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GESTÃO DE SISTEMAS PRODUTIVOS DE CARNE BOVINA PELA PERSPECTIVA DO DESVIO POSITIVO

JOANA GASPAROTTO KUHN
Zootecnista – Universidade Federal do Pampa
Mestre em Zootecnia – Universidade Federal do Rio Grande do Sul

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Júlio Otávio Jardim Barcellos
PPG Zootecnia/UFRGS
Orientador

Ines Andretta

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"...As proporções do produto total da terra..., sob os nomes de renda, lucro e salário, serão essencialmente diferentes, o que dependerá principalmente da fertilidade do solo, da acumulação de capital, da população, e, da habilidade da engenhosidade e dos instrumentos empregados"

David Ricardo

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GESTÃO DE SISTEMAS PRODUTIVOS DE CARNE BOVINA PELA PERSPECTIVA DO DESVIO POSITIVO[1]

Autora: Msc. Joana Gasparotto Kuhn
Orientador: Prof. Dr. Júlio Otávio Jardim Barcellos
Co-orientadora: Prof. Dra. Letícia de Oliveira

Resumo: A adoção de tecnologias será fundamental para atender a demanda alimentar e para tornar a pecuária de corte mais competitiva em três pilares: produtivo, econômico e ambiental. Atendendo estes preceitos, o presente estudo buscou identificar por meio de uma revisão de literatura em base de dados, Science Direct® e Web of Science®, o uso de indicadores produtivos, econômicos e ambientais em sistemas produtivos de bovinos de corte na fase de terminação em condição de pastejo (Capítulo II). Na sequência, estes indicadores compuseram um questionário estruturado e dividido em três partes para pecuaristas de sistemas produtivos de bovinos de corte com animais terminados à pasto em dois estados brasileiros: Mato Grosso do Sul e Rio Grande do Sul (Capítulo III). Ao total foram 20 entrevistados. A metodologia de análise adotada foi o Desvio Positivo, ou seja, produtores que em uma análise de distribuição, estão situados acima da média em indicadores produtivo, econômico e ambiental. Deste modo, agrupando os desempenhos em cada indicador por meio da análise categórica de dados, e posterior no conjunto total. Dos resultados obtidos na revisão, 58,2% dos estudos avaliaram indicadores produtivos, 25,2% econômicos e 16,4% ambientais. Já nos resultados para desvio positivo na soma de desempenho nos três indicadores, observou-se que o pecuarista desviante positivo apresenta área intermediária (290 ha), mas elevado número de animais terminados (n = 700) com ganho médio diário entre 0,901 – 1,200 Kg/dia, emitindo 3,72 kg CO_2e/ha na terminação. Tem custo intermediário (R$ 76,00/cab./mês) e receita elevada (R$31.500,00/ha). A partir deste estudo, foi possível identificar quais os indicadores mais utilizados e com eles averiguar produtores desviantes positivos. Com isso, conclui-se que os indicadores ganho médio diário ou peso vivo de abate podem ser utilizados como indicador produtivo, uma vez que constou na maioria dos estudos (87,5%); como ambientais destacam-se os indicadores que estudam carbono (37,5%) e, por fim, como indicador econômico, a margem bruta (25%). Quanto ao pecuarista desviante positivo, concluímos que a metodologia do desvio positivo na identificação do desempenho e práticas que beneficiam indicadores produtivos, econômicos e ambientais produz resultados promissores com um grande potencial para impulsionar a competitividade.

Palavras-chave: ambiental, indicador; lucro; pastagem

[1] Tese de doutorado em Zootecnia – Produção Animal, Faculdade de Agronomia, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brasil. 130p. Março, 2024.

MANAGEMENT OF BEEF PRODUCTION SYSTEMS FROM THE PERSPECTIVE OF POSITIVE DEVIATION[2]

Author: Msc. Joana Gasparotto Kuhn
Advisor: Prof. Dr. Júlio Otávio Jardim Barcellos
Co-advisor: Prof. Dra. Letícia de Oliveira

Abstract: The adoption of technologies will be essential to meet food demand and to make beef cattle farming more competitive in three pillars: productive, economic, and environmental. In compliance with these precepts, the present study sought to identify, through a literature review in databases, Science Direct® and Web of Science®, the use of productive, economic, and environmental indicators in beef cattle production systems in the production phase. Finishing in pastel condition (Chapter II). Subsequently, these indicators make up a structured questionnaire divided into three parts for livestock farmers in beef cattle production systems with animals raised on pasture in two Brazilian states: Mato Grosso do Sul and Rio Grande do Sul (Chapter III). In total there were 20 interviewees. The analysis methodology adopted was Positive Deviation, that is, producers who, in a distribution analysis, are located above the average in productive, economic, and environmental indicators. In this way, grouping the performances in each indicator through categorical data analysis, and later in the total set. Of the results obtained in the review, 58.2% of the studies evaluated productive indicators, 25.2% economic and 16.4% environmental. In the results for positive deviation in the sum of performance in the three indicators, it was demonstrated that the positive deviant rancher has a fun area (290 ha), but a high number of winter animals (n = 700) with an average daily gain between 0.901 – 1.200 Kg /day, emitting 3.72 kg CO_2e/ha at finishing. It has an intermediate cost (R$76.00/head/month) and high revenue (R$31,500.00/ha). From this study, it was possible to identify which indicators were most used and use them to identify positive deviant producers. With this, it is concluded that the indicators average daily gain or live weight at slaughter can be used as a productive indicator, as it was included in most studies (87.5%); as environmental indicators, the indicators that study carbon stand out (37.5%) and, finally, as an economic indicator, the gross margin (25%). As for the positive deviant livestock farmer, we conclude that the positive deviation methodology in identifying performance and practices that benefit productive, economic, and environmental indicators produces promising results
potential for productivity and competitiveness.
Keywords: environmental, indicator, profit, pasture

[2] PhD thesis in Animal Science, Faculdade de Agronomia, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil. 130p. March, 2024.

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1. Introdução

Em 2022, o Brasil produziu 7,9 milhões de toneladas equivalente de carcaça de carne bovina, e, como maior exportador comercializou ao mercado externo 2,8 milhões de toneladas equivalentes de carcaça (FAOSTAT, 2022). Porém, mesmo sendo o maior exportador em termos de volume, o Brasil encontra-se apenas na terceira colocação em termos de valor (EMBRAPA, 2021). Isso porque o Brasil tem sido, principalmente, um fornecedor de carne bovina commodity. A eficiência de produção no Brasil também é menor do que nos Estados Unidos e Austrália (Greenwood, 2021), e, mesmo que o número de bovinos alimentados em confinamento, com dietas à base de grãos, tenha aumentado no país nos últimos anos, a maior parte dos bovinos brasileiros é alimentado com pasto (Meat & Livestock Australia, 2020).

Ter o maior rebanho comercial de bovinos de corte, e custos de produção 50% menores do que os Estados Unidos, dada a utilização de pastagem, permite que o Brasil seja capaz de satisfazer o aumento de demanda mundial por carnes (Neto et al., 2014). No entanto, para atingir os níveis de abastecimento necessários, a eficiência de produção brasileira de bovinos de corte precisa melhorar.

Uma vez que em diferentes etapas e áreas de produção de bovinos têm espaço para estudos e busca por eficiência, o presente estudo terá como objetivo identificar por meio da metodologia do desvio positivo (Pascale et al., 2010). Uma técnica comparativa do desempenho qualitativo e quantitativo (Toorop et al., 2020) nas competências produtiva, econômico e ambiental em sistemas produtivos de bovinos de corte terminados a pasto em dois estados brasileiros, no Rio Grande do Sul e no Mato Grosso do Sul devido ao cenário produtivo contrastante.

Para isso, com o uso da revisão (Capítulo II) identificou-se os indicadores mais citados na literatura, e posterior, com o uso da metodologia de desvio positivo (Capítulo III) entrevistou-se pecuaristas nestes estados, a fim de identificar, os que estão superando seus pares (Pascale et al., 2010; Vadera et al., 2013; Albanna & Heeks, 2018; Modernel et al., 2019; Ulukan et al., 2022), e obtendo vantagem competitiva (Porter, 1998).

2. Justificativa

O agronegócio brasileiro é pujante, dado que o Brasil é o 5° maior país do mundo em extensão, e o maior, com 66,3% (2,47 milhões de km^2) do território composto por áreas terrestres protegidas (UNEP, 2016). Compondo este cenário, o setor de pecuária bovina de corte, apresentou representatividade de 8,5% do Produto Interno Bruto Brasileiro em 2019 (ABIEC, 2022), com mais de 70% dos animais sendo produzidos (ABIEC, 2022) nos 177 milhões de hectares de pastagens (Bolfe et al., 2024)., com uma taxa de desfrute de 23,5% (ABIEC, 2022).

Além disso, dada a conversão de forragens em alimento de alto valor (Mottet et al., 2017), novas tecnologias são adotadas por muitos gestores de sistemas produtivos de bovinos de corte, mas limitam-se ao aprimoramento da genética do rebanho, por exemplo (ANUALPEC, 2013) e manutenção de práticas de preservação obrigatórias (BRASIL, 2012). Sendo baixa a adoção de práticas de gestão econômica (Dill, 2015).

Diante as mudanças econômicas e a redução das margens de segurança financeiras ao longo dos anos, especialmente pós pandemia, o uso de indicadores produtivos a possibilita a adaptação às mudanças econômicas, ambientais, e de mercado, atendendo a tendência de consumo por produtos diferenciados, com apelo natural e/ou sustentável (Guerrero et al., 2014). Considerando a continentalidade do País, e a complementação técnica de estratégias administrativas, optou-se por estudar dois diferentes cenários produtivos. Isso se deu nos estados de Mato Grosso do Sul, que tem rebanho de corte de 21.678.811 cabeças em 15.635.498 hectares de pasto, uma produtividade de 69,2 kg de carcaça por hectare e do Rio Grande do Sul, que tem 11.530.078 cabeças em 7.721.084 hectares de pasto com produtividade de 78,8 kg de carcaça por hectare (ABIEC, 2022). Sendo que o Rio Grande do Sul tem 4 vezes mais propriedades rurais (261.717) com bovinos de corte que o Mato Grosso do Sul (54.931).

Além da diversidade produtiva indo de sistemas com baixa a alta tecnologia, foram escolhidos por reduzirem a área para pecuária, dado que aumentaram a área produtiva com soja na safra 22/23 em relação à safra 21/22 (3,76 milhões de hectares no MS e 6,5 milhões de hectares no RS). Neste sentido, o presente estudo busca identificar vantagens competitivas em sistemas produtivos de bovinos de corte desviantes positivos, também conhecidos como desvio positivo ou desvio construtivo (Vadera et al., 2013) em indicadores produtivos (ex. número de animais por área), econômicos (ex. custo por animal) e ambientais (ex. emissões de gases de efeito estufa por área). A escolha desses indicadores considerou quatro atributos: relevância, acurácia, clareza e exequibilidade (EMBRAPA, 2018).

Por meio deste estudo será possível verificar o desempenho desviante positivo (DP) dos sistemas produtivos em cada indicador, assim como direcionar estratégias de comunicação e divulgação de desvios positivos provenientes de pares, uma vez que os desviantes positivos (DPs) são mais eficientes do que qualquer outra pessoa na condução da mudança (Seidman e McCauley, 2008).

