ANIMAL WELFARE AND SUSTAINABLE MANAGEMENT OF NATURAL RESOURCES IN THE DAIRY ACTIVITY OF SMALL FARMS

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ABSTRACT

The objective of this article is to analyze the relationship between animal welfare and the sustainable management of natural resources in the dairy activity of small rural properties, with emphasis on the economic impacts. Methodologically, this is a research with a qualitative approach, using an integrative literature review and case study. The locus of the research is a small rural property located in the community of Linha Eduardo Chaves, in the municipality of Prudentópolis/PR. The literature review addresses topics such as animal welfare practices, sustainable management and their economic effects. The results indicate that the adoption of sustainable practices that promote animal welfare are economically beneficial for small dairy farms, notably from environmental, social and economic perspectives, with emphasis on the reduction of operating costs, increased productivity and product appreciation contributing to the economic self-sufficiency of these properties.

Keywords: Animal welfare. Sustainable management. Dairy Production. Economic Sustainability.

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INTRODUCTION

Milk production plays a key role in Brazilian family farming, contributing significantly to food security and income generation in rural areas. The analysis of costs and profitability of milk production is necessary to understand the economic viability and development prospects of this sector (Labiak; Stroparo, 2023). In this bias, the Organization for Economic Cooperation and Development (OECD), in a survey carried out in 2018, points to an increase in world milk production (OECD, 2018). In this same research, the data show the potential of Brazilian milk production due to efforts to intensify production systems and the use of new production and information technologies (OECD, 2018; Bassotto et al., 2021; Labiak; Stroparo, 2023).

In this same context, FAO data (2024) indicate that, between the years 2020 and 2021, national milk production exceeded the mark of 36 billion liters. However, in 2022, there was a slight decrease in this volume. Despite this reduction, Brazil continues to be one of the main milk producers worldwide.

Specifically dealing with the State of Paraná, in 2023, the state stood out as the second largest milk producer in Brazil, with an estimated production of approximately 5.3 billion liters, representing about 15% of national production, which exceeds 34 billion liters annually (MAPA, 2024; Embrapa, 2024). Dairy farming in Paraná is predominantly carried out on family farms, many of them adopting sustainable management practices and contributing to the local economy and food security (Embrapa, 2024)

In addition, milk production in Paraná involves about 50 thousand properties, most of them small and medium-sized, which use varied production systems, from conventional to organic. The state has also invested in sustainable practices and the adoption of technologies to improve the efficiency and profitability of production (MAPA, 2024; AgroPlanning, 2024). Recent research addresses the milk panorama in the Municipality of Prudentópolis, such as a study carried out by Labiak & Stroparo (2023) that provides a detailed analysis of the activity on family farms, emphasizing the importance of cost and profitability analysis to identify areas of financial impact and improve production efficiency.

However, the research delves into the costs and results (even if subjective) arising from the adoption of practices that integrate animal welfare and the sustainable management of natural resources in the dairy activity (Vilela et al., 2016; IBGE, 2023). The state of Paraná, in particular, consolidates itself as one of the largest milk producers in the country, representing 12.51% of national production, which highlights the relevance of this activity for local economic development (Anuário do Leite, 2023; Labiak; Stroparo, 2023).

Proper management of production costs, along with the adoption of sustainable practices, is essential to ensure the profitability of the activity, especially in properties that use family labor and depend on small plots of land (Mezadri; Stroparo, 2017). Similar research developed (Labiak; Stroparo, 2023) demonstrates that dairy farming, when well managed, can achieve profitability of up to 24.76% of gross revenue, making it an economically viable alternative for small plots of land.

It is understood that animal welfare is a complex and multifaceted topic, which involves scientific, ethical, economic, cultural, social, religious and political dimensions (OIE, 2015). It is not only an ethical issue, but a practical necessity to ensure productive efficiency. In a context of dairy production, management practices that ensure animal comfort, continued access to quality food and water, and ethical management have been shown to significantly improve milk production and animal longevity (Broom, 2010; Fraser, 2008; Ceballos; Sant'Anna, 2018; Stroparo, 2021, 2023)

The adoption of practices aimed at animal welfare, such as rotational grazing, ethical management and the provision of comfortable environments, results in greater production efficiency, since less stressed animals tend to produce better quality milk in greater quantities (Fraser, 2008). In addition, these practices are also associated with reduced operating costs, such as less use of medications and increased longevity of animals in the herd (Broom, 2010; Pea; Gomes, 2022).

