Reducing the carbon footprint of the milk and the weaned beef calf using a beef-on-dairy system

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Palavras-chaves:

Sustainability, Animal welfare, Livestock production

Introdução:

Livestock systems face increasing pressure to reduce greenhouse gas (GHG) emissions, particularly methane from enteric fermentation and manure. Global beef demand is projected to reach 84 million tons by the next decade (FAO, 2025), intensifying the need for more sustainable production models. Dairy systems are also criticized for low-value male calves and welfare concerns. Integrated co-production systems, such as beef-on-dairy, represent a viable strategy to mitigate these issues by producing both milk and high-value crossbred calves for beef within a single system. The use of beef semen in dairy cows allows a partial redistribution of the carbon footprint (CF) between milk and meat (Laca *et al.*, 2023), increasing resource-use efficiency and reducing emissions intensity per product while addressing dairy ethical concerns. This study aimed to model the CF associated with milk and meat production in a Brazilian beef-on-dairy system.

Material e Métodos:

The study followed the ISO 14040 and ISO 14044 (ISO, 2006a,b) guidelines for Life Cycle Assessment (LCA), using a cradle-to-farm-gate boundary. Data were based on 2024 records from a dairy farm in a free-stall confinement system, located in Minas Gerais, Brazil. The farm has, on average, 120 Holstein cows, a productivity of 35.6 kg of milk/cow/day, 8 % dry cows, and a calving interval of 13 months. The herd operated in a steady state structure of 245 animals, 50% lactating cows, a 30% replacement rate (39 heifers/year), 8% calve-to-heifer mortality, and 95% sexed semen accuracy. The crossbred beef calves were weaned and left the system at three

months of age (120 kg) and were raised to 9 months of age (350 kg) in a beef production system. Data modeling and CO_2 equivalent emissions estimations were carried out using OpenLCA 3.11.1 software. Diets and supplies were adjusted proportionally to the herd size in the scenario that included the beef-on-dairy calves. Results were expressed as kilograms of CO_2 equivalent per kilogram of fat- and protein-corrected milk (kg CO_2eq/FPCM) and per kilogram of live weight (kg CO_2eq/LW). The meat CF was obtained in the LCA reference database from calf-raising systems in Brazil (Folegatti Matsuura & Picoli, 2018).

Resultados e Discussão:

The implementation of sexed semen and beef-on-dairy strategies shifted calf distribution from 100% Holstein to 37% Holstein and 63% crossbred beef calves, removing 16 surplus heifers and enabling the sale of 75 crossbred calves. This scenario led to a 12% reduction in GHG emissions from milk production in confinement systems (1.03 vs. 1.17 kg CO_2eq/FPCM, Figure 1). For meat, the CF of crossbred calves was 13.2 kg CO_2eq/LW (Figure 2), 68% lower than pasture-based beef systems (41.4 kg CO_2eq/LW, Folegatti Matsuura & Picoli, 2018) and 53% lower than supplemented systems (28.5 kg CO_2eq/LW, Folegatti Matsuura & Picoli, 2018). Integrating beef production into dairy systems improves resource efficiency, reduces emissions, and mitigates animal welfare concerns. Traditional cow-calf beef systems have higher emissions due to greater land use and maintenance requirements for breeding cows (Folegatti Matsuura & Picoli, 2018). In contrast, beef-on-dairy leverages existing dairy infrastructure, enhancing productivity. Although based on a modeled scenario and not accounting for carcass traits, the results demonstrate the potential of beef-on-dairy systems to improve environmental sustainability while meeting rising global demand for high-quality animal protein.

Agradecimentos:

We thank the Embrapa team and the Young Cattle Network for their valuable contributions to this work. Fapemig and CNPq for providing student scholarships, and Danone for the financial support.

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Figure 1. Model carbon footprint of a beef-on-dairy and conventional confinement dairy system based on kg of CO2 equivalent produced based on fat and protein-corrected milk.

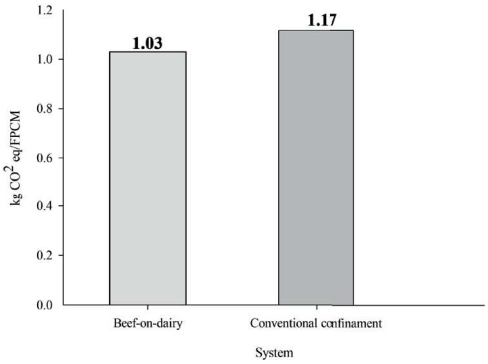

Figure 2. Model carbon footprint of a beef-on-dairy, pasture-based, and supplemented pasture-based beef system based on kg of CO2 equivalent produced based on live weight.