3. Revisão de Literatura

Na revisão de literatura são tratados temas que embasam conceitualmente as abordagens temáticas apresentadas ao longo da pesquisa, de forma que, as variáveis do estudo estejam amparadas por pesquisas anteriores ou referencial conceitual. Primeiramente destaca-se os sistemas produtivos de bovinos de corte, apresentando suas definições. Posteriormente apresentam-se abordagens relacionadas à terminação de bovinos de corte, uma explanação dos indicadores produtivo, econômico e ambiental como variáveis a serem estudadas e por fim o tema de destaque, desvio positivo nestes sistemas.

3.1 Sistemas Produtivos de Bovinos de Corte

O sistema produtivo de bovinos de corte é constituído por um conjunto coordenado de etapas (cria: fase inicial com nascimento do bezerro; recria: fase intermediária e terminação: engorda para abate) inter-relacionadas que tem como objetivo final a produção de carne, buscando benefícios econômicos (Herring, 2014). Esse sistema possui em sua configuração, aspectos relacionados com o meio ambiente, capital, recursos humanos, aspectos sociais da região, perfil do gestor, mercado, tecnologia de produção e a logística.

A produtividade em qualquer fase (cria, recria e terminação) depende do manejo nutricional, seja pastoril ou confinado, e por nível de intensidade que os insumos entram no sistema (mais insumo = mais intensificação). No manejo pastoril temos os níveis de intensificação: extensivo (pouco uso de insumo e tecnologias), semiextensivo (uso intermediário de insumos e tecnologias) e o intensivo (maior uso de insumos e tecnologias) (Allen, 2011; McAllister, 2020).

3.2 Terminação de Bovinos de Corte

As pastagens brasileiras cobrem aproximadamente 177 milhões de hectares, dos quais aproximadamente 40% apresentam médio vigor vegetativo e sinais de degradação, enquanto 20% apresentam baixo vigor vegetativo, entendida como degradação severa (Bolfe et al., 2024).

No Mato Grosso do Sul, com área de 35,7 milhões de hectares, apresenta 4,3 milhões de hectares de pastagens degradadas com potencial agrícola (Bolfe et al., 2024), conta com mais de 21 milhões de bovinos, distribuídos em 54,9 mil estabelecimentos agropecuários (ABIEC, 2022).

Já ao extremo sul do Brasil, no Rio Grande do Sul, com 28,1 milhões de hectares apresenta 0,3 milhões de hectares de pastagens degradadas com potencial agrícola (Bolfe et al., 2024), conta com mais de 11,4 milhões de bovinos em 261,7 mil estabelecimentos agropecuários (IBGE, 2017).

Em ambos os estados os sistemas produtivos de bovinos de corte utilizam do ambiente pastoril, e, em ambos os estados a agricultura compete por terra com os sistemas produtivos de bovinos de corte (Oliveira et al., 2017), ocasionando aumento no preço das terras de pastagens (ANUALPEC, 2017). Isto é um fator que impõe aos gestores a necessidade de serem cada vez mais produtivos, o que propicia uma maior intensificação dos sistemas para manter a competitividade.

A principal característica no desenvolvimento dos sistemas produtivos de bovinos de corte nestas regiões é a heterogeneidade nos sistemas de produção e nos mecanismos de gestão e de comercialização do gado (Carvalho e Zen, 2017). Coexistindo dois subsistemas produtivos bastante distintos, o primeiro de alta qualidade, caracterizado pela adoção de tecnologia avançada (adubação e suplementação, por exemplo) e padrões eficientes de gestão e de comercialização. E o de baixa, com pouca adoção de tecnologia, menos eficiente e com gestão deficiente. Enquanto os eficientes usam tecnologia e tem manejo de pasto ideal as ineficientes possuem super pastejo ou sub pastejo (Figura 1).

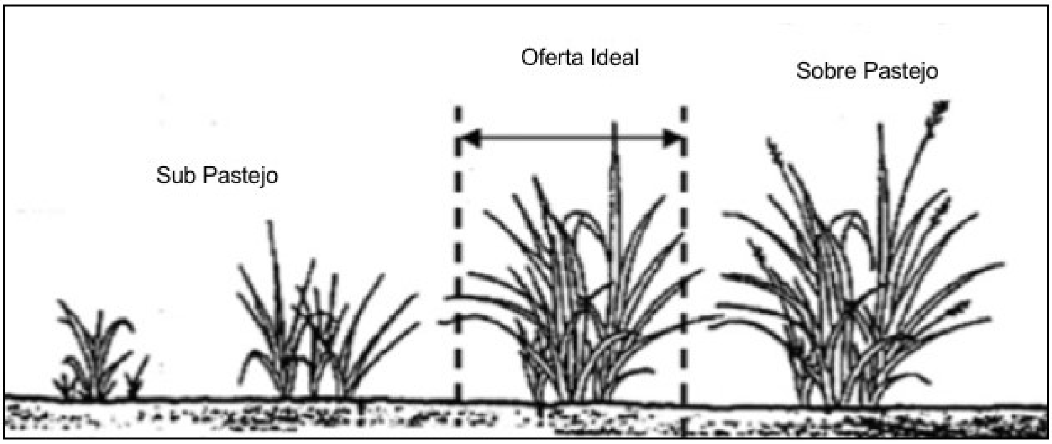

Figura 1. Exemplo da estrutura do pasto em decorrência da oferta e manejo de pastagem. Fonte: Autora (2023).

Essas diferenças se dão porque o processo de gerenciamento dos sistemas produtivos no passado se restringia a duas ou três atividades eminentemente laborais e hoje é uma atividade complexa envolvendo múltiplas atividades notadamente intelectuais (Brozova et al., 2008). Dentre as atividades desenvolvidas pelos gestores destes sistemas estão as do processo decisório. São estas que definem o sucesso ou não de um sistema produtivo.

Para Marques et al., (2015), apenas propriedades altamente competitivas mostraram práticas de gestão eficientes. Com o aumento do desempenho dessas, as relações de mercado que historicamente são conflitantes, tendem a diminuir em importância e o ambiente institucional torna-se um motor mais importante. Para o autor, os pecuaristas com perfil de maior competitividade (alta e média) necessitam de inovação, enquanto aqueles com menor competitividade necessitam de uma melhor gestão.

Por essa ótica e por meio de indicadores, será possível identificar e traçar um desempenho que englobe questões produtivas, econômicas e ambientais de sistemas produtivos de bovinos de corte na fase de terminação a pasto, uma vez que todos os sistemas estão susceptíveis ao alto risco climático, a necessidade do uso consciente de recursos, produção sustentável, e afins.

3.3 Indicadores Estratégicos de Desempenho

No meio rural, os sistemas produtivos são abertos pois tem capacidade de crescimento, mudanças e adaptação ao ambiente externo (Salazar, 1991). Com base nesses conceitos pode-se dizer que gerenciar um sistema produtivo de bovinos de corte consiste em previsão, organização, comando, coordenação e controle (Fayol, 1968) de esforços para um objetivo comum.

Com isso, a gestão tem papel fundamental para o desenvolvimento, na qual o gestor deve estar atento a todos os nichos do negócio pecuário sendo a ponte entre os objetivos e as metas conquistadas (Matos, 2020).

Estas atividades são executadas, quase sempre, pelo (s) pecuarista (s), na condição de administradores[3] e gerentes[4] de seus sistemas. Isso os permite estimar suas próprias curvas de receita e custo, conforme imprevisibilidade e caraterísticas do

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[3] Na definição de Stone e Freeman (1985), administrar é o "processo de planejar, organizar, liderar e controlar o trabalho dos membros da organização, e de usar os recursos disponíveis da organização para alcançar os objetivos disponíveis".

[4] Segundo Chanlat (1999), gestão é "um conjunto de práticas e de atividades fundamentadas sobre certo número de princípios que visam uma finalidade [Por exemplo, gestão rural (ou agroindustrial) "pode ser definida como o processo em que o pecuarista administra da melhor forma possível o seu empreendimento, combinando, para isso, os recursos disponíveis como a força de trabalho familiar, os recursos econômicos, os conhecimentos técnico-produtivos, o capital social, os seus recursos naturais, etc., para obter os melhores resultados e desenvolver de forma sustentável a sua unidade de produção e de processamento de alimentos" (Pelegrini e Gazolla, 2008)].

sistema, e permite também que optem por métodos e ferramentas de produção que melhor se adequem a sua realidade produtiva e que melhor avaliem seu planejamento, Por isso que os resultados de decisões precisam ser monitorados e avaliados, aplicando medidas de controle a partir de indicadores de desempenho organizacionais (Kay et al., 2014), seguindo preceitos básicos (Figura 2).

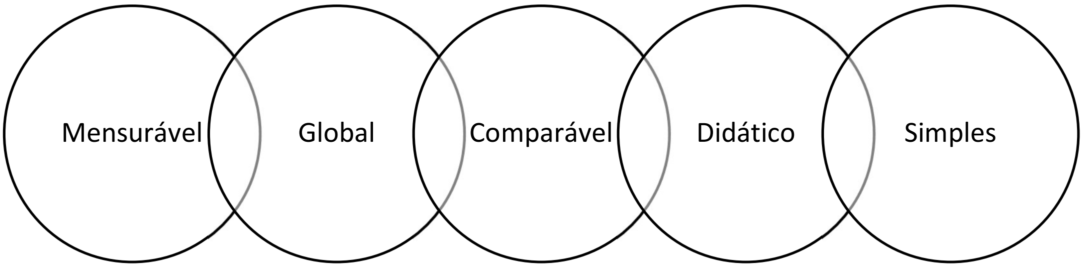


Figura 2. Características dos indicadores na avaliação e controle de sistemas produtivos de bovinos de corte. **Fonte:** Adaptado de (Embrapa, 2018).

A avaliação de desempenho parte do pressuposto de que os objetivos organizacionais são traduzidos em sistemas de controle (Anthony, 1965) e operacionalizados através de indicadores, isto é, fórmulas ou regras que permitem quantificar o desempenho (de Haas e Kleingeld, 1999).

Isso permite alcançar vantagem competitiva, e seguir as estratégicas genéricas (Porter, 1996), que neste mercado de commodity e concorrência perfeita (Marshall, 1982), envolve a redução de custos, diferenciação e/ou enfoque.

Embora seja possível dizer que o aspecto econômico permanece como um pilar fundamental para controle, ele não é isoladamente suficiente. Com as perspectivas do consumidor e as múltiplas esferas da sociedade interessadas em atender a demanda de alimentos com segurança alimentar e sustentabilidade, não se admitem análises de gestão redutoras a ponto de examinar apenas o aspecto econômico ou produtivo.

Portanto, o uso de múltiplos indicadores como ferramenta de estratégia competitiva pode estabelecer vantagens, atendendo a premissa inicial de um sistema produtivo de bovinos de corte, de ser fundamentado nos pilares de sustentabilidade econômica, institucional, social e ambiental, uma vez que tratá-las de forma isolada não garante a continuidade da atividade (Barcellos, 2019).

3.3.1 Indicadores na Terminação de Bovinos de Corte a Pasto

Tendo a tomada de decisão em sistemas produtivos impacto direto na eficiência da produtividade, os gestores demandam dados específicos (Simon, 1965), expressos por indicadores. Estes indicadores permitem também auferir aspectos de sustentabilidade dos sistemas (produtivo, econômico e ambiental) identificando o uso de recursos.

