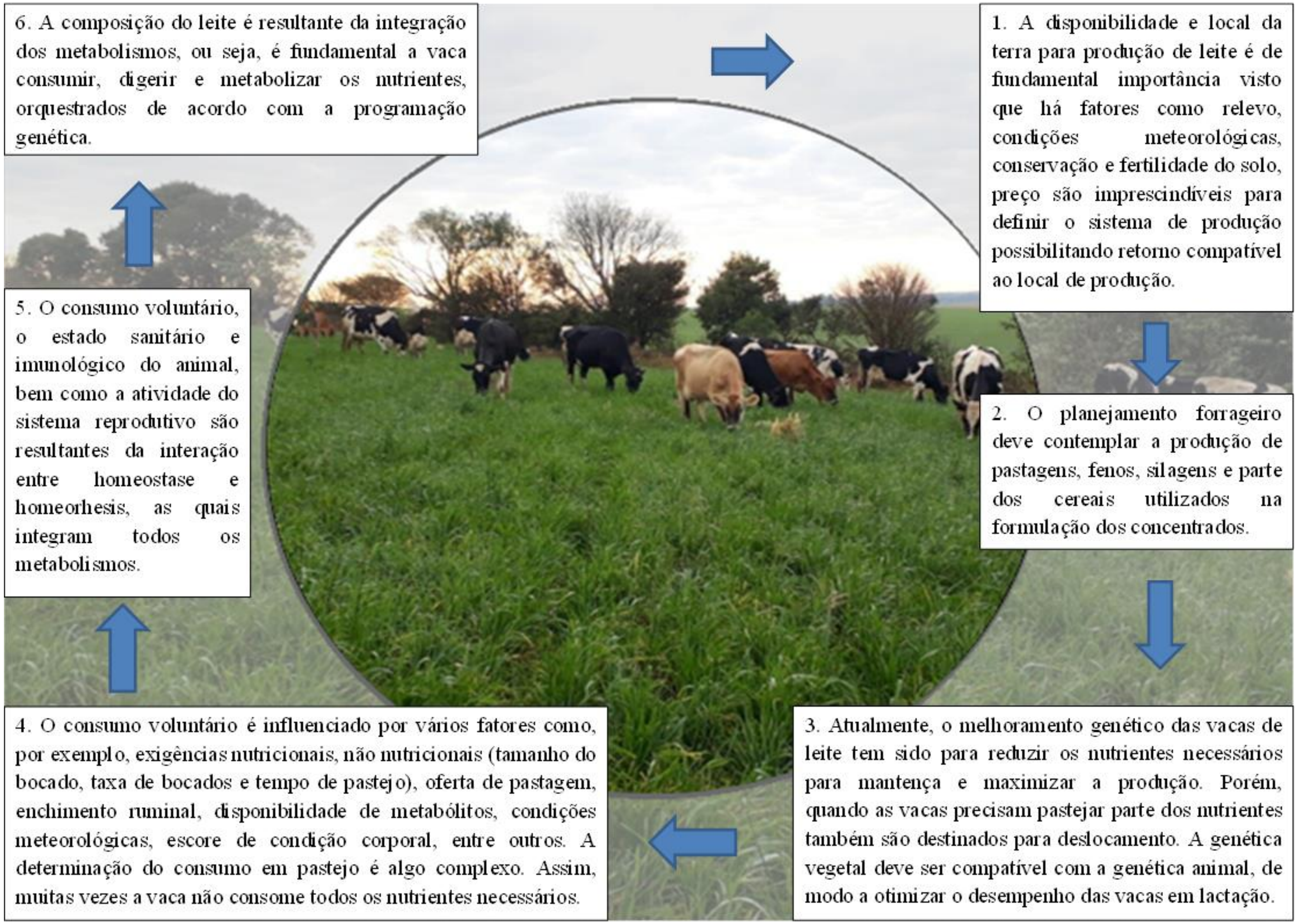
Fonte: Preparado pelos autores (IBGE, 2018).

De acordo com IBGE (2018), as mesorregiões do Rio Grande do Sul que mais produziram leite no ano de 2016 são a Noroeste e Nordeste (Figura 1), alcançando 77,38% da produção total, enquanto as mesorregiões Centro Oriental e Metropolitana produzem aproximadamente 22,61%, demonstrando que há concentração na produção de leite nas duas primeiras regiões citadas, as quais também concentram as maiores produções de soja (*Glycine max.*) e milho (*Zea mays*) do estado.

2.2 REVISÃO DE LITERATURA E CONSIDERAÇÕES SOBRE A PRODUÇÃO DE LEITE NO RIO GRANDE DO SUL, BRASIL

A fim de organizarmos a revisão de literatura, elaboramos um mapa conceitual, resumido, sobre os principais fatores que impactam sobre a produção de leite no Estado do Rio Grande do Sul (Figura 2), principalmente com foco na propriedade rural, pois sabemos que por mais que tentemos fazê-lo completo faltarão informações, em função, da complexidade que permeia a cadeia produtiva do leite, sobretudo em países emergentes como é o caso do Brasil, em que as condições mercadológicas variam bastante ao longo dos anos e das décadas e assim dificulta o planejamento da atividade a médio e longo prazo. A fotografia contida no mapa conceitual é da propriedade estudada e apresentada na seção (4) metodologia, a qual representa parte considerável das propriedades de leite do Rio Grande do Sul, pois como consta na Figura 1 a produção de leite concentra-se nas mesorregiões Noroeste e Nordeste em que o relevo das regiões é coxilhas com algumas partes mais acidentadas, ou seja, as áreas não são planas e, portanto é necessário maneja-las com curva de nível para preservar o solo.

Figura 2 – Mapa conceitual resumido sobre alguns fatores que interferem com a produção de alimentos (forragens), melhoramento genético, desempenho das vacas em lactação e composição do leite nas condições do Rio Grande do Sul, Brasil



Fonte: Preparado pelos autores.

Um dos principais fatores que determina as características da atividade leiteira é a localização geográfica da propriedade, visto que o sistema de produção escolhido (a pasto, semi-confinado ou confinado) deve ser determinado com base nas seguintes particularidades: preço das terras, relevo (tipo, conservação e fertilidade do solo), continentalidade (umidade relativa do ar, precipitação pluviométrica, temperatura e altitude), disponibilidade de água e capacidade de produção de alimentos volumosos e concentrados para alimentação e nutrição do rebanho, em função, de interferirem no custo de produção. Entretanto, verifica-se que no Rio Grande do Sul parte dos produtores de leite não tem conseguido fazer um planejamento adequado, repercutindo no abandono da atividade conforme apresentado na tabela 1.

Contudo, segundo estudo realizado por Trennepohl (2010), a pecuária leiteira é a atividade primária com maior impacto na economia local, em relação aos outros produtos agrícolas. Conforme o autor, para cada unidade de valor bruto da produção de leite, gera-se um impacto de 1,166 no valor adicionado da economia estadual do Rio Grande do Sul. Esse impacto é resultado da soma do índice multiplicador de impacto da produção leiteira de 0,790 de valor adicionado, com o índice de 0,375 por unidade de Valor Bruto da Produção - VBP, cujo índice deveria ser utilizado na construção das políticas públicas governamentais em função do impacto social da cadeia produtiva do leite.

Até 1950, a terra foi percebida como uma possibilidade de expandir a riqueza das nações, sendo que os economistas aderiam ao conceito de que a renda oriunda da produção determinaria o preço da terra, posterior a esse período, o preço elevou-se acima da renda (MALASSISE et al., 2016). Esse aumento de preços, acima dos ganhos produtivos foi chamado de “paradoxo do preço da terra”, que atribuiu outros fatores, além da renda da terra, para compreender o comportamento do preço (FERRO; CASTRO, 2013).

De acordo com Belik (2015), uma das formas mais seguras de promover o desenvolvimento rural é a adaptação de programas públicos e privados para diferentes realidades, por meio de formulação de políticas regionais e de caráter tecnológico, visando reduzir as desigualdades e levando em consideração o caráter heterogêneo da produção agropecuária. No mesmo sentido Costa et al., (2013) comentam sobre a necessidade de conhecer e compreender as peculiaridades dos diferentes sistemas de produção de gado leiteiro, para a construção e implementação de políticas públicas e programas de extensão que visem o crescimento da indústria de laticínios. Assim elencam algumas prioridades: ajudar na infraestrutura e práticas para o cumprimento da legislação dentro dos padrões exigidos pela lei; fomentar o uso de sistemas eficientes para melhorar o manejo de pastagens, água e sombra; e controlar e prevenir problemas de saúde com o rebanho.

Em função das vacas serem ruminantes é importante potencializar a fermentação ruminal, bem como a ruminação propriamente dita através da presença de alimentos volumosos que apresentem fibra fisicamente efetiva (VAN SOEST, 1994).

Segundo Tambara et al. (2017) a produção de carne, leite e/ou lã baseado em pastagens é influenciada pelas variações na produção e composição das forrageiras em função das estações do ano, principalmente durante os vazios forrageiros tradicionais de outono e primavera. Para garantir índices zootécnicos satisfatórios é imprescindível haver pastos de qualidade ao longo do ano. A combinação de gramíneas e leguminosas melhoram a palatabilidade, valor nutricional e incrementam a produtividade (OLIVO et al., 2016).

Avaliando a produção e a composição do leite de 259 rebanhos leiteiros (165.311 observações), pertencentes aos cooperados de quatro cooperativas localizadas na Região Noroeste do Rio Grande do Sul, entre janeiro de 1998 e julho de 2003, Noro et al., (2006) verificaram produção diária média de leite anual de 19,36 litros por vaca, constituídos por 3,54% de gordura, 3,12% de proteína e 4,52% de lactose e com escore de células somáticas da ordem de 3,57 (escala de 0 a 9). Considerando a produção diária média de leite anual verificada, evidencia-se que os rebanhos leiteiros do Noroeste Gaúcho apresentam alto mérito genético, assim as condições ambientais precisam ser avaliadas constantemente, a fim de alcançar a expressão máxima dos genótipos e, sobretudo evitar distúrbios metabólicos como, por exemplo, cetose, decorrente de baixo consumo de alimentos e/ou dietas com baixa concentração energética. Capper et al., (2009) demonstraram que entre 1944 e 2007 (63 anos) a produção de leite média por lactação nos Estados Unidos da América passou de 2,074 para 9,193 quilogramas, ou seja, um incremento de 443%, cujo aumento é decorrente do melhoramento genético e mudanças nas raças, mas também por alterações nos sistemas produtivos passando de forragens (pastagens e fenos) + concentrado para ração totalmente misturada (silagem de milho, silagem de alfafa e concentrado), de modo a proporcionar quantidade suficiente de nutrientes para expressão do genótipo e fenótipo. Como os produtores brasileiros adquirem sêmen de touros selecionados por empresas de genética norte-americanas é possível que o potencial genético mencionado por Capper et al., (2009) já esteja disponível no Brasil, mas em função do ambiente não ter sido adequado em 100% das situações não ocorre a máxima expressão fenotípica.

Ponderando que o produtor rural almeje produção e composição do leite conforme as médias supracitadas para todo o seu rebanho, além de uma bezerra por vaca por ano, é imprescindível cuidados especiais na alimentação e nutrição das vacas de leite, bem como das condições que proporcionam bem-estar animal.

A nutrição de bovinos de leite pode ser definida amplamente como o uso dos componentes de alimentos para os processos de mantença, crescimento, reprodução, lactação e saúde; a nutrição aplicada é a seleção e a distribuição de alimentos e ingredientes para fornecer as quantidades e o equilíbrio corretos de nutrientes necessários para um ótimo desempenho produtivo e reprodutivo (DRACKLEY et al., 2006).

O grande desafio na alimentação do ruminante de alta produtividade é aumentar sua capacidade de ingestão de alimento, para suprir suas necessidades nutricionais, sem prejuízo aos processos fisiológicos no rúmen, ou seja, mantendo a atividade de ruminação, com um consumo adequado do alimento volumoso. A planta inteira de milho, verde ou na forma de silagem, permite maior consumo face ao teor relativamente baixo de FDN menos de 50%, pois menor teor de FDN significa FDN de maior taxa de fermentação, ou seja, um esvaziamento mais rápido do rúmen (VELHO et al., 2006).