In this context, the integration of animal welfare and sustainable management of natural resources is fundamental for the economic and environmental sustainability of dairy activity in small farms. This article aims to analyze the relationship between animal welfare and the sustainable management of natural resources in dairy farming, using as a case study a small rural property located in the community of Linha Eduardo Chaves, in the municipality of Prudentópolis/PR. The analysis will be based on an integrative literature review and data collected directly on the property, focusing on the economic, environmental and social impacts of the practices implemented.

In this perspective, the article aims to analyze the relationship between animal welfare and the sustainable management of natural resources in dairy farming, using as a case study a small rural property located in the community of Linha Eduardo Chaves, in the municipality of Prudentópolis/PR. The analysis is based on an integrative literature review and data collected on the property.

METHODOLOGY

The research uses a qualitative approach, combining an integrative literature review with a case study (Guerra *et al.*, 2024). The integrative review was carried out to identify and synthesize the main studies and findings related to animal welfare, sustainability and economic performance in milk production, with a focus on small farms. For this, searches were carried out in scientific articles in the Web of Science, Scopus and ScienceDirect databases, using the following descriptors: "Animal Welfare in Dairy Farming," "Sustainable Dairy Practices," "Economic Performance in Dairy Farming," "Family Farming," "Milk Production Efficiency," and their equivalents in Portuguese: "Animal Welfare in Dairy Farming," "Sustainable Practices in Milk Production," "Economic Performance in Dairy Farming, "Family Farming," and "Efficiency in Milk Production."

The inclusion criteria selected were: articles published in peer-reviewed journals; studies that discuss sustainable practices, animal welfare and economic performance in milk production; publications in English or Portuguese; and recent or classic studies, defined as those with a significant number of academic citations, in order to ensure the relevance and timeliness of the data. Articles that did not directly address animal welfare or production efficiency, duplicate publications, and studies with insufficient methodology or inconclusive data were excluded from the portfolio.

To complement the review, a case study was carried out whose locus is a small rural property located in the community of Linha Eduardo Chaves, in the municipality of Prudentópolis/PR. The case study identified the practices related to animal management, related to welfare and sustainable management of natural resources adopted on the property, with emphasis on the economic and productive impacts of their implementation. Data collection occurred through direct observation and semi-structured interviews with the owner, addressing issues related to animal management, use of natural resources and economic results.

RESULTS AND DISCUSSIONS

Family farming, according to Law No. 11,326/2006, are rural lands with up to four fiscal modules, predominant family labor, and significant income from the activities of the establishment. Family farming is prevalent globally, with about 500 million farmers involved (LOWDER et al., 2016). In Paraná, 81.63% of the establishments fit this model (IPARDES, 2008). Milk quality is evaluated by several indicators, and the volume produced affects the payment to the producer, as observed in the cooperatives in the Campos Gerais region (Wasana et al., 2015).

Milk production is present in all 399 municipalities in the state and is vital economically and socially, involving more than 110 thousand producers (VOLPI, 2018). The evaluation of the viability of agricultural activity depends on the analysis of costs, classified as fixed and variable, or according to the standards of the Institute of Applied Economics (Hoffmann et al., 1987)

Among recent researches, the high volatility of the selling prices of milk production stands out as one of the biggest problems and risks inherent to the activity. A possible explanation for this phenomenon is the significant amount of milk produced, which confers greater bargaining power to larger farms. In addition, the reduction of production costs, resulting from the scale effect, is an aspect that has been widely discussed in the literature (Lopes et al., 2007; Ferrazza et al., 2020; Ferrari & Braga, 2021; Bassotto *et al.*, 2021; Labiak; Stroparo, 2023)

Furthermore, it is possible to assess some relevant trends on the costs and economic performance of milk production in small rural properties, focusing on family farming. Initial data suggests that production costs vary significantly between the farms analyzed, with factors such as herd size, type of feed, and technologies used playing crucial roles in defining total costs. Research published by Parzonko et al. (2024) corroborates these assertions and indicates that the economic competitiveness of dairy farms is directly related to the efficient management of resources and the adoption of appropriate technologies. (Kreczkiuski; Stroparo, 2024)

In addition, production efficiency is directly related to the technical knowledge of farmers and the adoption of sustainable practices, such as proper pasture management and the use of efficient irrigation systems. This relationship is corroborated by Savickienė and Galnaitytė (2024), who highlight that properties that invest in modern technologies and in the training of their managers tend to have better economic performance. Stroparo Research, (2024); Stroparo *et al.*, (2024) also discuss the relationships between technology and production efficiency, although they are not directly related to dairy activity.