Entendendo que independentemente do tamanho[5] do sistema produtivo, alguns indicadores produtivos, econômicos e ambientais serão similares em seus valores numéricos. Para isso os indicadores como, por exemplo, uso de Adubação e Suplementação (Figura 3), Taxa de Lotação (Allen et al., 2011) ou Altura do Pasto (Barthram, 1986) que refletem em produtividade animal.

Outros indicadores produtivos como Ganho Médio Diário e Idade de Abate são relevantes e indispensáveis (Papaleo Mazzucco et al., 2016), e, para Costa et al., (2005) taxa de mortalidade é associado a eficiência.

Pensando na eficiência, é natural supor que os objetivos dos sistemas produtivos sejam pautados na busca pela viabilidade financeira do negócio (Barcellos et al., 2019). Por isso indicadores econômicos são importantes, pois permitem entender se os gestores consideram ou desconsideram seus custos, como o Custo de Oportunidade da Terra (Siqueira & Duru, 2016), Depreciação dos Bens (Simões et al., 2007), e Margem Bruta (Oiagen, 2011), por exemplo.

[5] É possível classificar o sistema produtivo em relação ao tamanho, dado o número de módulos fiscais do sistema produtivo para estabelecer se a propriedade rural é pequena (de 1 a menos de 4 módulos fiscais), média (de 4 a menos de 15 módulos fiscais) ou grande (acima de 15 módulos fiscais).
*Módulos fiscais podem variar de 5 a 110 hectares

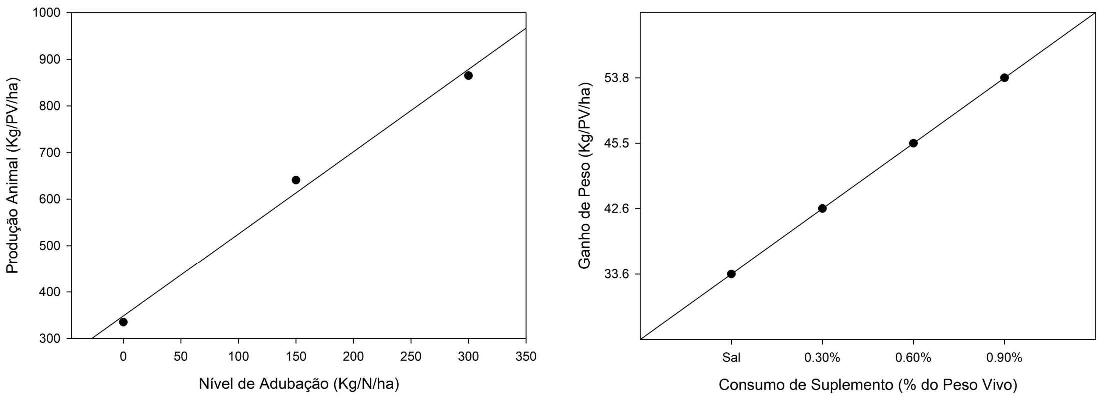


Figura 3. Exemplos de diferentes níveis de uso das principais tecnologias utilizadas para maximizar ganho de peso na terminação.

Fonte: Lupatini et al., (2013) e Silva et al., (2010).

Além destes, o planejamento tributário com suas alternativas jurídicas, pessoa física (PF) ou pessoa jurídica (PJ) com regime de tributação diferentes podem ser associadas a quanto maior e mais complexo o número de tributos, maior a necessidade de ser melhor gestor (dos Santos et al., 2016), e consequentemente menos impactado pela economia tributária (Marion, 2021).

E ainda, a atividade pecuária requer indicadores mercadológicos, como o número de possíveis compradores e diversificação de produtos para comercialização (Asante, 2018), assim como a compreensão da volatilidade de preços que afetam a rentabilidade do negócio (Wedekin et al., 2017). Alguns indicadores possíveis são o uso do hedge na proteção de preços (Bohl, 2018) e uso de seguro contra adversidades climáticas (Prado, 2012) ou exemplos da percepção de riscos (Damodaran, 2009; Buainain e Silveira (2017).

Por fim, os indicadores ambientais que controlam a escolha das melhores técnicas e processos que originem o menor impacto negativo possível sobre o meio ambiente (CONAMA, 1986). Esta sistemática consiste, no cumprimento da legislação como Cadastro Ambiental Rural (CAR), sancionada pelo Decreto Estadual no. 2.593/2006 como instrumento de controle prévio ao exercício de atividades agrossilvipastoris, Área de Preservação Permanente (APP) (Brasil, 2012) e Reserva Legal (Brasil, 2012).

Considerando esse tema, autores embasaram seus estudos na literatura científica sobre indicadores ambientais, como a circularidade da produção (Boer, 2018) e Índice de Integridade do Sistema (Blumetto et al., 2019), recebimento de Pagamento de Serviços Ambientais - PSA (Brasil, 2021), avaliação do uso de Dejetos e Qualidade da Água (Verona, 2008;); Utilização e destino de embalagens de agrotóxicos e fertilizantes; Prática de queimada, e outros.

Neste cenário, têm-se também os sistemas que podem atender preceitos da bioeconomia (Georgescu-Roegen, 1995; Kuhn et al., 2024), que ao longo dos últimos anos ampliou sua percepção com as inovações ligadas aos produtos e processos biológicos em inúmeras áreas, especialmente a agropecuária e a biotecnologia. Pela ótica de Georgescu-Roegen (1995), como exemplo, temos trabalhos de Díaz et al., (2020), na Espanha, com uso de resíduos agroindustriais na nutrição animal, permitindo atender a nichos de mercado, se diferenciando, e atraindo investimentos verdes.

Outros sistemas produtivos possíveis de serem identificados no estudo são os de integração lavoura-pecuária-floresta, ou as detentoras de selos de qualidade como Carne Carbono Neutro (Alves et al., 2015) ou Boas Práticas Agrícolas (GAP, *Good Agricultural Pratices*) (GlobalGAP, 2020), por exemplo. Todos os citados com a percepção que investimentos ambientais devem gerar retornos econômicos ou se tornarem fontes de vantagem competitiva, permitindo obter, por exemplo, certificados ISO, como a ISO 14001 (ABNT, 1997) que diferencia produtos produzidos com base em prerrogativas ambientais.

3.4 Desvio Positivo

Na literatura em gestão, existem duas correntes sobre comportamento desviante, uma com fluxo de comportamento desviante negativo, enfatizando comportamentos intencionais que ameaçam o bem-estar de uma organização, de seus membros ou de ambos (Robinson e Bennett, 1995). E, em contraste, o segundo fluxo que enfatiza o comportamento positivo pelo qual uma prática benéfica, que não é considerada normal, é adotada e disseminada, pressupondo sua capacidade estratégica de ser bem-sucedida para resolver problemas comuns (Marsh al., 2002).

O foco deste estudo, os desvios positivos, podem ser classificados ao longo de três eixos (Mertens et al., 2016). O primeiro eixo distingue o objeto de desvio positivo: pode se referir a um resultado tangível (por exemplo, desempenho excepcional) (Pascale e Sternin, 2005), ou a um comportamento por exemplo, *workaholism* (Galperin, 2012). O segundo eixo diz respeito à interpretação da noção "positiva": como um efeito sobre a organização (Cohn, 2009), ou uma emissão de intenção positiva (Spreitzer e Sonenshein, 2004). Por último, o terceiro eixo reconhece diferentes conceituações de desvio. Possivelmente, a abordagem mais comum para o desvio é referida como desvio estatístico (Clinard e Meier, 2015).

Este desvio positivo estatístico, objeto deste estudo, refere-se a comportamentos avaliados como desviantes positivos (DP) da média ou representados graficamente na extrema direita (Figura 4) de uma distribuição normal de comportamentos (Quinn e Quinn, 2002). E para classificação pode-se utilizar a escala de Likert (1932) de cinco pontos como já utilizado em estudos de desvio positivo (Moon et al., 2019; Cohen et al., 2020; Siraneh et al., 2022; Tamirat et al., 2023).

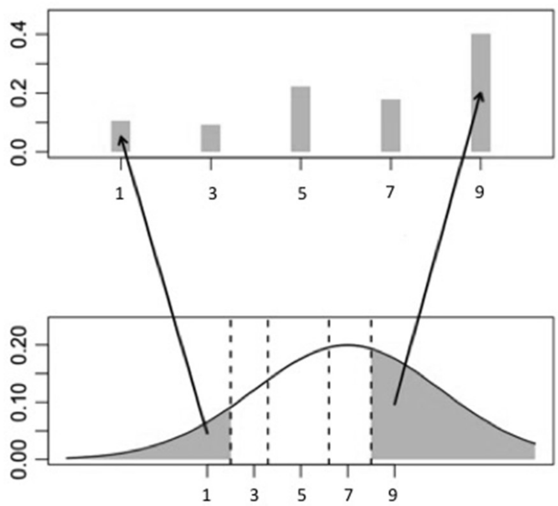


Figura 4. Abordagem estatística do desvio positivo associada a Escala Likert. **Fonte:** Adaptado de Likert (1932); Spreitzer e Sonenshien (2003).

Estes DPs podem ser indivíduos (Warren, 2003) de uma organização, comunidade ou empresa que alcança desempenho acima do esperado nas condições existentes (Flora, 2011). E embora a maioria dos problemas tenha causas subjacentes complexas e interligadas, a presença de DPs demonstra que é possível encontrar soluções bem-sucedidas, uma vez que DPs são capazes de acessar recursos de redes para implementar suas novas ideias que podem ter desvios radicais do que se espera que seja normal (Pascale et al., 2010).

Como DPs vão além dos saberes convencionais e sem criar uma situação conflitante ainda descobrem e inovam formas de funcionar, tornam-se fonte de inovação (Seidman e McCauley, 2008). Eles estão bem cientes das ações necessárias, formas de mitigar ou gerenciar riscos e utilização de recursos para produzir o máximo impacto com sua inovação (Seidman e McCauley, 2008; Pascale e Sternin, 2005; Shortell et al., 2005).

Um indivíduo que é identificado como um desviante positivo demonstra comportamentos ou práticas diferentes que o permitem alcançar consistentemente uma alta taxa de indicadores bem-sucedidos (Chakraborty e Mishra, 2014). Esses gestores incorporam melhores soluções para os problemas, como por exemplo, superar objeções de preços, embora compartilhem o mesmo recurso que outros gestores.

O desvio positivo identifica também aqueles gestores que devem ser os menos prováveis de ter sucesso, mas de uma forma ou de outra conseguiram obtê-lo. Isso porque ao escolher como desviantes positivos os com menor área produtiva, por exemplo, ou que não têm acesso a recursos especiais, mas ainda tendo sucesso contra todas as probabilidades, garante a acessibilidade de suas estratégias de sucesso, pela premissa de que “Se eles podem fazer isso qualquer um pode” (Pant, 2009).

Com o objetivo de ilustrar esse comportamento via desempenho nos indicadores e dentro das características da estrutura de mercado que os sistemas produtivos de bovinos de corte se inserem, o estudo não se limita a apenas uma categoria de gestão, e sim na produtiva, econômica e ambiental. Assim o pecuarista Desviante Positivo permitirá ser exemplo de replicação do processo, mostrando suas soluções como veremos nos próximos capítulos.