Em recente revisão bibliográfica sobre os efeitos do estresse por calor sobre o bem-estar de gado leiteiro Polsky e von Keyserlingk (2017) relação entre os efeitos imediatos do estresse térmico ambiental e os três principais construtos do bem-estar animal: (1) funcionamento biológico e saúde (ofegante (comportamento estereotipado); ↓ comportamento estral (aumento de anestro); ↓ produção de leite; ↑ fome e sede; ↑ frustração; ↑ agressão; ↑ mal-estar) e (3) vida natural (↑ adaptações evolutivas; ↑ comportamento de agrupamento; ↑ busca de sombra), considerando o número de dias em que o índice de temperatura-umidade (THI) excede o limiar de conforto (> 72).

Bauman e Currie (1980) conceituaram homeostase e homeorhesis conforme inserido abaixo:

> O controle do metabolismo durante a gestação e a lactação envolve dois tipos de regulação - homeostase e homeorhesis. O controle homeostático envolve a manutenção do equilíbrio fisiológico ou a constância das condições ambientais dentro do animal. A homeorhesis é o controle orquestrado ou coordenado no metabolismo dos tecidos corporais, necessário para suportar um estado fisiológico. A regulação do particionamento de nutrientes durante a gestação envolve controles homeórreticos decorrentes do conceito. Isso garante o crescimento do concepto (feto e membranas fetais) e do útero gravído, bem como o desenvolvimento da glândula mamária. Com o início da lactação, muitos talvez até tecidos mais maternos passam por adaptações adicionais para apoiar a lactação. As adaptações coordenadas nas taxas de lipogênese e lipólise no tecido adiposo são exemplos de importantes controles homeorréticos de particionamento de nutrientes que são necessários para suprir as necessidades mamárias de síntese láctea.

Como em sistemas de produção de leite eficientes a vaca na maior parte do tempo da lactação (305 dias) também deve estar gestando então a interação entre homeostase e homeorhesis é permanente e dinâmica, ainda mais quando as vacas são acometidas por estresse pelo calor. Porém, os problemas em vacas de leite não se resumem apenas ao estresse pelo calor, mas tem haver com as condições ambientais, uma vez que o ciclo das pastagens é influenciado pelas condições meteorológicas variáveis no decorrer das estações do ano, de modo que no outono e primavera há vazios forrageiros clássicos quando os sistemas são baseados essencialmente em pastagens, mesmo com suplementação estratégica. Logo, no dia-a-dia da atividade é necessário potencializar o consumo voluntário, mas há diversos fatores que agem prejudicando o mesmo e assim as demais respostas são influenciadas em cascata.

Durante a fase de balanço energético negativo caracterizado pela limitada capacidade de consumo de alimentos e alta exigência nutricional repercute em mobilização de reservas corporais (NRC, 2001), as quais precisam ser recuperadas em curto espaço de tempo. Caso contrário, haverá prejuízos sobre os índices produtivos da lactação e reprodutivos ao longo da vida útil da vaca (PRYCE et al., 2001; CHEBEL et al., 2018), repercutindo sobre a receita financeira da propriedade rural (SANTOS; LOPES, 2014). Todavia, em condições tropicais não apenas os fatores supracitados interferem nas exigências nutricionais de mantença e produção, mas também as condições meteorológicas, sobretudo a interação temperatura e umidade relativa do ar que impactam sobre as exigências nutricionais de mantença e também sobre o consumo de alimentos (NRC, 2001; TYLUTKI et al., 2008).

Assim como os fatores climáticos, as condições do relevo também devem ser consideradas na produção leiteira, pois diminuem consideravelmente o aporte de nutrientes para produção de leite de vacas em pastejo. O deslocamento das vacas lactantes gera gasto energético o que acaba por influenciar nas exigências nutricionais desses animais. Segundo Fox et al. (2004), quando o animal se desloca por uma distância plana, o gasto energético é de 0.621 megacalorias para cada 1,000 metros, enquanto que o deslocamento em aclive e/ou declive demanda 6.69 megacalorias para cada 1,000 metros percorridos.

A redução do consumo de alimento em virtude de fatores ambientais ocorre quando as condições térmicas estão fora da zona termoneutra, que se situa entre 5 a 20°C (NRC, 2001). Conforme Collier et al., (2017) o estresse é um evento ou condição externa que afeta o sistema biológico, de modo que a resposta do animal a um estresse envolve o gasto de energia para remover ou reduzir o impacto do estresse, aumentando as exigências de mantença o que resulta em perdas na produção. Assim, vacas em estresse térmico e em início de lactação, sofrem um déficit nutricional que em consequência acarreta redução da produção leiteira e perda de condição corporal, em função da mobilização de reservas corporais (NRC, 2001).

A mobilização de gordura corporal quando excessiva induz a um aumento no plasma de ácidos graxos não-esterificados que são captados pelo fígado, levando ao desenvolvimento do fígado gorduroso (esteatose hepática). A fertilidade de vacas com síndrome do fígado gordo é geralmente baixa, podendo chegar a taxas de concepção ao primeiro serviço inferior a 50% ocorrendo uma redução estimada de um porcento na taxa anual de concepção (PETIT, 2009). O fígado gordo é um dos principais distúrbios metabólicos de muitas vacas leiteiras no início da lactação e está associado à diminuição do estado de saúde e do desempenho reprodutivo, em casos graves, a produção de leite e a ingestão de alimentos diminuem (BOBE et al., 2004).

No estudo sobre indicadores-referência de sistemas de produção de leite, os autores, Oliveira et al., (2007), realizam a análise, baseados no perfil tecnológico, em indicadores zootécnicos, indicadores econômicos e no tamanhos das propriedades. Estes autores classificaram os indicadores da seguinte forma:

Indicadores de tamanho: a produção diária de leite, a área total, número de vacas em lactação, total de vacas, total do rebanho, total de unidades animais, mão-de-obra total, fornecimento de concentrado para o rebanho e capital total investido.

Indicadores zootécnicos: produtividade por vaca em lactação, produtividade por total de vacas, relação de vacas em lactação pelo total de vacas, relação de vacas em lactação pelo total do rebanho, taxa de lotação, número de vacas em lactação por área, produtividade da terra e produtividade da mão-de-obra.

Indicadores econômicos: renda bruta da atividade leiteira (RBA), renda bruta do leite (RBL), participação da renda bruta do leite na renda bruta da atividade, preço do leite, custo operacional efetivo (COE) da atividade leiteira, custo operacional total (COT) da atividade leiteira, custo total da atividade leiteira, margem bruta da atividade, margem líquida da atividade, lucro da atividade, custo operacional efetivo por litro de leite, custo operacional total por litro de leite, custo total por litro de leite, margem bruta por litro de leite, margem líquida por litro de leite, lucro por litro de leite, gasto com concentrado para o rebanho em relação ao valor da produção de leite, gasto com mão-de-obra em relação ao valor da produção de leite, participação do COE na RBA, participação do COT na RBA, taxa de remuneração do capital investido e capital investido na atividade em relação à produção diária de leite.

Quanto aos indicadores de eficiência econômica, Lopes et al., (2008), considera para avaliação e comparação, a margem bruta, a margem líquida e o resultado. Para Silveira et al., (2011), na análise de indicadores econômicos, deve-se avaliar o valor presente e a taxa interna de retorno.

De acordo com Santos e Lopes (2014), é grande o número de propriedades que são geridas com empirismo, pela falta de conhecimento sobre os custos de produção, que deveriam dar suporte, para a gestão. Os produtores necessitam conhecer a realidade onde estão atuando. Para, a partir da identificação e mensuração dos custos de produção, poder realizar o planejamento da propriedade, com estratégias de identificação de gargalos, redução de custos, maximização de recursos e lucros.

De acordo com Oliveira et al., (2007), identificar os indicadores é uma forma de instruir o processo de tomada de decisão, com informações esclarecedoras sobre a viabilidade econômica de sistemas de produção de leite.

Salientamos que as proposições do trabalho e metodologia consta no artigo apresentado do próximo capítulo.

3 ARTIGO: LONGITUDINAL RETROSPECTIVE RURAL STUDY ON THE EFFECT OF SEASON ON MILK PRODUCTION AND MILK COMPOSITION IN RIO GRANDE DO SUL, BRAZIL

ABSTRACT

The production of foods of animal origin such as meat, milk, and their derivatives must be intensified on a global scale in a sustainable way. Here, our objective was to evaluate milk production, chemical composition (total dry extract, defatted dry extract, fat, protein, and lactose), somatic cell count, and total bacterial count, in relation to season (summer, fall, winter, and spring) on a rural property in the municipality of Palmeira das Missões, Rio Grande do Sul, Brazil between January 2009 and December 2016. This case study was delineated as a longitudinal retrospective. The main variable analyzed was the production of milk per hectare per month, as this is paramount in the evaluation of a rural property. The consecutive longitudinal retrospective study over the course of 8 years serves to emphasize that the organized execution of the activities related to animal husbandry and milk production reduces the coefficients of variation referring to the composition of the milk. In other words, it is easier to maintain milk quality, in addition to the generation of extra revenue by way of a bonus milk quality. The normative instructions from Nos. 51 and 62 of the Ministério da Agricultura, Pecuária e Abastecimento serve as a guide to help milk farmers to improve milk production systems as a whole, as the activity is multifactorial by nature.

Keywords: Lactose, Milk farmers, Milk prices, Production system, Temperature-humidity index

1. Introduction

The production of animal products such as meat, milk, and their derivatives must be intensified globally to meet increasing market demand. However, this growing demand must be met in a sustainable manner (i.e., following the three pillars of sustainability: economically viable, environmentally correct, and socially just) (Tedeschi et al., 2015). This is especially important, as in 2030, the global population will exceed eight billion people (Samir and Lutz, 2017), further increasing to greater than nine billion in 2050 (Alexandratos and Bruinsma, 2012). At the same time, there has been an increase in life expectancy not only reflected in the greater number of years lived, but also in social changes related to culture and health care (Salomon et al., 2012), increased income (Valin et al., 2014), and increased urbanization (Smith, 2017) all necessitating improved food security (Seto and Ramankutty, 2016). Thus, it is crucial to understand the impacts of food production on human health (Patz et al., 2005, Liu et al., 2015, Tedeschi et al., 2017). For example, by naturally altering the fatty acid profile of milk and its derivatives, it is possible to provide healthier foods to the human population via improved nutraceutical characteristics (da Silva et al., 2007, Ferlay et al., 2013; Oeffner et al., 2013; Puppel et al., 2013), in addition to adding value to the products sold.

Owing to the socioeconomic and nutritional importance of the Productive Milk Chain (PMC), the Ministério da Agricultura, Pecuária e Abastecimento (MAPA) of Brazil, normative instructions Nos. 51 and 62 (Brasil, 2002; Brasil, 2011) have standardized—and sought to improve—the composition and quality of the milk produced in Brazil. However, it is known that milk production is the result of the interaction between multiple factors, such as soil availability and soil fertility (Mueller et al., 2014; Gerssen-Gondelach et al., 2017); waste management, nutrients, and the mitigation of greenhouse gases (Asselin-Balençon et al., 2013; Holly et al., 2017; Veltman et al., 2017); the availability, quality and water use (Coimbra et al., 2012; Willers et al., 2014; Kraub et al., 2015; Palhares and Pezzopane, 2015);

pasture production (Henz et al., 2016; Roche et al., 2017; Tambara et al., 2017); silage production (Hentz et al., 2017; da Silva et al., 2018); cow genetics (da Silva et al., 2015; Hardie et al., 2017; Rangel et al., 2018); feeding systems (Larsen et al., 2010; Fajardo et al., 2015; Virbat et al., 2017); the health status of the mammary gland (Busanello et al., 2017; Gonçalves et al., 2018), among several other parameters.

