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Strategies for mitigating the carbon footprint of milk production in the South and Southeast of Brazil

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1. INTRODUCTION

Livestock production faces the challenge of reducing greenhouse gas (GHG) emissions without compromising productivity. Brazil has the third-largest milk production in the world; however, animal productivity is low, with around 2600 kg milk/cow/year (Andrade et al., 2023). The country's climate regions and social and economic diversity influence the environmental impact of dairy production in Brazil. Despite this, it is necessary to improve milk production efficiency, such as increasing individual productivity and optimizing herd composition by increasing the proportion of dairy cows. The construction of environmental metrics for milk production is the way to identify strategies to reduce the carbon footprint of milk. The estimate of a milk's carbon footprint is complex because it relates a large amount of direct and indirect data associated with the product system. Life Cycle Assessment (LCA) is a standardized and internationally recognized method that supports science-based decision-making and the development of strategies to reduce environmental impact (IDF, 2022). This study aimed to estimate the carbon footprint of milk from farms in southeastern and southern Brazil and to evaluate strategies focused on enteric CH_4 mitigation.

2. METHODS

The study used data from 400 farms in Brazil's southeast and south regions, which account for 67.7% of the country's milk production. farm data was collected from the research project carried out by Embrapa Cattle Dairy, between 2021 and 2023, considering diversified production systems. The study followed the ISO 14040 and ISO 1044 (ISO, 2006) guidelines for LCA and adopted the cradle-to-farm-gate boundary. The IPCC (2019) equations were used to estimate GHG emissions. The functional unit used was 1 kg of fat and protein-corrected milk (FPCM) (IDF, 2022).

To design the scenarios, identified critical points that affect the carbon footprint of milk production were considered, such as low individual productivity and the proportion of animals in production (% lactating cows) and other categories of the herd (% dry cows, heifers, and dairy calves). Therefore, it was hypothesized these factors could be used to achieve a reduced carbon footprint in milk production. The milking rate of cows achieved by better reproductive efficiency can leverage the reduction of methane emissions (Abreu et al., 2023). Based on the two factors, scenarios were applied to fixing the herd composition to 49% dairy cows, and to adjust 7% dry cows, 21% heifers, and 23% dairy calves, and a 10% increase in milk production per cow for the farms studied. The calculations were carried out using the OpenLCA version 1.11 software for impact analysis in the climate change category.

3. RESULTS AND DISCUSSION

Milk yield ranged from 5.05 to 43.7 kg FPCM cow^{-1}. day^{-1} (average 19.5 kg FPCM cow^{-1} day^{-1}). The proportion of lactating cows ranged from 25.2 to 67.3% (average 48.2%). The milk carbon footprint averaged 1.44 and a weighted average of 1.02 kg of CO_2 eq. kg $FPCM^{-1}$, a figure lower than that presented in the IFCN report, which was 2.16 kg of CO_2 kg $FPCM^{-1}$ for Brazilian milk (IFCN, 2022). Enteric CH_4 emissions accounted for 69% (30-95%) of the total GHG emissions. The main sources of variability were herd composition, animal productivity, and diet quality. The data variability shows heterogeneity of the dairy systems and the opportunity to improve herd composition and cow's milk yield.

The CH_4 emissions were reduced by 35% caused by a reduction of 12% in the total number of cattle in the farms. However, emissions from feed production were less influenced, 11%, due to the higher food intake from the lactating cows (49% herd cattle). The milk carbon footprint ranged from 0.42 to 7,03 kg of CO_2 eq. kg $FPCM^{-1}$, with an average of 1.01 and a weighted average of 0.92 kg of CO_2 eq. kg $FPCM^{-1}$.

4. CONCLUSIONS

The study showed that in the proposed scenario, it is possible to achieve the objective of reducing CH4 emissions by more than 35%, reaching the goal of the Global Methane Pledge, and reducing the carbon footprint by 30%.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

Andrade, R. G., de Magalhães Oliveira, S. J., Hott, M. C., de Magalhães Junior, W. C. P., Carvalho, G. R., & da Rocha, D. T. (2023). Evolução recente da produção e da produtividade leiteira no Brasil. Revista Foco, 16(5), e1888-e1888.

Baruselli, P. S., Abreu, L. Â. D., Paula, V. R. D., Carvalho, B., Gricio, E. A., Mori, F. K., ... & D'Occhio, M. (2023). Applying assisted reproductive technology and reproductive management to reduce CO 2-equivalent emission in dairy and beef cattle: a review. Animal Reproduction, 20, e20230060. https://doi.org/10.1590/1984-3143-AR2023-0060

IDF-International Dairy Federation. The IDF global Carbon Footprint standard for the dairy sector. https://doi.org/10.56169/FKRK7166. Accessed on 30 Dez 2023.

IFCN-International Farm Comparison Network. Annual Dairy Sector Database Long-term Dairy Outlook 2050.

ISO-International Organization for Standardization (2006a) Environmental Management- Life Cycle Assessment - Principles and Framework ISO 14040.

ISO-International Organization for Standardization (2006b) Environmental Management - Life Cycle Assessment - Requirements and Guidelines ISO 14044.

Table 1. Carbon footprint and enteric CH4 emissions of milk in baseline and scenario for increasing yield per cow and optimizing herd composition.

	Carbon footprint (kg of CO2 eq. kg FPCM-1)			Enteric CH_4 emissions (kg of CO2 eq. kg FPCM-1)		
	Mean	Weighted mean	Range (max-min)	Mean	Weighted mean	Range (max-min)
Baseline	**1.44**	**0.92**	**9.63-0.43**	**1.01**	**0.65**	**3.57-0.39**
Scenario	**1.01**	**0.85**	**7.03-0.42**	**0.65**	**0.56**	**2.09-0.30**

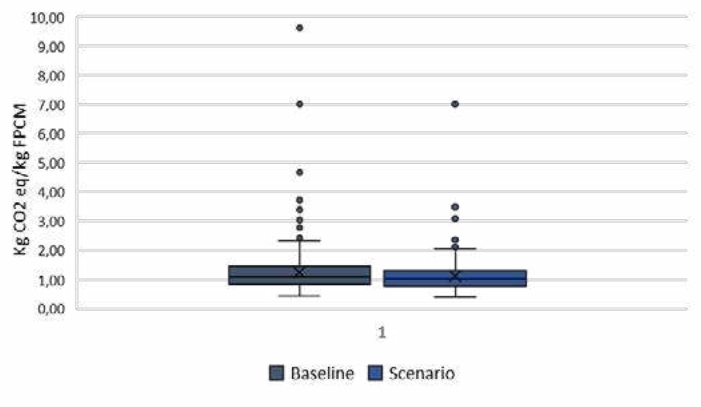

Figure 1. Box plot to show the variation in the carbon footprint of the milk production of the 400 farms in the baseline and scenario for increasing yield per cow and optimizing herd composition