4. Hipóteses

H_1: O uso isolado de indicador (produtivo, econômico e ambiental) não é suficiente para avaliar o desempenho da terminação de bovinos de corte em pastagem.

H_2: O pecuarista desviante positivo será o que apresentar melhores resultados em indicadores de desempenho na terminação de bovinos em pastagem, porém, o ótimo produtivo pode não ser o ótimo econômico, independente do estado;

H_3: Mesmo com maior uso de tecnologias na terminação de bovinos de corte em pastagem aumentando custo e produtividade, as emissões de gases são maiores em sistemas com menor custo e menor produtividade, ou seja, com menos uso de tecnologias, independente do estado.

5. Objetivo Geral

Identificar desempenho desviante positivo de sistemas produtivos de bovinos de corte terminados em pastagem, por meio de indicadores produtivos, econômicos e ambientais no Rio Grande do Sul e Mato Grosso do Sul.

5.1 Objetivos Específicos

Verificar indicadores produtivos, econômicos e ambientais de relevância utilizados em sistemas produtivos de bovinos de corte terminados em pastagem.

Averiguar em sistemas produtivos de bovinos de corte terminados em pastagem, no Rio Grande do Sul e Mato Grosso do Sul, o pecuarista desviante positivo por meio de indicadores de desempenho com a metodologia do desvio positivo.

CAPÍTULO II

PRODUCTIVE, ECONOMIC AND ENVIRONMENTAL INDICATORS: WHICH IS THE MOST IMPORTANT FOR DECISION-MAKING IN BEEF CATTLE FINISHED IN PASTURE: NEW APPROACH

Joana Gasparotto Kuhn[a*]; Letícia de Oliveira[b]; Júlio Otávio Jardim Barcellos[c]

[a] Zootechnist, PhD Student Animal Science, Faculty of Agronomy, Department of Animal Science, Federal University of Rio Grande do Sul - UFRGS, Ave. Bento Gonçalves 7712, 91540-000, Porto Alegre, RS, Brazil.
* Correspondence email: joanagk@hotmail.com
[b] Administrator, PhD in Agribusiness, Faculty of Agronomy, Center for Studies and Research in Agribusiness – CEPAN, Federal University of Rio Grande do Sul - UFRGS, Ave. Bento Gonçalves 7712, 91540-000, Porto Alegre, RS, Brazil.
[c] Veterinarian, PhD in Animal Science, Faculty of Agronomy, Department of Animal Science, Núcleo de Estudos em Sistemas de Produção de Bovinos de Corte e Cadeia Produtiva - NESPRO, Federal University of Rio Grande do Sul - UFRGS, Ave. Bento Gonçalves 7712, 91540-000, Porto Alegre, RS, Brazil.

Abstract: The use of performance indicators to assist in decision making, in production systems, is a promising strategy to improve efficiency. The objective of this study is to identify the use of productive, economic, and environmental indicators in the beef cattle production systems under grazing conditions, in the finishing phase, through a systematic review. A systematic literature review was conducted in two scientific databases, Scopus® and Web of Science®. One thousand and eighty-seven documents have been retrieved. Inclusion and exclusion criteria have been used, such as the six-year period of analysis (2016–2021), open access files, and complete studies on pasture-fed beef steers and heifers, on whether or not they are using supplementation. Twenty-three publications from 12 countries have been included. Of these, 47.8% address the three areas of interest: productive, economic, and environmental. Three hundred and seventy-six indicators have been observed, 58.2% of which are productive indicators, 25.2% are economic, and 16.4% are environmental. The average daily gain of the indicator can be used as a productive indicator, as it appears in most studies (78.2%). As environmental, indicators carbon and methane (34.7%). And finally, as economic indicators, related to costs. Finally, this review demonstrates that indicators need to be related to each other and answer questions important because, from the market perspective, processes involving cattle, such as financing or commercialization, for example, must be followed by management schemes, which aim to reduce the provision of resources with the improve financial returns.
Keywords: beef, carbon, gross margin, production

1. Introduction

To feed the future world population in a sustainable manner, it is essential to look for alternatives. Being inspired more by systems that apply practices with less environmental impact, that save resources, and contemplate the systemic view of production processes (De Vries et al., 2015), it is possible to align with the sustainable competitiveness of agribusiness (Romeiro, 1998).

Brazil, the second-largest producer of beef in the world and leader in world exports (USDA, 2020), has its production of Brazilian beef from cattle that graze on extensive areas of pastures. It is a practice that has been recognized as being advantageous in terms of integral sustainability (Chang et al., 2015), which makes the country a differentiated producer of beef, especially given the new demands of the markets regarding environmental commitment (Loo et al., 2020). However, feeding cattle directly from the pasture, without proper management, is not enough to guarantee environmental sustainability (Zubieta et al., 2021).

Although they are still affected by interannual variability (Detman et al., 2005; McAllister et al., 2020) different strategies can be used (Tilman et al., 2006; Craven et al., 2018). These effects add complexity to the adoption of processes or methods (Vale et al., 2019) for making Brazilian production systems diverse. This reflects the average time required for slaughtering the animal, which reaches three-and-a-half years in Brazil, a period much longer than the two years observed in countries that employ more intensive production techniques (Greenwood, 2021).

In addition to the average slaughter time, according to Barbosa et al., (2014), the production systems have low stocking rates (<1 animal unit (AU) ha^{-1}) and productivity (<120 kg live weight ha^{-1}). Therefore, Brazilian livestock is still below its real potential for productivity (Mandarino et al., 2019). It is consequently below the real potential for sustainability, as the sustainable intensification of livestock production, which involves greater efficiency in the use of resources, can promote the reduction of greenhouse gas emissions (Adesogan et al., 2020) at the same time it meets this growing global demand for livestock products (FAO, 2019).

In search of greater productivity with sustainability, the productive and economic logic associated with the application of technological alternatives contributes to the competitiveness of the sector. However, these current strategies and technologies have productive efficiency as their main objective (Faria et al., 2009;

Silveira et al., 2018). The studies already developed explore the extremes, few or many final indicators, and in only one or two areas: economic, environmental, or productive. On the other hand, there are some limitations regarding the availability of information from the literature regarding joint applications (Mércio et al., 2021), that is, the animal (productive), economic, and environmental response.

This will make it possible to meet the demand for food from animals, which can only be met through improvements in the efficiency of land use by the current livestock systems (FAO, 2011; Garnett et al., 2017; Kamilaris et al., 2020) or filling the 'yield gap' between the current production and the best potential production (Godfray et al., 2010). To equate production, its costs and environmental impacts, bioeconomic models (Georgescu-Roegen, 1971) have been developed for agricultural production, however, few have been applied to livestock (Stehfest et al., 2013).

In this manner, in studies on finishing beef cattle on pastures, one needs to identify the association among the productive, economic, and environmental indicators, to suggest a new proposal for use, by utilizing the indicators validated on a global scale, to determine the performance criteria in the economic, productive and environmental association, as systems in favor of environmentally adjusted production processes will be replaced by extractive and extensive models, as it is essential not to lose competitiveness (Malafaia et al., 2021).

2. Material and Methods

2.1 Protocol and Research Problem

This systematic review was developed to identify the productive, economic, and environmental indicators in the production systems for finishing beef cattle in pastures. The review protocol was developed in line with the guidelines previously published by Higgins and Green (2011) and Sargeant et al., (2005). With the PICo methodology, the Population (P) was established: Finishing of beef cattle; Interest (I): productive, economic, and environmental indicators; Context (Co): Performance of Beef Cattle Production Systems.

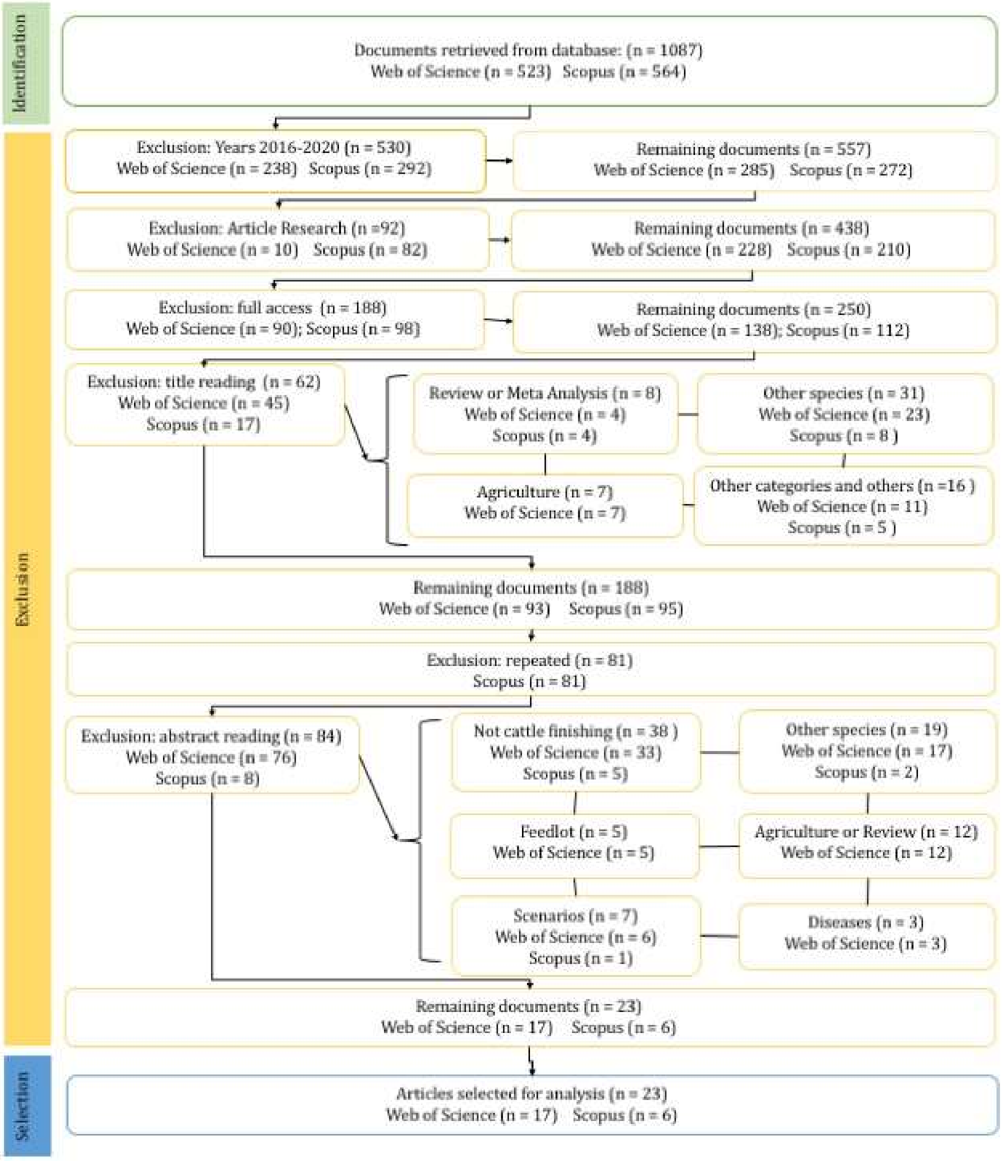
2.2. Literature search strategy

The database used consisted of original and complete research articles published in national and international journals. Considering the population, intervention, and results, the search strategy, in the title, abstract, or keywords, in English, using Boolean operators 'AND' and 'OR' was ((“environmental OR economic OR productive) AND (“finishing beef cattle” OR “livestock production systems”)). They were searched in the Scopus® (Elsevier, 1960–2021) and Web of Science® (Thomas Reuters, 1900–2021) online databases, on December 8, 2021. The period analyzed was six (6) years (2016–2021). Within this time frame, in addition to allowing the search for consolidated indicators, updated indicators on production systems were sought, when contemplating the advent of integrated crop-livestock systems (de Moraes et al., 2014). With this period of analysis, for a larger sample, we opted for a search using OR in the classification of indicators. We chose not to use the term “indicator” preceding the search words (economic, productive, and environmental) in scientific databases, as there is some confusion with the terms indicator, descriptor, parameter, variable, and standard, especially when there is a difference between numerical information and an indicator, and its difficulty in meeting global studies (Masera et al., 2000).