The aforementioned information highlights the truly dynamic nature of milk production, and how a systemic and integrated approach to the industry could increase efficiency. However, this holistic and integrated approach is challenging, as there is a need to coalesce information on the many factors that interact with one another. Therefore, it is necessary that the rural producer has technical assistance in the short, medium, and long term. In short, providing assistance to rural farmers to help streamline such a dynamic approach to milk production would help increase profitability in developing countries.

Stürmer et al. (2018) concluded that for milk production in the municipality of Chapada in the Northwest Region of Rio Grande do Sul, there is a strong relationship between climatic variables and monthly production, milk pricing, and composition, where approximately 10.2% of the variation in milk composition, monthly production, and pricing are explained by a set of climatic variables (temperature, solar radiation, rainfall, and the temperature-humidity index).

However, the influence of climatic variables on milk composition and quality occurs indirectly, primarily owing to the effect of heat stress on milk cows (Gantner et al., 2017), which results in substantial metabolic changes (e.g., reduction in lipolysis, increased glycolysis, increased catabolism of amino acids). Furthermore, long-term heat stress also interferes with immune and inflammatory functions (Min et al., 2017).

Thus, our objective was to evaluate milk production, chemical composition, somatic cell count, and total bacterial milk count in relation to season on a rural property in Palmeira das Missões, Rio Grande do Sul, Brazil between January 2009 and December 2016.

2. Methodology

2.1. Database and herd management practices

The data used in the present study (January 2009 to December 2016) originated from the Escola Estadual Técnica Celeste Gobbato (EETCG), Palmeira das Missões, Rio Grande do Sul, Brazil, which performs secondary vocational training of Técnicos em Agropecuária. The results were generated in the Unidade Educativa Bovinocultura de Leite (UEBL), and the case study was delineated as a longitudinal retrospective. The Holstein herd management and production conditions between January 2009 and December 2012 were described by Haygert-Velho et al. (in press). We note that the production system between January 2013 and December 2016 is the same as described in the aforementioned article.

2.2 Milk composition

For milk analysis, two to four samples of the cooling tank were collected monthly by the company that buys the milk from the Escola Estadual Técnica Celeste Gobbato and sent for analysis to the Serviço de Análise de Rebanhos Leiteiros (SARLE) of the Universidade de Passo Fundo (UPF), certified by the Ministério da Agricultura, Pecuária e Abastecimento (MAPA) of Brazil. To determine amounts of the total dry extract (TDE), defatted dry extract (DDE), lactose, fat, and protein, the samples were analyzed by near-infrared Raman spectroscopy (NIRS, Bentley 2000, Bentley Instruments, USA) according to ISO 9622. Somatic cell count (SCC) and total bacterial count (TBC) were determined using flow cytometry (Somacount 300, Bentley Instruments, USA), according to ISO 13366-2. Both methods are prescribed in INMETRO IEC 17025: 2002.

2.3. Temperature-humidity index (THI)

The temperature-humidity index (THI) was calculated according to official data from the meteorological database of the Instituto Nacional de Meteorologia (INMET) for the Estação Meteorológica Automática de Palmeira das Missões (Longitude: O 53 19 4.976; Latitude: S 27 55 13.364; Altitude: 614m asl), which is nearly 2 km from the UEBL – EETCG management center. The climate of the region is characterized as Cfa (subtropical humid with hot summers and without defined dry season), according to the Köppen classification system, with average an annual rainfall of 1,029 mm (Alvares et al. 2013). The formula used to determine the THI according to Kibler (1964) is presented below:

$$THI = 1{,}8 \times Ta - (1 - RH) \times (Ta - 14{,}3) + 32$$

where

Ta – mean daily temperature (°C)

RH – mean daily relative air humidity as a fraction of the unit (%).

Oliveira Neto et al. (2001) recommend three classes to assess heat stress through THI: threshold values for mild stress THI = 72 − 79, moderate stress THI = 80 – 89, and severe stress THI = 90 − 98. However, we had to use only two classes smaller and greater than 72%.

2.4. Deflation of milk price

The Índice Geral de Preços–Disponibilidade Interna (IGPD-DI), published by the Instituto Brasileiro de Economia (IBRE) linked to the Fundação Getúlio Vargas (FGV), was used to carry out the deflation of the milk values, which measures the behavior of milk prices in the Brazilian economy. The IGP-DI is a weighted arithmetic average between the Índice de Preços no Atacado (IPA), which measures the variation of wholesale prices, and the Índice de

Preços ao Consumidor (IPC), and measures the price oscillation by the retail sector and consumer services (IBRE − FGV, 2016). The Real Price of Milk $RPM = \frac{NPM}{IGP-DI} * 100$ was determined as follows: where NPM = Nominal Price of Milk. The base date used was 12/2016. Figure 1 shows the nominal and real prices of milk, considering the evaluation period of the EETCG herd (January 2009–December 2016).

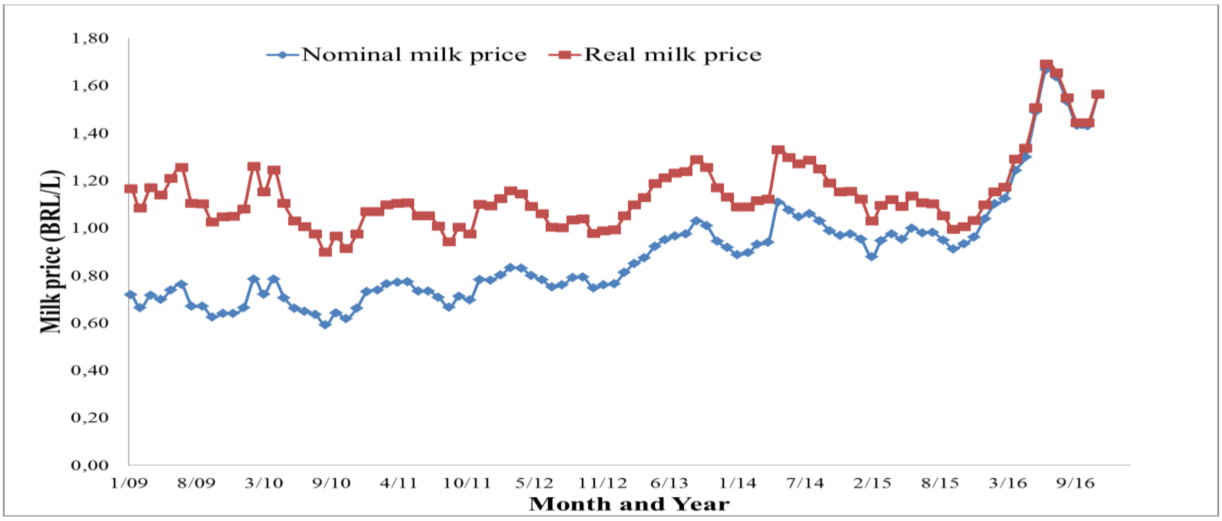


Figure 1. Nominal and real prices of milk, between January 2009 and December 2016, in Palmeira das Missões, Rio Grande do Sul, Brazil.

This variable has great importance in an open economy and exerts a strong influence on other macroeconomic variables (Grijó, 2005). According to Bresser-Pereira (2012), a competitive exchange rate stimulates export-oriented investments and correspondingly increases domestic savings. Almeida and Bacha (1999) distinguish the real exchange rate from the effective exchange rate, where the first refers to the deflated value of the price in the national currency of a unit of foreign currency taken as a reference. The real effective exchange rate is the deflated value of the domestic currency price of a weighted average of foreign currencies (Figure 2).

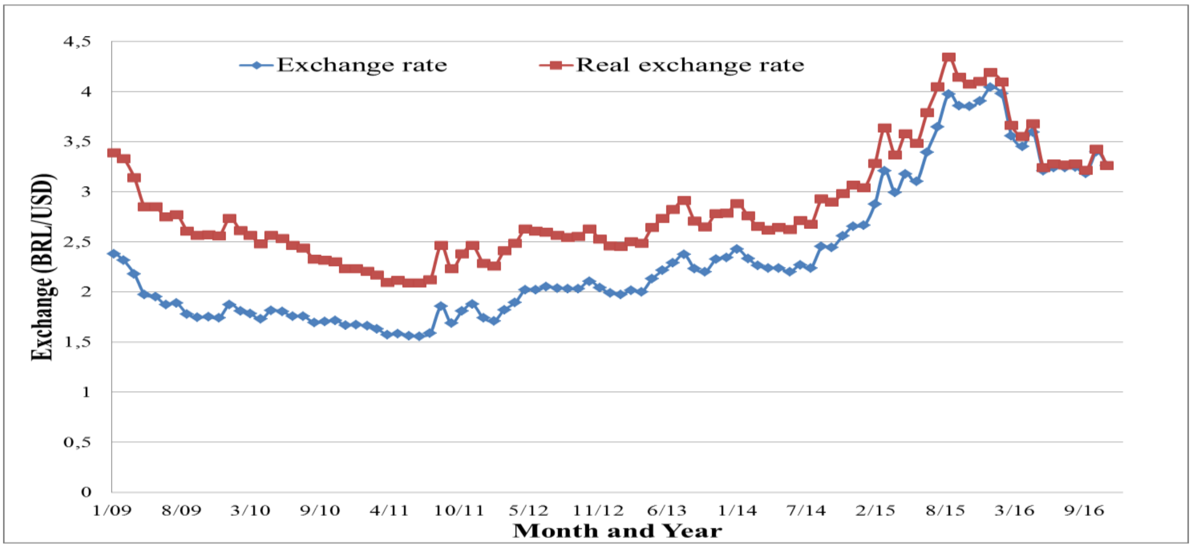


Figure 2. Real exchange rate (BRL/USD): 01/2009 to 12/2016.

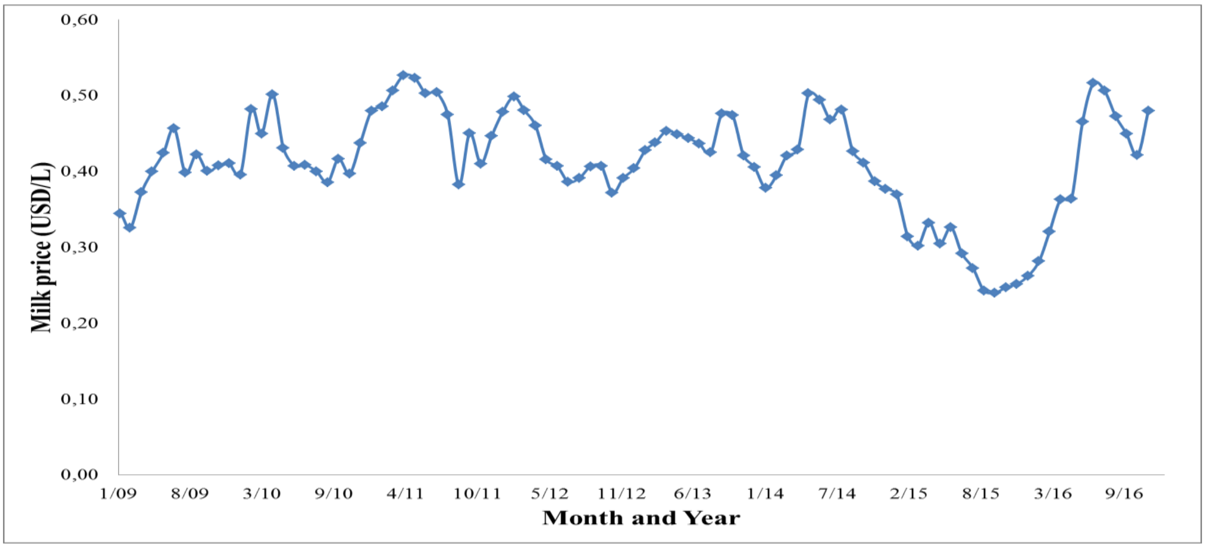


Figure 3. Real price of milk (USD/liter) in Palmeira das Missões, Rio Grande do Sul, Brazil: 01/2009 to 12/2016.

2.5. Statistical analyses

The statistical analyses (Table 1) and the non-parametric Kendall method (PROC CORR of SAS; SAS Institute, 2012) were performed between the variables in the database: milk production per hectare per month, milk price in USD, total dry extract (TDE), defatted dry extracted (DDE), fat, protein, lactose, somatic cell count (SCC), total bacterial count

(TBC), hours in the month with THI below and above 72. These methods were used because variables such as SCC and TBC presented extreme values, and were not normally distributed.