The results also point out that, although the challenges are significant, such as the volatility of milk prices and competition in the market, there are opportunities to improve profitability through diversification of activities and participation in cooperatives, which can offer better access to markets and cost reduction. Chand et al. (2015) point out that small-scale milk production contributes to food security and the resilience of rural families, which reinforces the importance of family farming in this context. (Amico, 2024)

National studies that consider Brazilian specificities can also be cited as Bassotto et al. (2021), Benedicto (2021), Merlo (2023) and Waquil (2024), which present discussions on

efficiency and risk in dairy farming, changes in the production systems of family farmers producing cattle milk in southern Brazil, the technical efficiency of family dairy farms in the State of Minas Gerais and also the main factors that affect the prospect of permanence of producers in the activity.

ANIMAL WELFARE

The discussion on animal welfare and the sustainable management of natural resources in small dairy farms highlights a significant relationship between practices that promote animal welfare and the economic and environmental viability of production (Ceballos; Sant'Anna, 2018; Labiak; Stroparo, 2023; Broom; Fraser, 2015; Broom, 1991). Animal welfare is understood to be the potentially measurable quality of a living animal at a given time and is therefore a scientific concept (Broom, 1991, 2011, 2014). The promotion of animal welfare goes beyond minimizing suffering; it includes ensuring conditions that allow animals to express natural behaviors and maintain physical and mental health, essential aspects for the sustainability of production (Broom, 2014)

RELATIONSHIP BETWEEN ANIMAL WELFARE AND SUSTAINABILITY

Indicators of well-being, such as adequate access to food and water, thermal comfort and socialization opportunities, are associated with increased productivity and reduced need for veterinary interventions (Broom, 1991). These factors decrease the operating cost and the use of medicines, contributing to the economic sustainability of the property. For small rural properties, these practices are advantageous not only from an ethical point of view, but also financially, by avoiding losses and waste. From the concept of animal welfare as proposed by Broom (1991), which includes the adaptation of animals to the environment and their behavioral responses, it becomes evident that environments that promote welfare improve productivity, as they avoid stressful conditions that compromise the health and quality of products

In this sense and based on theory, notably by the writings of Broom (1991) who spoke about animal welfare, a survey of the actions identified on the rural property, object of the research, was carried out. The data were collected on a rural property whose main economic activity is milk. Sustainable practices are adopted and it is intended in the short term to obtain certification of organic milk production. To this end, there is a legal framework that defines very strict rules regarding the production process, transparency regarding the inputs and food used, traceability, etc. Therefore, in this process of transition from

conventional to organic, some management practices were defined for adoption. The practices are described below:

Table 1. Management Practices

PRACTICE	DESCRIPTION
Rotational Grazing	Rotation of pastures to ensure access to fresh pastures reducing animal stress.
Comfortable Environments	Provision of shade, shelter and adequate spaces for rest, avoiding overcrowding.
Natural Food	Offer of natural and nutrient-rich pasture, without the use of industrialized feed.
Health Monitoring	Regular health checkups and minimization of painful practices such as tail docking.
Ethical Management	Respect for the natural cycle of animals, avoiding the excessive use of hormones and medications
Avoid Painful Procedures	Avoid or minimize painful procedures such as dehorning and tail docking
Parasite Control	Implementation of a preventive parasite control program and minimization of the use of chemical products, such as dewormers
Continuous Access to Drinking Water	Ensure that animals have constant access to clean, fresh water, especially in hot climates or periods of drought.

Source: The authors, (2024).

The table above lists some practices developed on the property whose objective is to improve animal welfare and increase financial results in the dairy activity developed. Such practices are in line with the recommendations of (Broom, 1991, 2011, 2011) who discusses the effects on animal welfare that although "... While it is not applicable to inanimate objects or plants, it is relevant to all animals because they have an ability to detect and respond quickly to impacts on environments, usually through the functioning of their nervous system.