2.3. Study selection and screening criteria

The screening of the studies selected in the search involved a complete review, being independently evaluated by reading the title, keywords, and abstract (Figure 1). The screening questions were: (1) Is the article that was evaluated an original work?; (2) Does the title or abstract have productive, economic, or environmental indicators of beef cattle production systems (steers and heifers) kept on pastures? If reviewers answered, “No,” to at least one of the above questions, the article was excluded.

Figure1. Diagram giving information on the different phases of the systematic review, with the respective number of identified records. Adapted from PRISMA guidelines (Moher et al., 2009).



Source: Authors.

In the abstract reading phase, the following exclusion criteria were established: Articles related to milk production (either from discarded dairy cows or calves, transferred to beef cattle systems); the production of categories other than steers and heifers (bulls) and other animals (sheep, swine, etc.); studies that did not represent real farms or detailed production systems, based on regional/national averages (meta-analysis); articles without productive, economic, and environmental indicators or metrics; articles that did not study production systems for finishing beef cattle on the pastures.

2.4. Data extraction

A form, in an electronic spreadsheet, was created to standardize the extraction of data in relation to the indicators used in the selected studies. We sought to confirm the relevance of previously selected studies by reading the article in full. Initially, it was observed if the language of publication was English or Portuguese and whether the results were sufficiently detailed, to allow the extraction of the indicators used. The information extracted regarding the article included the name of the scientific journal, name(s) of the author(s), year of publication, the country where the methodology was developed, and the number of citations of the study. The information extracted, regarding the experiment through indicators, was identified, accounted for, and separated into categories: Economic, productive, and environmental.

2.5. Evaluation of the quality of publications

During data extraction, the risk of publication bias of the individual studies was assessed using the Cocharane Collaboration Risk of Bias Tool (Higgins & Green, 2011), but with one change in the evaluation of the domain, "blinding the evaluators of the results". For weight gain, slaughter age, and slaughter weight, as they were objective measures, the bias was considered low risk, regardless of the presence or absence of blinding. The same was followed for the economic indicators. As for the environmental indicators, as they were subjective, it was classified as high risk in the absence of blinding. The quality assessment was performed by the main researcher, with evaluation and verification of results by the co-author.

2.6 Data Analysis

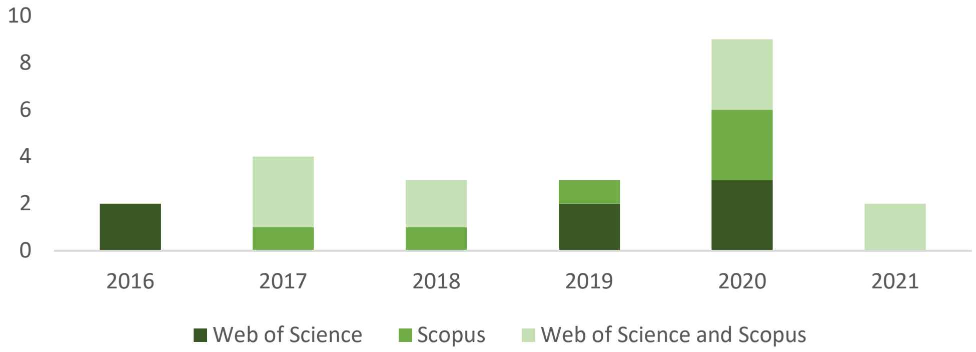
For the analysis and interpretation of the data, aiming to reach the objective, descriptive research was carried out. It was inferred by bibliometrics, the study of the quantitative aspects of the selected articles and studying the use of the indicators utilized in the selected articles. In identifying these indicators used, we chose to consider the four attributes established by Rosado Jr. and Lobato (2010): Relevance (being useful to users), accuracy (having a precise and unique mathematical definition), clarity (as to the meaning of the indicator and its interpretation), and feasibility (translated, in practice, by the ease of obtaining data for its calculation). Mostly, descriptive statistical techniques were used, using Microsoft Excel ®, v. 16. Data for each variable of interest (publications per year; country, citations per year, journals, total number of productive indicators per study, total, number of environmental indicators per study, and total number of economic indicators per study, etc.) were pooled and simple arithmetic averages and relative percentages were established.

3. Results

On the Web of Science®, 523 results were observed. Limiting the time period, 285 results were observed. When limiting the research articles, 228 articles were observed, of which 138 had free access. In the analysis of titles, 45 were excluded by title. and with regard to the abstract, 76 articles were excluded. Finally, 17 selected articles were selected.

In Scopus® 564 results were observed. Within the time limit, 272 were observed. As a research article, 210 articles were observed, of which 112 had open access. In the analysis of titles, 17 articles were excluded, as they were repeated from the Web of Science, and 81 articles were excluded from Scopus. In the abstract, eight articles were excluded. In the end, six articles were observed within the searched topic. Adding the research articles from the two databases, there were 23 articles according to the search criteria (Figure 2).

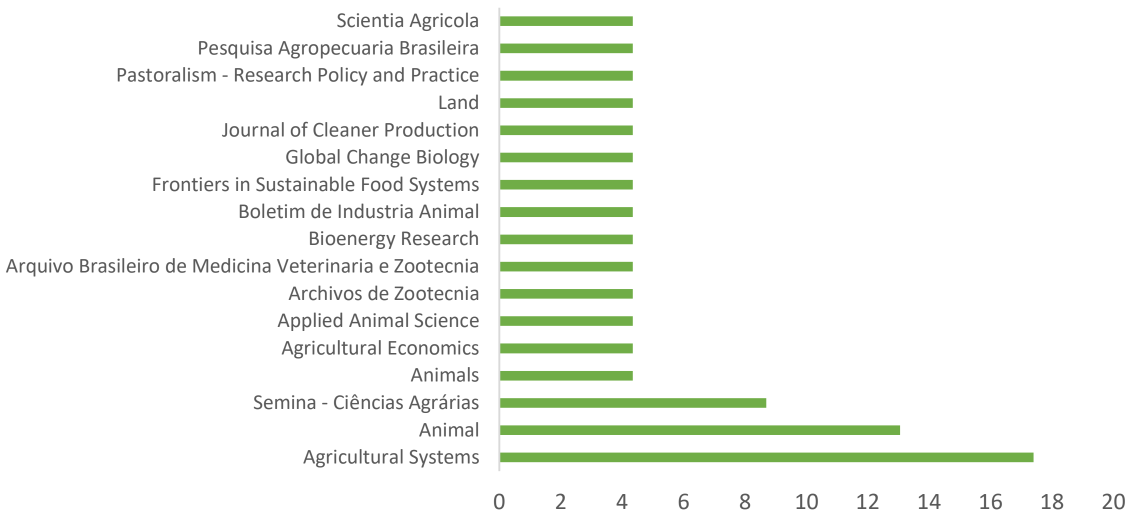
Figure 2. Number of selected research articles, per year of publication, per database.



Source: Authors.

Of the 23 selected articles, 39.1% were published between the years 2016 and 2018. The rest was published between 2019 and 2020. It was observed that Agricultural Systems magazine had the highest number of publications (17.3%) in the years 2017 and 2020.

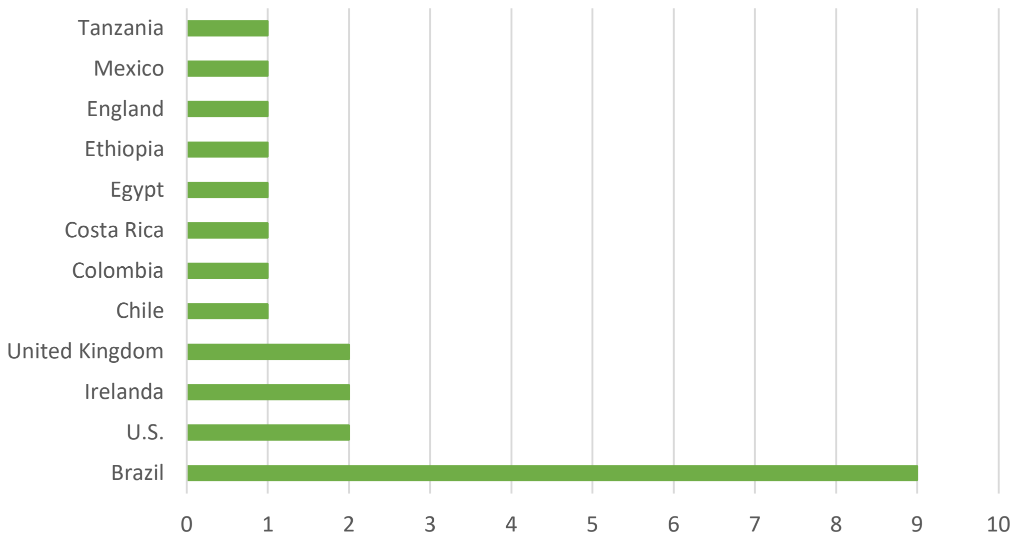
Figure 3. Percentage (%) of selected articles published by journals (n = 23 articles)



Source: Authors.

The analysis of the periodicals revealed that this theme had been constant in many of them. These 23 articles were published in 17 journals (Figure 3). In Animal, 13.04% of the selected articles were published, followed by Semina-Agricultural Sciences with 8.7%. In the other journals, only one article was selected.

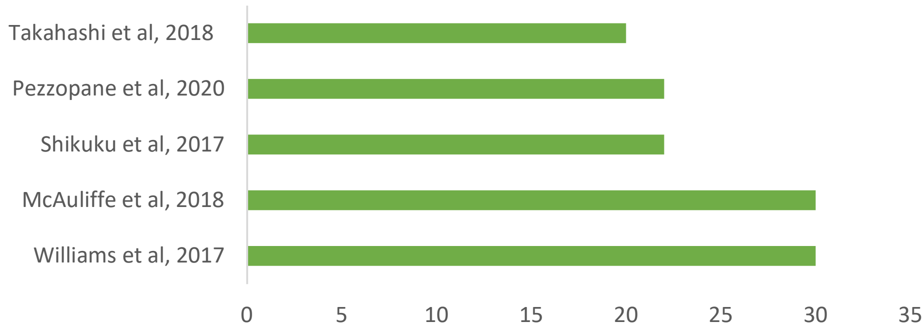
Figure 4. Research articles in the area of beef cattle selected from the literature review by country (n = 23 articles).