In the sequence, the variables described above were compared between the seasons and years. In order to verify the influence of climatic seasons on the results, years were segmented considering the southern hemisphere as follows: summer (January, February, and March), fall (April, May, and June), winter (July, August, and September), and spring (October, November, and December). First, all the variables were verified in relation to the normality of the data by means of histograms (SAS PROC UNIVARIATE). Subsequently, a generalized linear mixed model (PROC GLIMMIX in SAS) was applied to the following variables that presented a normal distribution: milk yield per hectare, milk price in USD, TDE, DDE, fat, protein, and lactose, using month as a random effect and a variance-covariance matrix of the unstructured type to model the repeated measurements, where this matrix resulted in the best fit of the model. Thus, a normal distribution was used to model these variables as follows:

$$Y_{ijk} = \alpha + \beta_i + \gamma_j + \delta_k + \varepsilon_{ijk}$$

where,

Y_{ijk} = value of the response variable within the i^{th} season, j^{th} year, and k^{th} month;

α = value of intercept, common to all observations;

β_i = fixed effect of the i^{th} season of the year with i = 4;

γ_j = fixed effect of the j^{th} year with j = 8;

δ_k = random effect of the k^{th} month with k = 12;

ε_{ijk} = random error associated with observation.

For the other variables that did not present a normal distribution (SCC, TBC, hours in the month with THI below and above 72), a model similar to the previous model was used with the same variance-covariance structure and same fixed and random effects. However, the distribution used was the lognormal, which allowed the best adjustment of the data. The model was performed as follows:

$$log(Y_{ijk}) = \alpha + \beta_i + \gamma_j + \delta_k + \varepsilon_{ijk}$$

where,

$log(Y_{ijk})$ = value of the response variable transformed into a natural logarithm within the ith season, jth year, and kth month;

α = intercept value, common to all observations;

β_i = fixed effect of the ith season of the year with i = 4;

γ_j = fixed effect of jth year with j = 8;

δ_k = random effect of the kth month with k = 12;

ε_{ijk} = random error associated with observation.

The averages obtained as a result of this second modeling were retransformed and presented in the original scale of each variable. In addition, for both models, the residuals were checked for normality by means of histograms (PROC UNIVARIATE of SAS), and when the p-value was significant, the Tukey-Kramer comparison test was used to differentiate between the seasons and years. Statistical differences were considered significant at the 0.05 (5%) level of probability.

3. Results

Table 1 demonstrates the amplitude of the variables (minimum, maximum, and the coefficient of variation) in relation to the average of the evaluated parameters. Our analyses show that the production of milk per hectare exhibited monthly amplitudes of 322, 375, 381, and 439 liters of milk per hectare, for summer, fall, winter, and spring respectively. These amplitudes are considered normal and are a result of the multifactorial nature of this variable and of differences in seasonal decisions (i.e., the number of lactating cows that can be altered by alimentary, nutritional, reproductive management, and also by the commercialization of animals).

Table 1. Descriptive statistical analysis of variables affecting milk production on a seasonal basis in the present study.

Variable	Seasons[1]															
	Summer				Fall				Winter				Spring			
	Min	Mean	Max	C.V.	Min	Mean	Max	C.V.	Min	Mean	Max	C.V.	Min	Mean	Max	C.V.
MPHM (L)[2]	364	514	686	22.57	313	505	688	18.65	502	639	883	16.06	384	565	823	19.28
PM (US$/L)[3]	0.2619	0.3990	0.5067	18.81	0.3046	0.4290	0.5267	14.72	0.2424	0.4179	0.5163	16.98	0.2401	0.3963	0.4800	16.17
TDE (%)[4]	11.29	11.61	12.21	2.22	11.33	11.93	12.50	2.39	11.76	11.97	12.57	1.64	11.13	11.79	12.18	2.52
DDE (%)[5]	8.07	8.34	8.81	2.27	8.17	8.48	9.09	2.80	8.38	8.64	8.96	2.12	8.05	8.45	8.74	2.12
Fat (%)	3.04	3.27	3.46	3.58	2.53	3.45	3.76	7.64	2.87	3.33	3.61	5.36	2.95	3.34	3.52	4.66
Protein (%)	2.77	3.01	3.24	3.97	2.97	3.13	3.47	4.17	2.99	3.16	3.33	2.94	2.80	3.05	3.34	4.65
Lactose (%)	4.27	4.41	4.57	1.66	4.24	4.41	4.60	1.86	4.38	4.52	4.82	2.19	4.28	4.43	4.60	1.96
SCC (x1000/mL)[6]	141	304	696	45.77	158	284	464	29.84	93	260	446	35.89	142	304	598	43.65
TBC (x1000/mL)[7]	8	131	730	153.98	12	35	211	116.72	8	112	811	183.07	7	96	498	132.17
THI less than 72 (%)[8]	31	53	81	24.55	50	90	100	13.07	84	93	100	4.99	43	66	92	20.57
THI greater than 72 (%)[9]	19	47	69	27.16	0	10	50	119.71	0	7	16	67.60	8	34	57	40.70

[1]Season = 1: Summer = January, February, March; 2: Fall = April, May, June; 3: Winter = July, August, September; 4: Spring = October, November, December. Seasons according to the Southern Hemisphere. [2]MPHM = Milk production per hectare per month (Kg). [3]PM (USD/L) = Price of milk (USD/L). [4]TDE (%) = Total dry extract (%).[5]DDE (%) = Defatted dry extract (%). [6]SCC (x1000/mL) = Somatic cell count (x1000/mL). [7]TBC (x1000/mL) = Total bacterial count (x1000/mL). [8]THI less than 72 (%) = Temperature-humidity index less than 72 (%). [9]THI greater than 72 (%) = Temperature-humidity index greater than 72 (%).

The price of milk in US dollars was highly variable between the minimum and maximum values (Summer = 0.2619 USD and 0.5067 USD; Fall = 0.3046 USD and 0.5267 USD; Winter = 0.2424 USD and 0.5163 USD, and Spring = 0.2401 USD and 0.4800/L USD, respectively). This is likely the result of fluctuations in the free market driven by supply and demand during the eight years of this longitudinal retrospective study. In Brazil, milk prices are usually defined by the company, with negotiation. The changes in the amplitude of the value per liter of milk were not only higher as a result of the bonus received for the quantity produced, but also because of the composition of the milk, which despite the differences between seasons (detailed below), still met the standards of buyer.

The variables TDE, DDE, fat, protein, and lactose (Table 4) exhibited reduced coefficients of variation over the years and seasons. The composition of milk is largely dependent on herd genetics. However, feed and nutritional management contributed to the observed increases in these variables, as the milk bonus is paid in accordance with the fat and protein contents of the milk, in addition to the SCC and TBC values. Here, we show that the SCC and TBC vary widely and are not normally distributed. Although there are values that are considered high, the average values demonstrate the potential for standardization in the production system, as the maximum values are punctual. These trends are normal under production conditions and over the eight consecutive years of evaluation (2,920 d).

As expected, the THI also exhibited high coefficients of variation, owing to the meteorological conditions of Palmeira das Missões – RS, where there are large variations in temperature and humidity on both a daily and monthly basis.

Table 2 shows the following correlations: TDE is highly correlated with DDE; fat is weakly and moderately correlated with DDE and TDE, respectively; protein is weakly correlated with the price of milk (in USD) and fat, mean with DDE and TDE; lactose is weakly correlated with milk yield per hectare, the price of milk (in USD), TDE, and protein, and is mean with DDE. THI<72 was weakly correlated with milk yield per hectare, the price of milk (in USD), fat and lactose, and average with DDE, TDE and protein. In contrast, THI>72 exhibited the same Kendall correlations as THI<72, but with the opposite relationships.

Table 2. Kendall correlation coefficients and probabilities between the variables examined in the present study.

	MPHM (L)[1]	PM (USD/L)[2]	TDE (%)[3]	DDE (%)[4]	Fat (%)	Protein (%)	Lactose (%)	SCC (x1000/mL)[5]	TBC (x1000/mL)[6]	THI less than 72 (%)[7]	THI greater than 72 (%)[8]
MPHM (L)[1]	1	0.0923	−0.0362	0.0356	−0.1000	−0.1080	0.2179	−0.0615	−0.0365	0.1975	−0.1975
		0.1827	0.6046	0.6113	0.1523	0.1222	0.0021	0.3754	0.5992	0.0044	0.0044
PM (USD/L)[2]		1	−0.0583	−0.0216	−0.0529	0.1494	−0.1664	−0.0524	−0.0786	0.1635	−0.1635
			0.4049	0.7575	0.4491	0.0325	0.0187	0.4493	0.2584	0.0184	0.0184
TDE (%)[3]			1	0.6269	0.5285	0.5535	0.2646	0.0257	−0.0569	0.3179	−0.3179
				< .0001	< .0001	< .0001	0.0002	0.7139	0.4176	< .0001	< .0001
DDE (%)[4]				1	0.1470	0.5936	0.5059	−0.0235	0.0242	0.3059	−0.3059
					0.0376	< .0001	< .0001	0.738	0.7307	< .0001	< .0001
Fat (%)					1	0.2783	−0.1007	0.0669	−0.1086	0.2489	−0.2489
						< .0001	0.1582	0.3388	0.1214	0.0004	0.0004
Protein (%)						1	0.1431	0.0824	−0.0953	0.3212	−0.3212
							0.0451	0.2387	0.1742	< .0001	< .0001
Lactose (%)							1	−0.2529	0.0931	0.1813	−0.1813
								0.0004	0.1899	0.0105	0.0105
SCC (x1000/mL)[5]								1	−0.0696	−0.0518	0.0518
									0.3171	0.455	0.455
TBC (x1000/mL)[6]									1	− 0.0938	0.0938
										0.1774	0.1774
THI less than 72 (%)[7]										1	−1
											< .0001
THI greater than 72 (%)[8]											1

[1]MPHM = Milk production per hectare per month (Kg). [2]PM (US$/L) = Price of milk (US$/L). [3]TDE (%) = Total dry extract (%).[4]DDE (%) = Defatted dry extract (%). [5]SCC (x1000/mL) = Somatic cell count (x1000/mL). [6]TBC (x1000/mL) = Total bacterial count (x1000/mL). [7]THI less than 72 (%) = Temperature-humidity index less than 72 (%). [8]THI greater than 72 (%) = Temperature-humidity index greater than 72 (%).

Milk production per hectare per month varies (P < 0.0057) depending on the season (Table 3), being higher in winter in comparison to fall and summer, but does not significantly differ (P > 0.05) from spring. There were no significant differences noted between summer, fall, and spring (P > 0.05). Milk production and total solids per hectare per year were: 6,893 and 800; 8,336 and 972; 6,886 and 806; 6,104 and 722; 6,853 and 822; 5,598 and 667; 6,107 and 731; 6,500 and 774, respectively for the years 2009, 2010, 2011, 2012, 2013, 2014, 2015 and 2016, demonstrating constancy in annual production despite THI interference and the effects of several other factors on variation in pasture quantity and quality.

Table 3. Statistical analysis of seasonal milk production in Escola Estadual Técnica Celeste Gobbato, Palmeira das Missões, Rio Grande do Sul, Brazil.