Proper management that favors animal welfare reduces anomalous behaviors such as stereotypies and aggressions, which can be caused by inadequate and restrictive environments (Broom & Molento, 2004). On small farms, where resources for veterinary intervention and medications are often limited, practices that prioritize welfare minimize costs by improving the physical condition of animals and reducing the incidence of disease, In addition, animal welfare has become a criterion valued by consumers, who demand ethical and quality products, creating a competitive advantage for producers who adopt these practices (Mellor, 2016).

Next, there was a need to raise the costs of sustainable actions. There was a need to adapt the pastures that were already planned within the principles of pasture optimization. The most significant costs refer to adaptations to comfortable environments, as follows:

Table 2. Costs with Implementation of Sustainable Practices

Practice	Startup Costs (R$)
Rotational Grazing	10,000 to 15,000 per hectare
Comfortable Environments	30,000.00 to 60,000.00
Natural Food	2,500 to 5,000 per hectare
Health Monitoring	5,000 to 10,000 annually
Ethical Management	1,500 to 3,000
Parasite Control	2,000 to 4,000 annually
Continuous Access to Drinking Water	3,000 to 7,000

Source: The authors, (2024).

It can be seen in the table above, that despite the advantages, the implementation of welfare practices in small dairy farms presents challenges, such as the initial investment in adequate facilities and the training of producers. However, the increased demand for ethical and sustainable products points to an opportunity to add value to the final product. According to Ceballos and Sant'Anna (2018), production ethics and socio-environmental responsibility have become strategic components in the production chain, and animal welfare is an increasingly demanded criterion in the consumer market.

However, for the analysis to be coherent, it is necessary to verify whether such actions have resulted in improvements not only in the conditions of the animals, but in financial return, translating into increased productivity, decreased need for medicines and complications in the health of the animals, etc.

Table 3. Comparative Results

Indicator	Before the Practices	After Implementing the Practices
Productivity (litres of milk/animal)	15 litres/animal	17 litres/animal (increase of approximately 13%)
Somatic Cell Count	High Count	Significant reduction
Veterinary Drug Expenditure	High Expense	20-30% reduction
Herd Replenishment Frequency	High annual replenishment	Replenishment every 1.5 years
Milk Quality (protein and fat contents)	Medium standard	High levels (increased quality)
Expenditure on Industrial Feed	Reliance on industrial feed	15-25% reduction
Return on Investment (months)	No return guaranteed	Return in 12-18 months
Contribution Margin (%)	Low margin	10-20% increase
Cost Per Liter of Milk	High custo per liter	8-12% reduction

Source: The authors, (2024).

Among the observable results, there was an increase in productivity of approximately 13%, due to the improvement in animal welfare conditions and adjustments in housing and natural feeding. It was also found that there was an increase in the fat content in the milk that can be attributed to the practices of rotational grazing and natural feeding.

On the other hand, the somatic cell count reflects an improvement in the quality of health of the animals, notably mastitis, which can be corroborated by the decrease in spending on veterinary drugs and/or medical interventions.

As for the financial aspects, there was an increase in the contribution margin between 10% and 20% as a result of the decrease in direct costs and increased production efficiency. Investments in good practices and animal welfare have a projected return (ROI) between 12 and 18 months.

FINAL CONSIDERATIONS

The article showed that the implementation of animal welfare practices and sustainable management of natural resources in small dairy farms can positively impact productivity, reduce costs and increase profitability. With the approximately 13% increase in milk productivity per animal and the improvement in milk quality, it is observed that practices such as rotational grazing, natural feeding, and ethical animal management contribute significantly to a more efficient and valued production.

The reduction in input expenses, including a decrease of up to 30% in veterinary drug costs and a 15% to 25% saving in industrial feed, reinforces that these sustainable practices have the potential to reduce operating expenses and improve the economic efficiency of dairy farming. In addition, the lower frequency of replacement of the herd.

In this way, the results point out that animal welfare and sustainability practices not only promote more environmentally and socially responsible production, but are capable of improving economic viability and ensuring greater resilience to small dairy producers. These findings reinforce the importance of public policies and training programs that encourage the adoption of sustainable practices and provide the necessary support for small producers to invest and enjoy the benefits of sustainable and efficient dairy production.

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