Source: Authors.

Interest in the subject is global, with Brazil being the country of study with the most selected articles (39.1%), followed by the United States, Ireland, and the United Kingdom with 8.7%. Several studies that were found (Salame et al., 2020; Chang-Fung-Martel et al., 2021) used data from different databases, that is, from third parties, not developing an experiment to build results. The total number of citations obtained from the entire sample was 170, but the distribution of citations (Figure 5) did not follow an annual pattern.

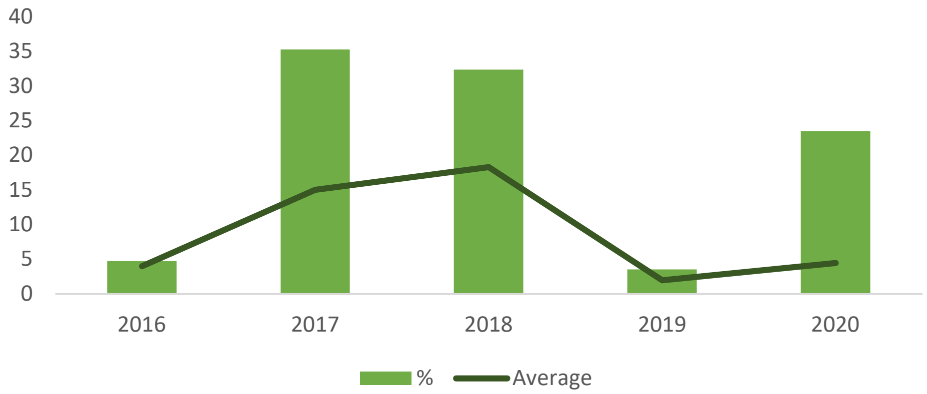
Figure 5. The 5 most cited selection articles and the number of citations.



Source: Authors.

The three most cited articles received 48.2% of all citations. The five most cited articles received 72.9% of the citations (use only one inference, 3 or 5). Six articles received one or two citations and four articles received no citations. It was observed, in terms of percentage, that the selected articles published (Figure 6) in 2019 had 3.5% of the citations, followed by the year 2016 with 4.7%. Also, for the percentage of the total, the year 2020 presented 23.5% and the year 2018 presented 32.3% of the citations. The year 2017 showed 35.2%.

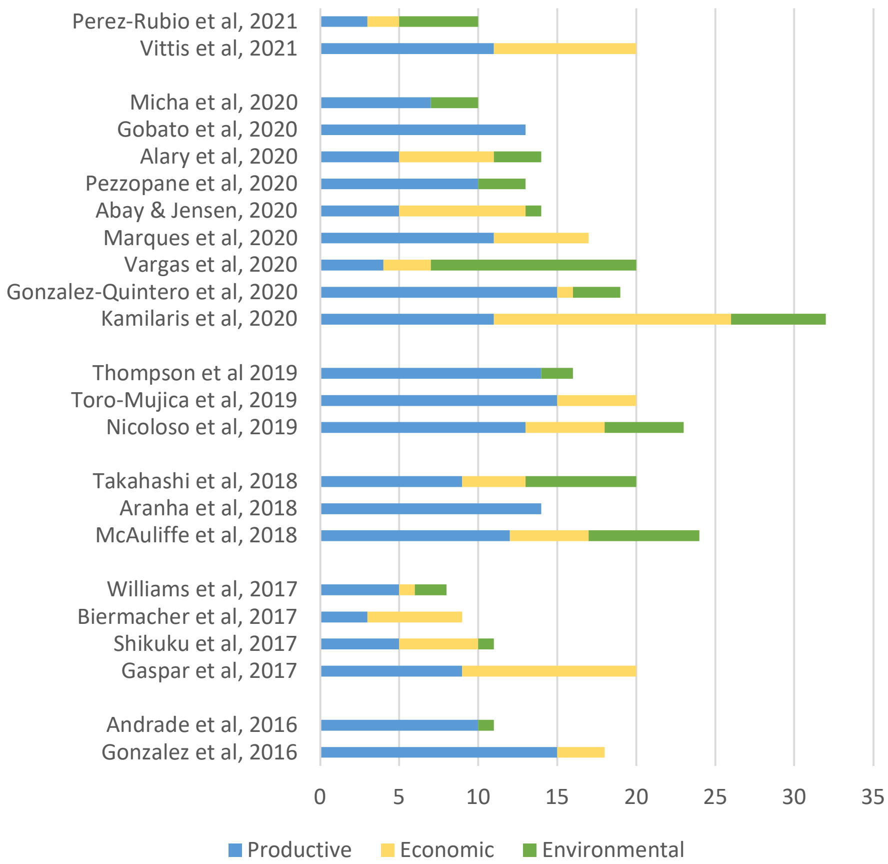
Figure 6: Percentage of citations (%) and average (x) of citations, per selected article and year of publication.



Source: Authors.

When we look at the average calculated with the year and number of publications, it is clear that the year 2018 has a higher average (18.3%) of citations per publication. Already 2017 with a high number of citations (35.2%) is in second place in the average of citations per publication. Even with recent publications, 2020 already has 23.5% of citations, surpassing 2016 and 2019. The selected articles aim at different interests (Figure 7), however, they have used productive, economic, and environmental indicators, and in most cases, have associated with them.

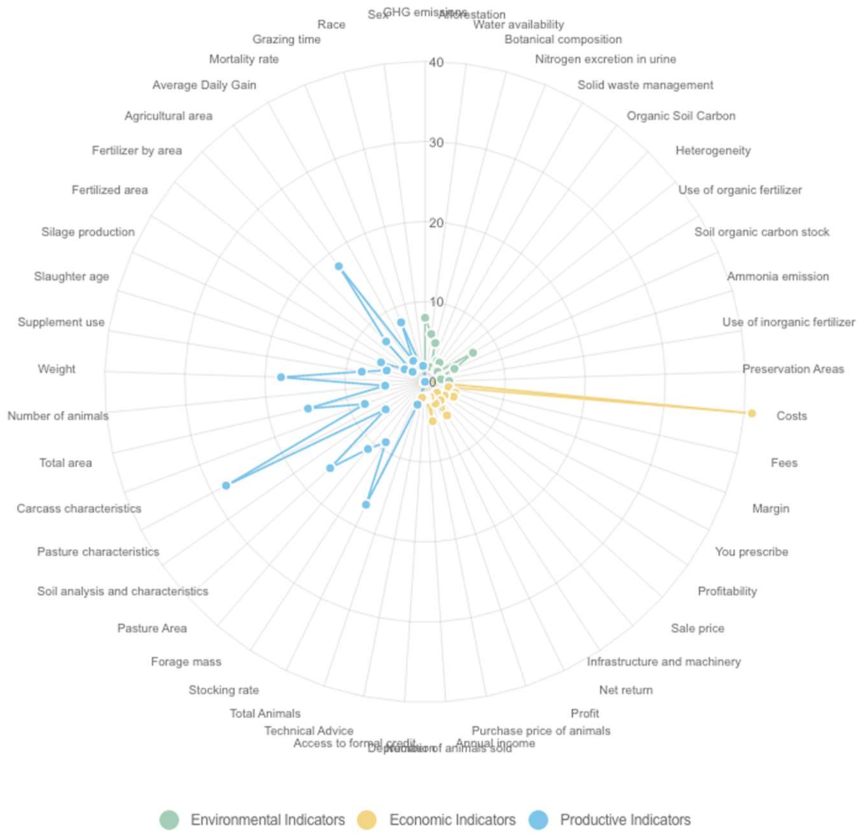
Figure 7. Number of indicators in each area found in the selected articles.



Source: Authors.

Of the twenty-three selected articles, a total of 376 indicators were used (Figure 8). Of these, 58.2% were indicators classified as productive, 25.2% as economic, and 16.4% as environmental.

Figure 8. Indicators used in more than one selected article, classified by color (productive = blue; economic = yellow; environmental = green) most used in the selected articles.



Source: Authors.

Of the research articles selected for this review, all used productive indicators, with 47.8% studying indicators in the three areas: Productive, economic, and environmental (Shikuku et al., 2017; Williamns et al., 2017; MacAuliffe et al., 2018; Takahashi et al., 2018; Nicoloso et al., 2019; Abay & Jensen et al., 2020; Alary et al., 2020; Gonzalez-Quintero et al., 2020; Kamilaris et al., 2020; Vargas et al., 2020; and Perez-Rubio et al., 2021).

Only 17.3% studied productive and environmental indicators (Andrade et al., 2016; Thompson et al., 2019; Pezzopane et al., 2020; Micha et al., 2020). Those who studied productive and economic indicators added up to 26% (Gonzalez et al., 2016; Gaspar et al., 2017; Biermarcher et al., 2017; Toro-Mujica et al., 2019; Marques et al., 2020; Vittis et al., 2021). Moreover, those who studied only productive indicators added up to 8.6% (Aranha et al., 2018; Gobato et al., 2020).

Considering that indicators were found in more than one article, the average daily gain (DMG) and live weight used in 78.2% of the articles stood out. Indicators appearing in more than 50% of the articles were all productive: The total number of animals, pasture area, forage mass, total area. It could be observed that in most of the studies (60.8%), due to their grazing conditions, supplementation was used at the finish, with 34.7% using feed and 26% feed and silage.

4. Discussion

Population growth, combined with changes in eating habits and the increased demand for beef in foreign and domestic markets, will require an improvement in the productivity of Brazilian livestock (Saath et al., 2018). These improvements are necessary when considering climate change, resource scarcity, and new geographic areas. Therefore, the adoption of technologies will be fundamental to meet these demands and to make beef cattle production systems more sustainable and attractive under the three pillars: productive, economic, and environmental (Silva et al., 2016).

4.1 Indicators for finishing cattle on pasture

The results of this analysis of indicators were promising; the average daily weight gain - ADG (78.2%) was the most used indicator, with great informative potential for isolated use. This indicator was used in 78.2% of the selected articles, which showed that weight gain per animal per day, during the evaluated period, was the key element, as, among all the indices, it had the greatest impact on the productivity result.

The live weight gain per hectare (kg BW ha -1) was obtained by multiplying the number of animals per hectare by the average daily gain and the number of grazing days in the stocking period. This indicator threw light on the productivity that the land could offer. That allowed in projecting the financial result. It was observed that in the selected articles, the supplement consumption indicator was used in 60.8% and costs in 73.9%. These were significant percentages that demonstrated the importance of these indicators. They allowed for control over disbursements, as producing cheaply did not mean spending very little (Neto, 2018).

The number of animals in relation to the land area is defined as a stocking rate, which could be reduced through slaughter or sale. This indicator was used in 39.1% of the selected articles. It determined the size and composition of the herd and varied with the availability of forage at a given time, conditioned by weather conditions (short term, unpredictable); seasons (medium-term, predictable), and year to year (medium and long-term, unpredictable).

Indicators, such as slaughter age was used in 20% of the selected articles, while the number of animals and availability of forage were used in 73.9% and 47.8%, respectively. These results were justified because they were indicators that measured the weight gain of cattle, directing management, and strategies.

In the economic indicator's category, gross margin or net margin and similar items were grouped under the margin indicator and were used in 17.3% of the selected articles. This indicator was usually the result of dividing gross profit by net revenue, and the higher it was, the better the managerial cost. Once this result was negative in the short and medium-term, it would be necessary to review the system, as the loss came from fixed costs.