Variable	Season[1]	Adjusted mean	Lower CI	Upper CI	P-value
Milk production per hectare per month (Kg)	Summer	513.53 B	459.14	567.93	0.0057
	Fall	504.69 B	450.30	559.08	
	Winter	639.20 A	584.81	693.60	
	Spring	564.63 AB	510.23	619.02	
Price of milk (USD/L)	Summer	0.3990	0.3838	0.4520	0.4533
	Fall	0.4290	0.3949	0.4631	
	Winter	0.4179	0.3622	0.4303	
	Spring	0.3963	0.3649	0.4331	
Total dry extract (%)	Summer	11.61B	11.46	11.75	0.0059
	Fall	11.93A	11.78	12.07	
	Winter	11.97A	11.83	12.12	
	Spring	11.79AB	11.64	11.93	
Defatted dry extract (%)	Summer	8.34B	8.26	8.42	0.0001
	Fall	8.48B	8.40	8.56	
	Winter	8.65A	8.57	8.73	
	Spring	8.45B	8.37	8.52	
Fat (%)	Summer	3.27	3.16	3.38	0.1457
	Fall	3.45	3.34	3.55	
	Winter	3.33	3.23	3.44	
	Spring	3.34	3.23	3.45	
Protein (%)	Summer	3.01 B	2.94	3.08	0.0200
	Fall	3.13 AB	3.06	3.20	
	Winter	3.16 A	3.09	3.23	
	Spring	3.05 AB	2.98	3.12	
Lactose (%)	Summer	4.41 B	4.37	4.45	0.0011
	Fall	4.41 B	4.37	4.45	
	Winter	4.52 A	4.48	4.56	
	Spring	4.43 B	4.39	4.47	
Somatic cell count (x1000/mL)	Summer	278	221	349	0.7761
	Fall	272	216	342	
	Winter	242	193	304	
	Spring	279	222	351	
Total bacterial count (x1000/mL)	Summer	50	34	75	0.0675
	Fall	26	17	39	
	Winter	44	29	66	
	Spring	51	34	77	
Temperature-humidity index less than 72 (%)	Summer	51 C	47	55	< 0.0001
	Fall	89 A	82	97	
	Winter	93 A	86	101	
	Spring	65 B	60	70	
Temperature-humidity index greater than 72 (%)	Summer	46 A	33	63	< 0.0001
	Fall	6 B	4	9	
	Winter	6 B	4	8	
	Spring	30 A	22	42	

[1]Season = 1: Summer = January, February, March; 2: Fall = April, May, June; 3: Winter = July, August, September; 4: Spring = October, November, December. Seasons according to the Southern Hemisphere. Different uppercase letters after averages in the same line indicate significant differences (Tukey-Kramer test, $P < 0.05$).

There were no differences ($P > 0.05$) in milk prices, fat contents, SCC, and TBC per season. Fat, SCC, and TBC are the main parameters evaluated in the subsidy, as they affect the price received for milk.

Amounts of TDE contents differed on a seasonal basis ($P < 0.05$), where amounts were found to be significantly lower in summer in comparison to fall and winter, but do not differ significantly ($P > 0.05$) from spring. There were no significant differences in TDE between fall, winter, and spring ($P < 0.05$). Our analyses also show that DDE content is significantly higher in winter in comparison to the other seasons of the year ($P < 0.05$), while there were no significant differences noted in DDE between summer, fall, and spring ($P > 0.05$). The protein content of milk significantly differed between summer and winter ($P < 0.05$), but did not differ between the other seasons ($P > 0.05$). Milk exhibits a higher percentage of lactose in the winter ($P < 0.05$) in comparison to the other seasons, which are not significantly different from one another ($P > 0.05$). The variable THI < 72, was highest in the fall and winter seasons but were not significantly different between them ($P > 0.05$) from each other. However, THI < 72 in fall and winter are significantly higher than both spring and summer ($P < 0.0001$). The percentage of THI > 72 is significantly greater in the spring and summer than in fall and winter ($P < 0.0001$), while there is no significant difference between spring and summer or fall and winter ($P > 0.05$).

Figures 4 and 5 show the milk production per hectare and per month; however, in Figure 4, the graph is continuous (January 2009–December 2016) to emphasize that this parameter is quite variable over the years, as milk production is an important factor in planning investments in the operation. Figure 7 shows the same data from January to December of each year so that similar behaviors can be observed on a seasonal basis.

Visualizing the data in this way shows that in the last two months of autumn (May and June), milk production per hectare per month was beginning to increase, whereas in winter, yields were the highest owing to the pastures having better nutritional quality (Table 4) and the lowest percentage of THI > 72.

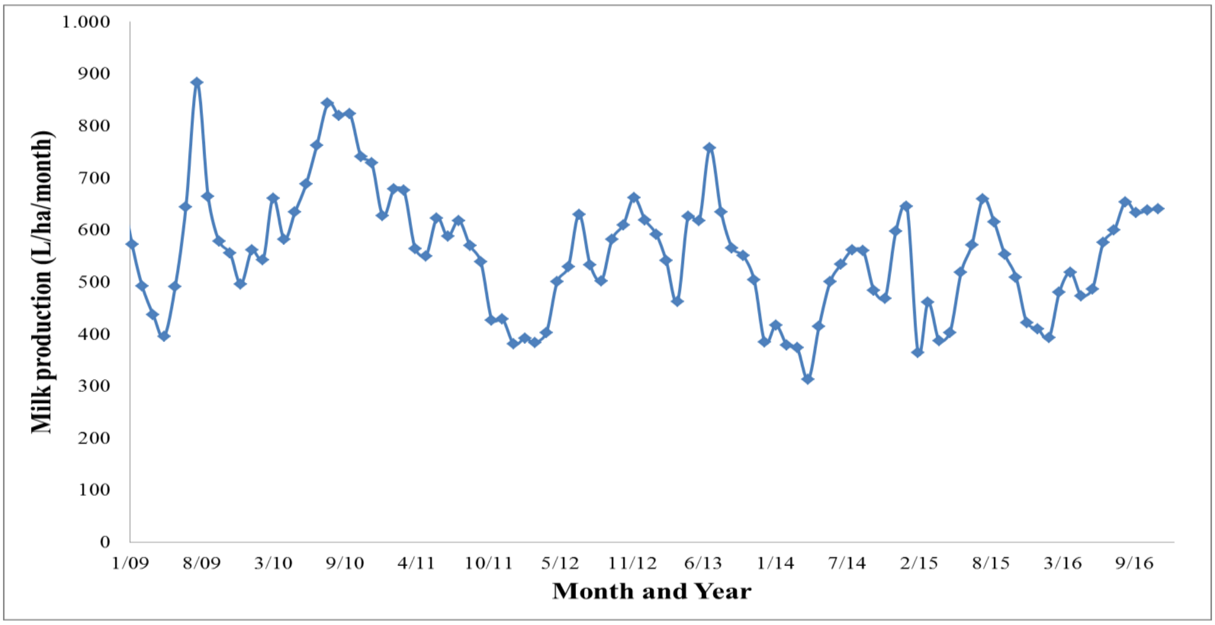


Figure 4. Visualization of milk production/hectare/month from January 2009 to December 2016.

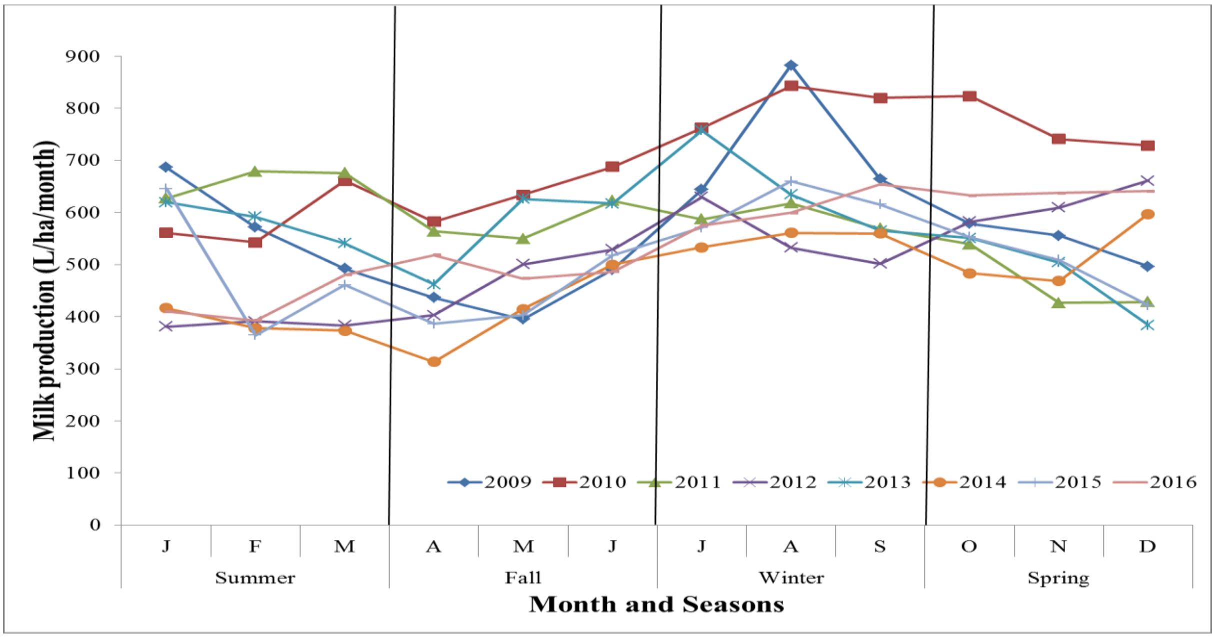


Figure 5. Visualization of milk production/hectare/month between January and December for each year evaluated.

4. Discussion

In the region of Palmeira das Missões, Rio Grande do Sul, Brazil, the valorization and commercialization of land is based on the price of soybeans (*Glycine max*), as soybeans occupy the largest area for cultivation, with an appreciation that follows the international market. Currently, price land has reached the importance of 1,000 bags of 60 kg of soybean per hectare. Therefore, the greater the value of land, the greater the need to optimize productivity per hectare. Thus, the knowledge of milk yield per hectare per month and/or year is of fundamental importance in order to be able to evaluate the efficiency of a given dairy operation, and compare it with other agricultural activities. Above all, this knowledge permits the more accurate and precise evaluation of the crop-livestock system. Although the importance of this variable in the evaluation of production systems is clear, it is rarely determined under production conditions or during research in Rio Grande do Sul.

Most of studies on dairy cow management and feeding are conducted over short experimental periods, using static statistical designs (e.g., Latin square and crossover) that only allow the modeling of empirical effects of a particular nature (Martin and Sauvant, 2002). Despite this, it is well accepted that knowledge of milk cow nutrition should be based on dynamic models, as the lactation curve is a reflection of the interdependence of the different stages of lactation. To study the effects of the following three parameters on lactation via a meta-analysis: DMI (dry matter intake; 10.1–24.7 kg DM/day), RMP (raw milk production; 15.5–44.4 kg/cow/day), and LW (live weight; 320–573 kg), Martin and Sauvant (2002) selected 37 studies published between 1959 and 1999 and confirmed that over the course of this 40 period, the variables had increased on the order of: 6.6 kg for DMI, 15.3 kg for RMP, and 51 kg in LW as a result of genetic improvement and better management conditions. These improvements resulted in an annual increase of 165 kg in milk per lactation at 44 weeks. They concluded that the models to be used should consider: voluntary intake and production, the mobilization of body reserves in the initial phase of lactation, and the effect of a nutritional plan that does not meet the energy requirements of the cows in the initial phase of lactation, as this results in decreased milk production and a decreased amount of fat in the subsequent stages of lactation. Longitudinal retrospective studies allow for evaluations that can be extrapolated to rural properties. According to Bello and Renter (2018) reproducible results are the nucleus of scientific integrity in modern research, which require interdisciplinary work in the animal sciences in order to maximize the reproducibility of the research results.

The report by EMATER and ASCAR (2017), which evaluated the Productive Milk Chain (PMC) of nearly all the municipalities of in the State of Rio Grande do Sul, states that it is possible to calculate the milk production per hectare per year (3.324 liters); however, this should be interpreted with parsimony, as this value may not apply to semi-confinement and total confinement systems. In the present study, the semi-confinement system studied averaged 6,666 liters of milk per hectare per year over the course of eight years. Therefore, the average production of the milk producers in the state of Rio Grande do Sul, Brazil, is approximately 50% lower than that of the property investigated in the current study.

It should be noted that the value of 6,666 liters of milk per hectare per year refers only to milk production. However, by converting the monetary amounts received from the marketing of heifers and surplus cows in milk, an additional 1,481 liters per hectare is added on average per year, resulting in an increase of 22% (reaching 8,147 liters of milk per hectare per year).

Regarding the optimization of the land, if we transform the value received by the monthly milk production into the value paid per 60 kg bag of soybeans in the same period and region, we are able to verify that the average quantity of soybean bags over a period of eight years would be 100.6 bags of soybeans per hectare per year, which is double the state's average soybean yield (50.1 bags per hectare in 2015) (FEEDADOS, 2015). If we analyze only the production and area indices, it is possible to affirm that the study area is more efficient than the average of the other properties of Rio Grande do Sul. However, it is important to note that this conclusion should not be based only on these two indicators, as they do not allow us to conclude whether production is sustainable.

The results we present here highlight the importance of season on the composition of milk; however, as the variation in the contents of fat, protein, and lactose are correlated with TDE and DDE, and are influenced by the THI, we will discuss them together. The discussion of these parameters together is justified by the concepts of homeostasis and homeorhesis according to Bauman and Currie (1980), where the final composition of the milk in the expansion tank is the result of the interaction between all the metabolic functions of the cow, as well as the characteristics of the herd (e.g., the lactation phase). The relatively small variation in the constituents of milk is largely attributed to the nutritional management strategy (i.e., semi-confinement), as more than 50% of the nutrients are consumed in the trough and with less variation than that in the pastures, which are altered by photosynthetic conditions.

Gonçalves et al. (2018) evaluated Brazilian databases and found that the somatic cell count results in daily losses, even with values of only 12,400 cells per milliliter. Therefore, somatic cell counts need to be reduced in Brazilian commercial herds as a way of increasing cow and per hectare performance, as investments in genetics and land are currently high. The total bacterial count must be decreased, as it is a reflection of hygiene practices during milking and the cooling of the milk. The mean values of SCC and TBC observed in the present study could be reduced; however, considering that they are the averages of eight consecutive years, and are in accordance with normative instructions Nos. 51 and 62 (Brasil, 2002; Brasil, 2011), are values to be reached by the highest farmers. Considering all of the results presented in the present article, it is possible to appoint the Escola Estadual Técnica Celeste Gobbato as a technology diffusion center for rural producers in the region, by way of training courses that could substantially assist rural dairy operations.

5. Conclusions

This consecutive longitudinal retrospective study, performed over the course of eight years, serves to emphasize that the execution of activities related to dairy farming in a planned manner reduces the coefficients of variation in the composition of the milk. Thus, a more holistic and integrative approach makes it easier to maintain milk quality, as well as generates extra revenue from the receipt of the bonus. The normative instructions, Nos. 51 and 62 of the Ministério da Agricultura, Pecuária e Abastecimento (Brasil, 2002; Brasil, 2011) serve as a guide for milk farmers to improve milk production systems as a whole, and since the activity is multifactorial by nature, only improving one or two indexes will not yield optimal results. In addition, it has become clear that the seasons interfere with milk production; however, with the use of conserved silage throughout the year and with an increased supply of concentrate, it is possible to minimize or even nullify the effect of the traditional fodder voids of fall and spring. Furthermore, the temperature and humidity index increases the frequency of heat stress in summer. The management of milk production systems on the rural property investigated in the present study has made it possible to produce, on average, 6,666 kg of milk per hectare per year (twice the state average), although it is still possible to improve performance by more intense use of a fully integrated agricultural production system, which recycles more nutrients.

Acknowledgments

This study was supported by the Financiadora de Estudos e Projetos (FINEP) of the Ministério da Ciência e Tecnologia (MCT) through the Public Call MCT/FINEP/CT-INFRA-CAMPI REGIONAL-01/2010.

References

Alexandratos, N. and Bruinsma, J., 2012. *World agriculture towards 2030/2050: the 2012 revision.* ESA Working paper No. 12-03. Rome, FAO.

Almeida, C.O. and Bacha, C.J.C., 1999. Evolução da política cambial e da taxa de câmbio no Brasil, 1961–71. Pesquisa & Debate. Pesquisa & Debate. Revista do Programa de Estudos Pós-Graduados em Economia Política 10, 5–29.

Alvares, C. A., Stape, J. L., Sentelhas, P.C., Gonçalves, J.L.M. and Sparovek, G., 2013. Köppen's climate classification map for Brazil. Meteorologische Zeitschrift 22, 711–728.

Asselin-Balençon, A.C., Popp, J., Henderson, A., Heller, M., Thoma, G. and Jolliet, O., 2013. Dairy farm greenhouse gas impacts: A parsimonious model for a farmer’s decision support tool. International Dairy Journal 31, 65–77.

Bauman, D.E. and Currie, W.B., 1980. Partitioning of nutrients during pregnancy and lactation: A review of mechanisms involving homeostasis and homeorhesis. Journal of Dairy Science 63, 1514–1529.

Bello, N.M. and Renter, D.G., 2018. *Invited review:* Reproducible research from noisy data: Revisiting key statistical principles for the animal sciences. Journal of Dairy Science 101, 5679–5701.

BRASIL, 2011. Instrução Normativa nº 62, de 30 de dezembro de 2011. Brasília: Diário Oficial da União 1, 8–10.

BRASIL, 2002. Instrução Normativa nº 51, de 20 de setembro de 2002. Brasília: Diário Oficial da União 1, 13.

Bresser-Pereira, L.C., 2012. A taxa de câmbio no centro da teoria do desenvolvimento. Estudos Avançados 26, 7–28.

Busanello, M., Rossi, R.S., Cassoli, L.D., Pantoja, J.C.F. and Machado, P.F., 2017. Estimation of prevalence and incidence of subclinical mastitis in a large population of Brazilian dairy herds. Journal of Dairy Science 100, 6545-6553.

Coimbra, P.A.D., Machado Filho, L.C.P. and Hötzel, M.J., 2012. Effects of social dominance, water trough location and shade availability on drinking behaviour of cows on pasture. Applied Animal Behaviour Science 139, 175–182.

Collier, R.J., Renquist, B.J. and Xiao, Y., 2017. *A 100-Year Review:* Stress physiology including heat stress. Journal of Dairy Science, 100, 10367–10380.

Côrtes, C., da Silva-Kazama, D.C., Kazama, R., Gagnon, N., Benchaar, C., Santos, G.T., Zeoula, L.M. and Petit, H.V., 2010. Milk composition, milk fatty acid profile, digestion, and ruminal fermentation in dairy cows fed whole flaxseed and calcium salts of flaxseed oil. Journal of Dairy Science 93, 3146–3157.

Dillon, E., Hennessy, T. and Cullinan, J., 2015. Measuring the economic impact of improved control of sub-clinical mastitis in Irish dairy herds. The Journal of Agricultural Science 153, 666–675.

Eckstein, I.I., Pozza, M.S.S., Ramos, C.E.C.O., Zambom, M.A., Santos,G.T., Kazama, R. and Pozza, P.C., 2016. Typification of factors related to milk production and its impact on the sanitary quality of milk. Scientia Agraria Paranaensis, Marechal Cândido Rondon 15, 56–63.

EMATER, 2017. Rio Grande do Sul/ASCAR. Relatório socioeconômico da cadeia produtiva do leite no Rio Grande do Sul. Porto Alegre, RS:Emater/RS-Ascar 64p.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA – EMBRAPA, 2013. *Sistema Brasileiro de Classificação de Solos.* 3nd ed. Brasília, DF: Centro Nacional de Pesquisa de Solos.

Fajardo, M., Mattiauda, D.A., Motta, G., Genro, T.C., Meikle, A., Carriquiry, M. and Chilibroste, P., 2015. Use of mixed rations with different access time to pasture land on productive responses of early lactation Holstein cows. Livestock Science 181, 51–57.

FEEDADOS. Fundação de Economia e Estatística. Disponível em: <http://www.fee.rs.gov.br/>. Acesso em: 02 jun. 2018.

Ferlay, A., Doreau, M., Martin, C. and Chilliard, Y., 2013. Effects of incremental amounts of extruded linseed on the milk fatty acid composition of dairy cows receiving hay or corn silage. Journal of Dairy Science 96, 6577–6595.

Fundação Getúlio Vargas (FGV), 2016. Instituto Brasileiro de Economia (IBRE) – Índice Geral de Preços – Disponibilidade Interna – METODOLOGIA.

Gantner, V., Bobic, T., Gantner, R., Gregic, M., Kuterovac, K., Novakovic, J. and Potocnik, K., 2017. Differences in response to heat stress due to production level and breed of dairy cows. International Journal of Biometeorology 61, 1675–1685.

Gerssen-Gondelach, S.J., Lauwerijssen, R.B.G., Havlík, P., Herrero, M., Valin, H., Faaij, A.P.C. and Wicke, B., 2017. Intensification pathways for beef and dairy cattle production systems: Impacts on GHG emissions, land occupation and land use change. Agriculture, Ecosystems & Environment 240, 135–147.

Gonçalves, J.L., Cue, R.I., Botaro, B.G., Horst, J.A., Valloto, A.A. and Santos, M.V., 2018. Milk losses associated with somatic cell counts by parity and stage of lactation. Journal of Dairy Science 101, 4357–4366.

Grijó, R.T., A Taxa de Câmbio Real e o Saldo da Balança Comercial Brasileira no Pós Plano Real. Vitória, 2005. Dissertação apresentada ao Programa de Pós-Graduação em Ciências Contábeis da Fundação Instituto Capixaba de Pesquisas em Contabilidade, Economia e Finanças, como requisito para obtenção do título de Mestre em Ciências Contábeis.

Haile-Mariam, M. and Pryce, J.E., 2017. Genetic parameters for lactose and its correlation with other milk production traits and fitness traits in pasture-based production systems. Journal of Dairy Science 100, 3754–3766.

Hardie, L.C., Van de Haar, M.J., Tempelman, R.J., Weigel, K.A., Armentano, L.E., Wiggans, G.R., Veerkamp, R.F., de Haas, Y., Coffey, M.P., Connor, E.E., Hanigan, M.D., Staples, C., Wang, Z., Dekkers, J.C.M. and Spurlock, D.M., 2017. The genetic and biological basis of feed efficiency in mid-lactation Holstein dairy cows. Journal of Dairy Science 100, 9061–9075.

Haygert-Velho, I.M.P., da Conceição, G.M., Cosmam, L.C., Alessio, D.R.M., Busanello, M. Sippert, M.R., Damiani, C., Almeida, A.P.A. and Velho, J.P., IN PRESS. Multivariate analysis relating milk production, milk composition, and seasons of the year. Anais da Academia Brasileira de Ciências.

Hentz, F., Velho, J.P., Nörnberg, J.L., Haygert-Velho, I.M.P., Henz, E.L. Henn, J.D., Peripolli, V. and Zardin, P.B., 2017. Fractionation of carbohydrates and nitrogenous constituents of late-crop corn silages ensiled with different specific masses. Semina: Ciências Agrárias 38, 491–502.

Henz, E.L., Gois de Almeida, P.S, Velho, J.P., Nörnberg, J.L., da Silva, L. das D., Backes, T.R. and Guerra, G.L., 2016. Dual purpose wheat production with different levels of nitrogen topdressing. Semina: Ciências Agrárias (37)2, 1091–1100.

Holly, M.A., Larsona, R.A., Powell, J.M., Ruark, M.D. and Aguirre-Villegas, H., 2017. Greenhouse gas and ammonia emissions from digested and separated dairy manure during storage and after land application. Agriculture, Ecosystems & Environment 239, 410–419.

INSTITUTO GAÚCHO DO LEITE (IGL); EMATER. 2015. Rio Grande do Sul/ASCAR. Relatório socioeconômico da cadeia produtiva do leite no Rio Grande do Sul. Porto Alegre, RS:Emater/RS-Ascar, 76p.

Instituto Nacional de Metrologia, Qualidade e Tecnologia (INMETRO) http/.inmetro.gov.br.

Jenkins T.C. and McGuire, M.A., 2006. Major advances in Nutrition: Impact on milk composition. Journal of Dairy Science 89, 1302–1310.

Kibler, H.H., 1964. Environmental physiology and shelter engineering. LXVII. Thermal effects of various temperature-humidity combinations on Holstein cattle as measured by eight physiological responses. University Archives of the University of Missouri, Columbia.