The sale-price indicator used in 8.6% of the selected articles, as also in 8.6% of all articles, is as important as the purchase price. This is an important indicator because when the price received by the producer of the finished steer is greater than the average variable cost, it is possible to remain in the activity for a certain period of time; however, if the price is lower than the operating cost, the loss will be equal to or part of the fixed production costs (Matsunaga et al., 1976; Martins, 2018; Santos et al., 2022).

In environmental indicators, the grouping of indicators that study carbon stands out, a result found in 30.4% of the selected articles. This indicator accounts for the effects of beef cattle production practices and their effects on the environment that have become a matter of concern for consumers, producers, the industry, and the general public. The indicator of water source use was also observed in 21.7% of the selected articles. It is important as there is a positive correlation between food consumption and consequently, weight gain, and water availability (Oliveira et al., 2017).

Although the role of indicators contributes to improving the overall efficiency of the production system, as demonstrated by the set of indicators found, it recognizes the complexity of the beef cattle finishing business, in addition to the cattle industry itself. Even in the simplest form of management, numerous decisions have to be dealt with on a daily basis (Grajar et al., 2019) to ensure, among other things, the health of the soil (Williams et al., 2017; Takahashi et al., 2018; McAuliffe et al., 2018), pasture growth (Behrendt et al., 2016), and adequate buying and selling channels (Takahashi et al., 2018; Toro-Mujica et al., 2019; Marques et al., 2020).

4.2 Perspectives of selected articles in the use of indicators

This joint analysis of the indicators becomes relevant in view of the use and/or association of one or two areas (economic, productive, and environmental), precisely because, currently, in the public and scientific debate on the future evolution of agriculture, the sustainability of systems, in relation to global concerns on climate change, population dynamics, and the quality of the agroecosystem services provided to society, is fundamental.

4.2.1 Productive Indicators

It is noticed that many of the productive indicators are quickly calculated and are practical, for example, weight gain, measured by ADG, which is a significant component of production. as Also, the time required to prepare the animal for sale or slaughter is measured by the age indicator. It is an important economic factor of efficiency (Mazzucco et al., 2016).

Corroborating this statement, Oliveira et al., (2018) concluded that the breed (Nelore), and the relatively long period (16 months) in which animals remained on pastures to reach slaughter weight (430 kg/LW), contribute to a lower ADG. The same applies to animals grazing in the system with degraded pastures.

Indicators such as pasture height (Barthram, 1986), used in articles by Andrade et al., (2016), Thompson et al., (2019), and Pezzopane et al., 2021, are important after studies have shown that height management of pastures between 20 and 30 cm favor animal productivity per capita, in mixed pastures of black oat / ryegrass, integrated into agriculture, while higher grazing intensities maximize animal productivity per area, but are detrimental to animal performance and carcass quality attributes (Rocha et al., 2011; Kunrath et al., 2014; Wesp et al., 2016).

Medium and long-term feeding plans involve market considerations to deciding on slaughter. The search for more specialized markets has stimulated producers to adopt technologies, such as pasture supplementation, which allow for the slaughter of younger and heavier animals, with positive effects on carcass and meat characteristics (finish, weight, marbling, and tenderness) (Guerra et al., 2016), in addition to improving the system's profitability (Pereira Junior et al., 2016). In this sense, productive and economic indicators are associated.

However, even if the supply of feed to pasture reduces the age at slaughter (Menezes et al., 2019) and provides greater fat deposition in the carcass (Guerra et al., 2016) with the production of heavier carcasses (Boito et al., 2018), it is necessary to account for the costs of these technologies, which demonstrate a complex logic that involves the application of technological alternatives, as it requires accurate knowledge of the causal relationships between the different elements that make their instrumentation and their animal (productive) response, economic and environmental. These decisions can be monitored and associated to improve productivity.

4.2.2 Economic indicators

It is natural to assume that the objectives of the production systems are based on the search for effectiveness, in order to lead to development and prosperity (Nascimento & Reginato, 2013), analyzing the viability of the production systems. That is why economic indicators are important, as they allow us to understand the performance and efficiency of the production systems.

Takahashi et al., (2018) described that the indicators they used were just examples and could be complemented or replaced by others. In addition, it encouraged the use of indicators, such as the Land Opportunity Cost (Siqueira & Duru, 2016) or Depreciation of Assets (Gaspar et al., 2017; Kamilaris et al., 2020), for example, indicators that are often disregarded in the presence of some financial difficulty (Lemos et al., 2018). According to Toro-Mujica et al., (2019) the labor price indicator is significant, as the recurrence of unpaid family work in certain financial conditions must be considered, since some production systems may or may not hire temporary workers (Alary et al., 2020).

In addition to these, a productive economic variable that could be used due to its practicality, but which was not observed in the articles found in the review, was the rate of enjoy indicator, which measures the ability of the herd to generate a surplus. It represents the production (in kilograms or head) in the year, in relation to the initial herd. That is, the higher the enjoyment rate, the greater the internal production of the herd (Neto, 2018), and the greater the number of animals sold, in relation to the herd quantity, and therefore, the greater the efficiency.

In this case, instead of using the number of animals for its calculation, a weight measurement, in contrast to the traditional model of the number of heads, would be used. The measure would then stop being the number of animals sold in the year/average number of animals on the property (%). It would change to the number of kilograms of the live weight sold in the year/average weight of the herd in kg live (%) (Costa et al., 2018).

In economic terms, improved and integrated systems present similar or even better returns when compared to traditional systems (Costa et al., 2018). Therefore, understanding the technologies and establishing accounting-financial measures (Carneiro & Silva, 2010) as performance indicators, provide subsidies to the decision-making process regarding the best allocation of scarce resources.

4.2.3 Environmental Indicators

With the environmental problems faced by our modern society, numerous significant researches had originated in association with productive and economic data. The emphasis on complexity, given by the idea of sustainability, by associating productive, economic, and environmental indicators, still challenges researchers and technicians to carry out interdisciplinary studies, that lack an effective construction of indicators (Bengtsson et al., 2018).

In addition to their primary function of meat production, production systems based on pastures tend to keep animals in their natural habitat, providing benefits to society, such as the sustainable management of renewable natural resources, the conservation of biodiversity, and the maintenance of socio-environmental aspects, economic viability for many rural areas, especially remote ones (Oliveira et al., 2020).

Several reviews have described how adverse environmental impacts of livestock production can be significantly reduced using strategies such as improving herd efficiency, health, and genetics; improved feed production and feeding practices, including pasture management; ensuring getting to market size weight sooner, and so on (Hristov et al., 2013; Knapp et al., 2014; FAO, 2018). With this environmental look at resources, Takahashi et al., (2018) suggest a potentially systematic interaction between 'soil health', ecological environment, and cattle grazing. They found that a higher level of soil organic carbon (SOC) stock is associated with better animal performance, and fewer nutrient losses in watercourses, with greater botanical diversity and higher SOC.

In the article by Thompson et al., 2019, the carbon footprint per hectare was calculated and considered the greenhouse gas (GHG) emission from inputs (diesel used by machines during liming and fertilization; electricity consumed in pasture irrigation; and production of N, P, and K). The study concluded that the use of rotation or intercropping with plant species, such as legumes, could reduce nitrogen fertilizer needs, and consequently, reduce GHG emissions, the same was observed by Cai et al., (2018).

The GHG emissions, an indicator presented in the article by Takahashi et al., (2018), indicate that the botanical heterogeneity was positively correlated with the animals' live weight gains (p = 0.07). As specified by Birkelo (2003), under grazing conditions, improvement in ADG was achieved ranging from 8% to 18%, as a result of differences in botanical composition and pasture quality. For Gonzalez-Quintero et al., (2020), ensuring the adoption of improved pastures was a high priority, to increase productivity in the finishing production systems.

McAuliffe et al., (2018), based on the intensity of emissions from individual animals, showed that there were significant differences between the intensity of emissions for pastures intercropped with the legume white clover (Trifolium repens), which was lower than in a system with permanent pasture and monoculture grasses, with high sugar content.

As estimated emissions from fertilizer use increased by 15 times between 1970 and 2016, in Brazil (SEEG-Brasil, 2018), and between 2000 and 2016, the increase in consumption of mineral fertilizers determined the proportional growth of emissions of GHG by around 158%. For Oliveira et al., (2020), the best pasture management strategies, therefore, can be an effective alternative for sustainable meat production, as they help in GHG mitigation and also bring many other benefits environmental, social, and economic.

Alary et al., (2020), research how to produce more with less damage to the environment, by utilizing the indicator of organic nitrogen (manure), as a diversification of the family farming system. This is because livestock manure provides organic fertilizer for more than 50% of the agricultural land in the world, converting waste into inputs, for the production of high-value food (FAO, 2018). Therefore, manure plays an important role in replenishing soil organic matter, which is critical to maintaining soil health and quality, thereby sustaining crop productivity and restoring degraded soils (FAO, 2018).

Regarding water use, Gonzalez-Quintero et al., (2020) concluded that lotic and lentic surface water bodies were the main sources of water in conditions of pasture-finished cattle. On the other hand, as it is common for animals to have free access to these water bodies, their physical quality can be reduced, their organic matter content increased, and their dissolved oxygen concentration reduced (Chará & Murgueitio, 2005), as the contamination of the water supply by human or animal material poses risks to consumers.

Indicators such as the use of pesticides are not included in the articles. This should be considered as a limitation, as a system that presents itself as more sustainable with a certain combination of indicators may, with another combination, be considered less sustainable. Regarding environmental protection laws, 13% of the articles analyzed the adequacy of Brazilian environmental laws (Permanent Preservation Area – APP and Legal Reserve) (Brasil, 2012) how indicators the legal conditions on production systems in environmental indicators.

4.3 Implications of the use of indicators in finishing cattle on pastures: A new proposal

Of the indicators identified in the review, a total of 376 indicators were used (Figure 8) and of these, 58.2% were indicators classified as productive, 25.2% as economic, and 16.4% as environmental. When grouped together, they still showed variation (41 productive; 29 economic; 29 environmental). This indicates that they can be chosen through quantitative assessment, with a substantially greater likelihood of having a positive impact on profitability than those chosen randomly or instinctively.

The indicators that showed a positive benefit in the registration of information on the production systems contributed to the advancement and permanence in the sector when production standards had improved. This is because in the future, production systems that are incapable or that do not adapt to the new economic–environmental–environment will be affected, likely going bankrupt for not observing the need for investments and control (Malafaia et al., 2021).

From the selected articles, it is unlikely that there will be greater profitability without a detailed and accurate understanding of the production processes and their contributions to the overall performance of the production system. For understanding the need for adequate performance measures, the average daily gain has been used as an indicator for more than 80 years in research (Black & Knapp, 1936; Knapp & Black, 1941), as well as the stocking rate for more than 40 years (Hart, 1972), for example, it demonstrates that with innovation, it is possible to complement the already consolidated indicators, and with that, look for an evaluation with a result set of variables.

Assuming this, indicators that associate productivity from an economic and environmental point of view, need to be developed currently, and this goes beyond determining that a relatively large percentage of the total costs of a production system is in termination (Smith & Free, 1971). Else, it is recommended, with regard to the records, that a production system preserve the definitions of terms used in management or use of a table with metric conversion factors (Nix, 1972) that have been researched for years.