Kraub, M., Kraatz, S., Drastig, K. and Prochnow, A., 2015. The influence of dairy management strategies on water productivity of milk production. Agricultural Water Management 147, 175–186. DOI:

Larsen, M.K., Nielsen, J.H., Butler, G., Leifert, C., Slots, T., Kristiansen, G.H. and Gustafsson, A.H., 2010. Milk quality as affected by feeding regimens in a country with climatic variation. Journal of Dairy Science 93, 2863–2873.

Liu, J., Mooney, H., Hull, V., Davis, S.J., Gaskell, J., Hertel, T., Lubchenco, J., Seto, K.C. and Gleick, P., 2015. Systems integration for global sustainability. Science 347, 963–972.

Martin, O. and Sauvant, D., 2002. Metaanalysis of input/output kinetics in lactating dairy cows. Journal of Dairy Science 85, 3363–3381.

Min, L., Zhao, S., Tian, H., Zhou, X., Zhang, Y., Li, S., Yang, H., Zheng, N. and Wang, J., 2017. Metabolic responses and “omics” technologies for elucidating the effects of heat stress in dairy cows. International Journal of Biometeorology 61, 1149–1158.

de Moraes, F., Lopes, M.A., Brunhn, F.R.P., Carvalho, F.M., Lima, A.L.R. and Reis, E.M.B., 2016. Efeito de índices técnicos e gerenciais na rentabilidade da atividade leiteira com diferentes tipos de mão de obra. Archivos Latinoamericanos de Producción Animal 24, 29–38.

Mueller, C., de Baan, L. and Koellner, T., 2014. Comparing direct land use impacts on biodiversity of conventional and organic milk—based on a Swedish case study. The International Journal of Life Cycle Assessment 19, 52–68.

Oeffner, S.P., Qu, Y., Just, J., Quezada, N., Ramsing, E., Keller, M., Cherian, G. Goddick, L. and Bobe, G., 2013. Effect of flaxseed supplementation rate and processing on the production, fatty acid profile, and texture of milk, butter, and cheese. Journal of Dairy Science 96, 1177–1188.

Oliveira Neto, J.B.D., Moura, A.D.A.A., Neiva, J.N.M. and Guilhermino, M.M., 2001. Indicadores de estresse térmico e utilização da somatotropina bovina (bST) em vacas leiteiras mestiças (*Bos taurus* × *Bos indicus*) no semi-árido do Nordeste. Revista Brasileira de Zootecnia 30, 360–367.

Palhares, J.C.P. and Pezzopane, J.R.M., 2015. Water footprint accounting and scarcity indicators of conventional and organic dairy production systems. Journal of Cleaner Production 93, 299–307.

Patz, J.A., Campbell-Lendrum, D., Holloway, T. and Foley, J.A., 2005. Impact of regional climate change on human health. Nature 438, 310–317.

Puppel, K., Kuczyńska, B., Nałęcz-Tarwacka, T., Grodzki, H. 2013. Influence of linseed variety in fatty acid profile in cow's milk. Journal Science Food Agricultural 93(9):2276–2280. DOI: https://doi.org/10.1002/jsfa.6037

Rangel, A.H.N., Araujo, T.P.M., Lima, G.F.C., Borba, L.H.F., Peixoto, M.G.C.D. and Lima Júnior, D.M., 2018. Estimation of genetic and phenotypic trends for dairy traits of Gyr and Guzerá breeds. Acta Scientiarum. Animal Sciences 40.

Roche, J.R., Berry, D.P., Bryant, A.M., Burke, C.R., Butler, S.T., Dillon, P.G., Donaghy, D.J., Horan, B., Macdonald, K.A. and Macmilan, K.L., 2017. *A 100-Year Review:* A century of change in temperate grazing dairy systems. Journal of Dairy Science, 100, 10189–10233.

Salomon, J.A., Wang, H., Freeman, M.K., Vos, T., Flaxman, A.D., Lopez, A.D. and Murray, C.J., 2012. Healthy life expectancy for 187 countries, 1990–2010: a systematic analysis for the Global Burden Disease Study 2010. The Lancet 380, 2144–2162.

Samir, K.C. and Lutz, W., 2017. The human core of the shared socioeconomic pathways: Population scenarios by age, sex and level of education for all countries to 2100. Global Environmental Change 42, 181–192.

SAS Institute. 2012. SAS Institute. 2000. Release 8.02. 2000. SAS Inst. Inc., Cary, NC.

Seto, C.K. and Ramankutty, N., 2016. Hidden linkages between urbanization and food systems. Science 352, 943-945.

da Silva, D.C., Santos, G.T., Branco, A.F., Damasceno, J.C., Kazama, R., Matsushita, M, Horst, J.A., dos Santos, W.B.R. and Petit, H.V., 2007. Production performance and milk composition of dairy cows fed whole or ground flaxseed with or without monensin. Journal of Dairy Science 90, 2928–2936.

da Silva, N.C. da, Nascimento, C.F., Nascimento, F.A., de Resende, F.D., Daniel, J.L.P. and Siqueira, G.R., 2018. Fermentation and aerobic stability of rehydrates corn grain silage treated with different doses of *Lactobacillus buchneri* or a combination of *Lactobacillus plantarum* and *Pediococcus acidilactici*. Journal of Dairy Science, 101, 4158–4167.

da Silva, R.P.A., Thaler Neto, A., Cobuci, J.A., Valloto, A.A., Horst, J.A. and Ribas Neto, P.G., 2015. Correlações genéticas entre algumas características de tipo e intervalo de partos em vacas da raça Holandesa. Arquivo Brasileiro de Medicina Veterinária e Zootecnia 67, 166–172. DOI: http://dx.doi.org/10.1590/1678-6445.

Smith, D.A., 2017. World city populations 1950–2030: Proportional circle time series map. Environment and Planning A 49, 3–5.

Stürmer, M., Busanello, M., Velho, J.P., Heck, V.I. and Haygert-Velho, I.M.P., 2018. Relationship between climatic variables and the variation in bulk tank milk composition using canonical correlation analysis. International Journal of Biometeorology 1–12.

Tambara, A.A.C. Sippert, M.R., Jauris, G.C., Flores, J.L.C., Henz, E.L. and Velho, J.P., 2017. Production and chemical composition of grasses and legumes cultivated in pure form, mixed or in consortium. Acta Scientiarum. Animal Sciences 39, 235–241.

Tedeschi, L.O., Fonseca, M.A., Muir, J.P., Poppi, D.P., Cartens, G.E., Angerer, J.P. and Fox, D.G., 2017. Invited Review: A glimpse of the future in animal nutrition science. 2. Current and future solutions. Revista Brasileira de Zootecnia 46, 452–469.

Tedeschi, L.O., Muir, J.P., Riley, D.G. and Fox, D.G., 2015. The role of ruminant animals in sustainable livestock intensification programs. International Journal of Sustainable Development and World Ecology 22, 452–465.

Valin, H., Sands, R.D., Mensbrugghe, D., Nelson, G.C., Ahammad, H., Blanc, E., Bodirsky, B., Fujimori, S., Hasegawa, T., Havlik, P., Heyhoe, E., Kyle, P., D'Croz, D.M., Paltsev, S., Rolinski, S., Tabeau, A., Meijl, H., Lampe, M. and Willenbockel, D., 2014. The future of food demand: understanding differences in global economic models. Agricultural Economics 45, 51–67.

Veltman, K., Jones, C.D., Gaillard, R., Cela, S., Chase, L., Duval, B.D., Izaurralde, R.C., Ketterings, Q.M., Li, C., Matlock, M., Reddy, A., Rotz, A., Salas, W., Vadas, P. and Jolliet, O., 2017. Comparison of process-based models to quantify nutrient flows and greenhouse gas emissions associated with milk production. Agriculture, Ecosystems and Environment 237, 31–44.

Virbat, R.E., Tavendale, M., Otter, D., Schwendel, B.H., Lowe, K., Gregorini, P. and Pacheco, D., 2017. Milk production and composition, nitrogen utilization, and grazing behavior of late-lactation dairy cows as affected by time of allocation of a fresh strip of pasture. Journal of Dairy Science 100, 5305–5318.

Willers, C.D., Ferraz, S.P., Carvalho, L.S. and Rodrigues, L.C., 2014. Determination of indirect water consumption and suggestions for cleaner production initiatives for the milk-producing sector in a Brazilian middle-sized dairy farming. Journal of Cleaner Production 72,146–152.

4 CONSIDERAÇÕES E SUGESTÕES PARA FUTUROS TRABALHOS

A realização do estudo foi essencial para compreensão dos sistemas de produção de leite de modo geral. O estudo bibliográfico baseado em importantes autores da área permitiu aprofundar teorias atuais e fazer uma retrospectiva longitudinal do tema.

Quando se trata de produção de leite, sabemos que estamos trabalhando com seres vivos, que tem suas peculiaridades e que há formas de otimizar a produção, todavia, não há “receita de bolo”, é preciso conhecer cada local, animal, produtor e suas especificidades para poder compreender e posteriormente diagnosticar as melhores formas de produção, com as melhores técnicas e melhor genética.

O setor de produção de leite vem passando por modificações, estando mais acentuadas no período atual. Diante do contexto, se faz necessário reavaliar conceitos e formas de pensar. Em decorrência das muitas faces da produção de leite, surge a cada instante adaptações nos sistemas produtivos, dificultando o processo de definição dos sistemas, bem como, um risco de erro a classificação básica em sistema a pasto, semi-confinado e confinado.

Há uma demanda para adaptar os conceitos estudados na teoria para a realidade diária dos produtores. Considerando o sistema produtivo como um todo, observando o manejo alimentar, percebe-se que as fontes de matéria seca ingeridas pelo animal não são suficiente. É possível identificar que de modo geral, as pastagens são utilizadas mais para descanso do animal do que para a fonte de nutrientes, assim a vaca demanda do fornecimento via cocho da totalidade ou quase totalidade da necessidade do aporte nutritivo, pois o fato de o animal estar no pasto, não significa que ele esteja consumindo.

Sendo assim, é possível de forma empírica e por meio da observação subjetiva, compreender que a reduzida ingestão de nutrientes via pastoreio, não percebida pelo produtor, acarretando num rebanho com escore corporal baixa ou inferior ao ideal, independente da fase em que a vaca se encontra, desencadeando uma série de complicações decorrentes da má nutrição, como por exemplo, baixa produção de leite e reprodução.

Foram utilizados dados de uma única propriedade, para fazer inferências da produção e composição do leite, em relação à continentalidade, estações do ano e sistemas de produção. Foi constatado que para cada ambiente há uma genética que melhor se adapta. É necessário ter a percepção e conhecimento para identificar como deve ser o manejo em cada propriedade, necessitando de uma visão sistêmica do todo produtivo. Com tanta heterogeneidade, em um único setor, há demanda de mais recursos destinados à pesquisa e extensão. Cabe à academia, fornecer subsídios de informação confiável, libertando produtores de assistências vinculadas à comercialização de produtos.

REFERÊNCIAS

AUAD, A. M. **Manual de Bovinocultura de Leite**. Embrapa e Senar, 2010.

BATALHA, M. O.; SILVA, A. L. Gerenciamento de sistemas agroindustriais: definições, especificidades e correntes metodológicas. In: BATALHA, M. O. (Coord.). **Gestão agroindustrial:** GEPAI: Grupo de estudos e pesquisas agroindustriais. 3. ed. São Paulo: Atlas, 2007. p. 1-60.

BAUMAN, D. E.; CURRIE, B. Partitioning of nutrients during pregnancy and lactation: A review of mechanisms involving homeostasis and homeorhesis. **Journal of Dairy Science**, v. 63. p.1514-1529, 1980.

BELIK, W. A Heterogeneidade e suas Implicações para as Políticas Públicas no Rural Brasileiro. **Revista de Economia e Sociologia Rural**, v. 53, p. 9–30, 2015.

BOBE, G.; YOUNG, J. W.; BEITZ, D. C. Invited Review: Pathology, Etiology, Prevention, and Treatment of Fatty Liver in Dairy Cows. J. American Dairy Science Association, 2004. **Journal of Dairy Science,** v. 87, n. 10, p. 3105–3124, 2004.