Considering this, the question is: Are the indicators we use today sufficient to measure productive, economic, and environmental performance? Will it be possible to create or associate with the existing indicators that can measure the new challenges in beef cattle? What would be the meaning and importance of this interaction? How are indicators of different dimensions (economic, productive, and environmental) related? These issues are important because, from the market perspective, processes involving cattle, such as financing, commercialization, and direct processes must be followed by environmental land management schemes, which aim to reduce the provision of resources and improve financial returns, contributing to the social and environmental well-being (DEFRA, 2021).

Furthermore, as the circular economy is a model of production and consumption, which involves sharing, renting, reusing, repairing, renewing, and recycling existing materials and products for as long as possible, it is possible that rural producers already do it, but not yet. used indicators that include prolonging the life cycle of products, which in practice implies reducing waste to a minimum. Pulina et al., (2021) corroborate this thought.

A solution to this is also found in bioeconomy (Georgescu-Roegen, 1975; Kuhn et al., 2024), which presents itself as an alternative when using methodological options of thermodynamic analysis, among which are energy analysis (EA), exergetic analysis (ExA), entropy analysis (EnA), and emergetic analysis (EmA) (Liao et al., 2012). Tools such as Life Cycle Analysis and Life Cycle Cost (Gianezini et al., 2014; Ruviaro et al., 2015; MacClelland et al., 2018) help to prioritize, environmental impacts, based on functional units, impact frameworks, and management scenarios, must be addressed with priority.

The cost-benefit analysis tool monetizes and compares the expected positive and negative effects of planning action. It lists parallel alternatives and points out whether or not it should be carried out, considering the costs of action with the costs of inaction (Dennig, 2017). With this in mind, we can consider, for example, GHG emission damages that would not occur if we avoided emissions.

However, these tools, using the indicators, are still complex to calculate at the level of the individual production system. In other words, with the advent of management technologies, applications, and software, it is possible to control diseases by monitoring rumination (Marchesini et al., 2018) and pre-slaughter animal welfare (Losada-Espinosa et al.., 2018), among others. Finally, this review also demonstrates that indicators need to be related to each other.

Can individual indicators inform different realities? For this, another contribution is proposed, the positive deviation tool (Vadera et al., 2013), which allows the evaluation of the individual production system to go beyond the benchmark between properties, and also, helps to verify the positive deviant performance (DP) of the productive systems in each indicator, as well as, direct communication and dissemination strategies of positive deviations from peers, as positive deviants (PDs) are more efficient than anything else in bringing about change (Seidman and McCauley, 2008).

5. Conclusion

The wide range of indicators found allows for their varied use according to the reality of each production system. In the need to choose, we concluded that for beef cattle finished in the pasture, the average daily gain indicator can be used as a productive indicator, as it is present in most studies. The environmental indicator can be used by those who study carbon and methane, and finally, the economic indicator for those related to costs. This study demonstrates that the association of productive indicators or metrics must be associated with environmental and economic issues, and even if production and its indicators currently seek to accompany environmental indicators, they are not limited to the preservation, but rather cover, for example, "How to produce a lot more efficiently — such as, with the use of mixed legumes in pastures and animals being terminated early, with greater weight" — as this reduces greenhouse gas emissions. Given the complexity and number of indicators, one of the limitations of this research stems from the specificity of the theme, which has been necessary due to the numerous formations possible for the termination of beef cattle in pastures. For use in new proposals, we have the bioeconomy and tools, such as positive deviation, which will be necessary for future studies, to establish a balance between the indicators.

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8. Appendices

Table 1: Information regarding the articles found (n = 23) in the Review.

Author	Article Title	Journal	Year	Country
McAuliffe et al., 2018	Distributions of emissions intensity for individual beef cattle reared on pasture-based production systems	Journal of Cleaner Production	2018	Reino Unido
Biermacher et al., 2017	Economic Feasibility of Using Switchgrass Pasture to Produce Beef Cattle Gain and Bioenergy Feedstock	Bioenergy Research	2017	Estados Unidos
Williams et al., 2017	Land-use strategies to balance livestock production, biodiversity conservation and carbon storage in Yucatan, Mexico	Global Change Biology	2017	México
Alary et al., 2020	Multi-criteria assessment of the sustainability of farming systems in the reclaimed desert lands of Egypt	Agricultural Systems	2020	Egito
Gonzalez et al., 2016	Performance of Heifers Supplemented with Different Levels of corn on Pasture	Boletim de Industria Animal	2016	Brasil
Shikuku et al., 2017	Prioritizing climate-smart livestock technologies in rural Tanzania: A minimum data approach	Agricultural Systems	2017	Tanzânia
Takahashi et al., 2018	Roles of instrumented farm-scale trials in trade-off assessments of pasture-based ruminant production systems	Animal	2018	Reino Unido
Toro-Mujica et al., 2019	Trends and Drivers of Change of Pastoral Beef Production Systems in a Mediterranean-Temperate Climate Zone of Chile	Animals	2019	Chile
Gaspar et al., 2017	Bioeconomic simulation of productive systems in beef cattle production activities which emphasis in	Archivos de Zootecnia	2017	Brasil

	maintenance and pasture recovery			
Perez-Rubio et al., 2021	To What Extent Are Cattle Ranching Landholders Willing to Restore Ecosystem Services? Constructing a Micro-Scale PES Scheme in Southern Costa Rica	Land	2021	Costa Rica
Vittis et al., 2021	Optimising the Spatial and Production Input Features to Improve Efficiency of Hill Farm Production Systems	Frontiers in Sustainable Food Systems	2021	Inglaterra
Pezzopane et al., 2020	Production and nutritive value of pastures in integrated livestock production systems: shading and management effects	Scientia Agricola	2020	Brasil
Gonzalez-Quintero et al., 2020	Technical and environmental characterization of dual-purpose cattle farms and ways of improving production: A case study in Colombia	Pastoralism - Research Policy and Practice	2020	Colômbia
Micha et al., 2020	Examining the policy-practice gap: The divergence between regulation and reality in organic fertilizer allocation in pasture based systems	Agricultural Systems	2020	Irlanda
Abay & Jensen, 2020	Access to markets, weather risk, and livestock production decisions: Evidence from Ethiopia	Agricultural Economics	2020	Etiópia
Gobato et al., 2020	Supplementation of grazing beef cattle with narasin	Pesquisa Agropecuaria Brasileira	2020	Brasil
Marques et al., 2020	An improved algorithm for solving profit-maximizing cattle diet problems	Animal	2020	Brasil
Thompson et al., 2019	An energy and monensin supplement reduce methane emission intensity of stocker cattle grazing winter wheat	Applied Animal Science	2019	Estados Unidos
Aranha et al., 2018	Performance, carcass and meat characteristics of two cattle categories finished on pasture during the dry season with supplementation in different forage allowance	Arquivo Brasileiro de Medicina Veterinaria e Zootecnia	2018	Brasil
Andrade et al., 2016	Herbage intake, methane emissions and animal performance of steers grazing dwarf elephant grass v. dwarf	Animal	2016	Brasil

	elephant grass and peanut pastures			
Vargas et al., 2020	Ecosystem services and production systems of family cattle farms: an analysis of animal production in Pampa Biome	Semina - Ciências Agrárias	2020	Brasil
Nicoloso et al., 2019	Typology of family livestock production systems in the Pampa biome using the MESMIS method	Semina - Ciências Agrárias	2019	Brasil
Kamilaris et al., 2020	A bio-economic model for cost analysis of alternative management strategies in beef finishing systems	Agricultural Systems	2020	Irlanda

Source: Authors.

CAPÍTULO IV

9. Considerações Finais

Os resultados deste estudo apontam vantagens competitivas via indicadores produtivos, econômicos e ambientais na terminação de bovinos de corte em pastagem. Os métodos de pesquisa em ambos os capítulos permitiram a identificação de indicadores chave e pecuaristas desviantes positivos. Foi possível assim estabelecer direcionadores de gerenciamento e exemplos de gestão.

Quantos as hipóteses, tem-se a H_1 verdadeira, uma vez que o uso isolado de indicador (produtivo, econômico e ambiental) não é suficiente para avaliar o desempenho da terminação de bovinos de corte em pastagem. Na H_2 o pecuarista desviante positivo não foi o que apresentou melhores resultados em indicadores de desempenho na terminação de bovinos em pastagem, e nem foi o ótimo econômico, mas sim, manteve todos os indicadores acima da média. Por fim, a H_3 é verdadeira, dado que mesmo com maior uso de tecnologias na terminação de bovinos de corte em pastagem aumentando custo e produtividade, as emissões de gases são maiores em sistemas com menor custo e menor produtividade, ou seja, com menos uso de tecnologias, independente do estado.

Por estudar sistemas produtivos em dois estados brasileiros, em especial na terminação, entregamos a literatura científica este estudo com abordagem comparativa entre os dois estados inexistente até o momento. E, dentre os principais desafios enfrentados no estudo, encontrar pecuaristas que conheciam e detinham suas informações financeiras como por exemplo, seus custos, para a análise comparativa e de desvio positivo foi um limitante.

Para trabalhos futuros, recomenda-se uma análise de todas as etapas produtivas de bovinos de corte dos sistemas, não apenas da fase terminação. Apesar da robustez de tal sugestão, permite compreender o sistema gerencial como um todo, reduzindo possível equívoco quanto a condição animal, em especial a fisiológica, que exprime desempenho. E, em complementação, com a identificação dos desviantes positivos, foi possível perceber que seus "diferenciais" estão simplesmente em aplicar o que a academia e a literatura recomendam na obtenção de lucro sustentável.

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11. Anexo

PRÓ-REITORIA DE PESQUISA DA UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL - PROPESQ UFRGS

CEP UFRGS

Plataforma Brasil

Continuação do Parecer: 5.212.320

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: GESTAO DE SISTEMAS PRODUTIVOS DE CARNE BOVINA PELA PERSPECTIVA DO DESVIO POSITIVO

Pesquisador: LETICIA DE OLIVEIRA

Área Temática:

Versão: 3

CAAE: 53876721.0.0000.5347

Instituição Proponente: Universidade Federal do Rio Grande do Sul

Patrocinador Principal: FUND COORD DE APERFEICOAMENTO DE PESSOAL DE NIVEL SUP

DADOS DO PARECER

Número do Parecer: 5.212.320

Apresentação do Projeto:

Trata-se de projeto de Doutorado de Joana Gasparotto Kuhn (PPG de Zootecnia), sob a orientação do Prof Júlio Otávio Jardim Barcellos e da Profa. Letícia de Oliveira.

Todas as pendências foram atendidas, estando a presente versão (#3) do projeto de pesquisa em acordo com a resolução CNS/MS 466/2012. Em condições de aprovação.

Considerações Finais a critério do CEP:

Aprovado.

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

PORTO ALEGRE, 26 de Janeiro de 2022

Assinado por:
Patrícia Daniela Melchiors Angst
(Coordenador(a))

Endereço: Av. Paulo Gama, 110 - Sala 311 do Prédio Anexo 1 da Reitoria - Campus Centro
Bairro: Farroupilha **CEP:** 90.040-060
UF: RS **Município:** PORTO ALEGRE
Telefone: (51)3308-3738 **Fax:** (51)3308-4085 **E-mail:** etica@propesq.ufrgs.br