CAPPER, J. L.; CADY, R. A.; BAUMAN, D. E. The environmental impact of dairy production: 1944 compared with 2007. **Journal of Animal Science**, v. 87, p. 2160-2167, 2009.

CEPEA. **Centro de Estudos Avançados em Economia Aplicada.** 2018. Disponível em: <https://www.cepea.esalq.usp.br/br/pib-do-agronegocio-brasileiro.aspx>. Acesso em: 05 jun. 2018.

CHEBEL, R. C.; MENDONÇA, L. G. D.; BARUSELLI, P. S. Association between body condition score change during the dry period and postpartum health and performance. **Journal of Dairy Science**, v. 101, p. 4595–4614, 2018. DOI: https://doi.org/10.3168/jds.2017-13732.

COLLIER, R. J.; RENQUIST, B. J.; XIAO, Y. A 100-Year Review: Stress physiology including heat stress. **Journal of Dairy Science**, v. 100, p. 10367–10380, 2017. DOI: https://doi.org/10.3168/jds.2017-13676.

COSTA, J. H. C.; HOTZEL, M. J.; LONGO, C.; BALCÃO, L. F. A survey of management practices that influence production and welfare of dairy cattle on family farms in southern Brazil. **Journal of Dairy Science**, v. 96, p. 307–317, 2013.

DALCIN, D.; TROIAN, A.; OLIVEIRA, S. V. A importância da atividade leiteira na renda dos agricultores familiares: Um estudo de caso no município de Caiçara-RS. **Revista OnLine CONGREGA,** Bagé, URCAMP, v.4, n. 4, nov. 2008.

DRACKLEY, J. K.; DONKIN, S. S.; REYNOLDSC, K. Major Advances in Fundamental Dairy Cattle Nutrition. American Dairy Science Association, 2006. **Journal of Dairy Science**, v. 89, n. 4, p. 1324–1336, 2006.

EMATER. Rio Grande do Sul/ASCAR. **Relatório socioeconômico da cadeia produtiva do leite no Rio Grande do Sul.** Porto Alegre, RS: Emater/RS-Ascar, 2017. 64p.

FERRO, A. B.; CASTRO, E. R. de. Determinantes dos Preços de Terras no Brasil: Uma análise de região de fronteira agrícola e áreas tradicionais. **Revista de Economia e Sociologia Rural,** v. 51, n. 3, p. 591-610, out. 2013.

FIGUEIREDO, E. **Perspectiva do Brasil agropecuário. Desafios da produção animal nos próximos 50 anos**. Embrapa. Zootec, Santa Maria-RS, 12 de Maio de 2016. Disponível em: <http://www.zootec.org.br/palestras/files/elsio_figueiredo.pdf>. Acesso em: 05 dez. 2018.

FOX, D. G. et al. The Cornell Net Carbohydrate and Protein System model for evaluating herd nutrition and nutrient excretion. **Animal Feed Science and Technology**, v. 112, p. 29-78. 2004. DOI: 10.1016/j.anifeedsci.2003.10.006.

FRAGA, D. R.; PALHARINE, D.; GUERRA, A.; CARBONERA, R. A importância dos debates na cadeia do leite. In: **O Rio Grande do Sul e a lei do leite**. Santa Cruz do Sul: Gazetta, 2016. p. 31-33.

GONÇALVES, L. C.; BORGES, I.; FERREIRA, P. D. S. **Alimentação de gado de leite**. Belo Horizonte: FEPMVZ, 2009. 412 p. Disponível em: <http://www.vet.ufmg.br/ARQUIVOS/FCK/file/Livro%20%20Alimenta%C3%A7%C3%A3o%20de%20Gado%20de%20Leite.pdf>. Acesso em: 05 jun. 2018.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE) Brasil. Disponível em: <http://www.ibge.gov.br/home/>. Acesso em: 09 jun. 2018.

INSTITUTO GAÚCHO DO LEITE (IGL); EMATER. Rio Grande do Sul/ASCAR. **Relatório socioeconômico da cadeia produtiva do leite no Rio Grande do Sul**. Porto Alegre, RS: Emater/RS-Ascar, 2015. 76p.

JORGE, J. T. **Agronegócio e desenvolvimento.** O Estado de São Paulo, São Paulo, 06 out. 2011.

LOPES, F. F.; NEVES, M. F.; BARA, J. G.; TROMBIN, V. G.; LUPINACCI, A. V.; SINPRINI, E. S.; TIBÉRIO, M. A. **Um método de Planejamento e Gestão Estratégica para empreendimentos agro visando alta performance**. São Paulo: Altas S.A., 2012.

LOPES, M. A.; DIAS, A. S.; CARVALHO, F. D. M.; LIMA, A. L. R.; CARDOSO, M. G.; CARMO, E. A. Efeito da escala de produção nos resultados econômicos de sistemas de produção de leite na região de Lavras (MG , Brasil), em 2004 e 2005, **Ciência e Agrotecnologi**a, Lavras, v. 33, n. 1, p. 252-260, 2009.

LOPES, M. A.; DIAS, A. S.; CARVALHO, F. D. M.; LIMA, A. L. R.; CARDOSO, M. G.; CARMO, E. A. Efeito da escala de produção nos resultados econômicos de sistemas de produção de leite na região de Lavras (MG, Brasil), em 2004 e 2005, **Archivos Latinoamericanos de Producción Animal,** p. 121-129, 2008.

MALASSISE, R. L. S.; PARRÉ, J. L.; FRAGA, G. J. O Comportamento do Preço da Terra Agrícola: um modelo de painel de dados espaciais. **Revista de Economia e Sociologia Rural**, v. 53, n. 4, p. 645-666, 2016.

MAPA. **Ministério da Agricultura, Pecuária e Abastecimento Secretaria de Política Agrícola**. Projeções do Agronegócio. Brasil 2015/16 a 2025/26 Projeções de Longo Prazo. Brasília (DF), Julho de 2016 – 7. ed., ano 2016. Disponível em: <http://www.agricultura.gov.br/arq_editor/Proj_Agronegocio2016.pdf>. Acesso em: 02 jun. 2018.

MAPA – Ministério da agricultura pecuária e abastecimento. Disponível em: <http://www.agricultura.gov.br/arq_editor/file/Desenvolvimento_Sustentavel/Produ%C3%A7%C3%A3o%20Integrada/PI_Brasil.pdf>. Acesso em: 15 jul. 2018.

NEVES, M. F.; CONEJERO, M. A. Sistema agroindustrial da cana: cenários e agenda estratégica. **Economia Aplicada**, v. 11, n. 4, out./dez. 2007, p. 587-604.

NORO, G.; GONZÁLEZ, F. H. D.; CAMPOS, R.; DÜRR, J. W. Fatores ambientais que afetam a produção e a composição do leite em rebanhos assistidos por cooperativas no Rio Grande do Sul. **Revista Brasileira de Zootecnia**, v. 35, n. 3 Suplemento, p. 1129-1135, 2006.

NRC – National Research Council. **Nutrient of requirements of dairy cattle**. 7th ed. Washington, D.C.: National Academic Press, 2001. 381 p.

OLIVEIRA, A. S.; FIGUEIREDO, D. N.; CUNHA, V.; CAMPOS, J. M. S.; VALE, S. M. L. R.; ASSIS, A. J. Identificação e quantificação de indicadores-referência de sistemas de produção de leite. **Revista Brasileira de Zootecnia,** v. 36, n. 2, p. 507-516, 2007.

OLIVO, C. J.; SANTOS, J. C. D.; QUATRIN, M. P.; SIMONETTI, G. D.; SEIBT, D. C.; DIEHL, M. S. Forage mass and nutritive value of bermuda grass mixed to forage peanut or common vetch. Acta Scientiarum. **Animal Sciences**, v. 38, n. 3, p. 255-260, 2016.

PACHECO, F. W; ARRUDA, P. C. L.; CARMO, A. B. R; LIMA, F. W. R. **A cadeia produtiva do leite: um estudo sobre a organização da cadeia e análise de rentabilidade de uma fazenda com opção de comercialização de queijo ou leite.** RRCF, Fortaleza, v. 3, n. 1, jan./jun. 2012. Disponível em: <http://www.institutoateneu.com.br/ojs/index.php/RRCF/article/viewFile/30/37>. Acesso em: 03 jun. 2018.

PETIT, H. V. Antioxidants and dairy production: the example of flax. **Revista Brasileira de Zootecnia**, v. 38, p. 352-361, 2009.

POLSKY, L.; VON KEYSERLINGK, M. A. G. Invited review: Effects of heat stress on dairy cattle welfare. **Journal of Dairy Science**, v. 100, p. 8645-8657, 2017. DOI: http://dx.doi.org/10.3168/jds.2017-12651

PRYCE, J. E.; COFFEY, M. P.; SIMM, G. The relationship between body condition score and reproductive performance. **Journal of Dairy Science**, v. 84, p. 1508–1515, 2001.

ROCHA, A. S.; COUTO, V. A. **Entraves ao agronegócio brasileiro em 2002**. Bahia Análise e Dados, Salvador, v. 12, n. 3, p. 93-103, dez. 2002. Disponível em: <http://www.nec.ufba.br/artigos/Artigos/Revista_Analise_e_Dados/2002.12%20-%20Entraves%20ao%20agroneg%C3%B3cio%20brasileiro%20em%202002.pdf>. Acesso em: 02 jul. 2018.

SANTOS, G.; LOPES, M. A. Indicadores econômicos de sistemas de produção de leite em confinamento total com alto volume de produção diária. **Ciência Animal Brasileira**, v. 15, n. 3, p. 239-248, 2014.

SILVEIRA, I. D. B.; PETERS, M. D. P.; STORCH, T.; ZIGUER, E. A.; FISCHER, V. Simulação da rentabilidade e viabilidade econômica de um modelo de produção de leite em free-stall. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v. 6, nº 2, p. 392–398, 2011.

TAMBARA, A. A. C.; SIPPERT, M. R.; JAURIS, G. C.; FLORES, J. L. C.; HENZ, E. L.; VELHO, J. P. Production and chemical composition of grasses and legumes cultivated in pure form, mixed or in consortium. Acta Scientiarum. **Animal Sciences**, v. 39 p. 235-241, 2017. DOI: 10.4025/actascianimsci.v39i3.34661

TRENNEPOHL, D. **Avaliação da contribuição potencial das principais atividades agropecuárias para o desenvolvimento econômico da região noroeste do Rio Grande do Sul.** 2010. Tese (Doutorado em Desenvolvimento Regional) – Universidade de Santa Cruz do Sul, 2010.

TYLUTKI, T. P.; FOX, D. G.; DURBAL, V. M.; TEDESCHI, L. O.; RUSSELL, J. B.; VAN AMBURGH, M. E.; OVERTON, T. R.; CHASE, L. E.; PELL, A. N. Cornell Net Carbohydrate and Protein System: A model for precision feeding of dairy cattle. **Animal Feed Science and Technology,** p. 174-202, 2008. DOI: 10.1016/j.anifeedsci.2007.05.010.

VAN SOEST, P. J. **Nutritional ecology of the ruminant.** 2nd ed. Ithaca, NY: Cornell University Press, 1994.

VELHO, J. P.; MÜHLBACH, P. R. F.; GENRO, T. C. M.; HAYGERT-VELHO, I. M. P.; NÖRNBERG, J. L.; ORQIS, M. G.; KESSLER, J. D. Alterações bromatológicas nas frações dos carboidratos de silagens de milho safrinha sob diferentes tempos de exposição ao ar antes da ensilagem. **Revista Brasileira de Zootecnia**, v. 35, n. 4, p. 1621-1628, 2006.

ZUGE, R. M; ABREU, C. O.; CORTADA, C. N. M. **Produção integrada de leite bovino.** Capítulo 17. p. 495-510. In: Produção Integrada no Brasil. Agropecuária sustentável, alimentos seguros. 2008.

ANEXO A – NORMAS PARA SUBMISSÃO NO JOURNAL OF RURAL STUDIES

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