LOW CARBON BEEF IN ICLS

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Abstract: Beef farming can have important environmental impacts especially related to greenhouse gas (GHG) emissions when associated to deforestation, low yields and pasture degradation. However, under good practices, its benefits go far beyond food production and carbon sequestration itself, being part of human life since ancient times. Regarding carbon, grazing cattle has great potential for fixing C in the soil, which is mostly disregarded by simplistic assessments. Today, Brazilian cattle farming is under pressure from the international community, since they link it to deforestation and increasing negative impacts related to GHG emissions. This article addresses Brazilian integrated crop-livestock systems (ICLS) developed for more efficient beef cattle production through land saving and good agricultural practices, reducing environmental impact and carbon emissions, under a conservationist approach towards a zero-carbon economic activity, following the global agenda for tackling climate change.

Key words: Carbon sequestration; Land-saving effect; Agricultural diversification; Sustainability.

Introduction

From the mid-2000s onwards, Brazil suffered strong international pressure due to deforestation, especially in the Amazon, linked to beef cattle farming. This recurring situation culminated in the Beef Moratorium and the G4 Agreement, in 2009, involving the largest Brazilian beef processors, NGOs, the Federal Public Prosecutors Office and many retailers. This agreement helped to reduce annual deforestation rate in the Legal Amazon from around 2 million hectares, in 2001-2005, to less than 0.5 million hectares from 2010 and onwards (Soendergaard et al., 2021). Furthermore, the Brazilian government proposed during the 2009 COP-15 in Copenhagen, the bases of what would be the National Plan for Low Carbon Emission Agriculture (ABC Plan), as a strategy to mitigate GHG emissions from agriculture, involving agricultural processes that mitigate GHG, in addition to tackling deforestation. ICLS was one of the processes chosen, and the proposed goal for the period from 2010 to 2020 was to increase an area of 4 million hectares with these systems, in addition to the 2 million hectares existing at the time (Brasil, 2012). According to estimates from the *Rede ILPF* (2020), in the 2020/2021 season, Brazil had around 17.43 million hectares with ICLS. According to Chiari et al. (2021), the land-saving effect promoted by ICLS in the 2015/2016 season was around 3.45 million hectares. Considering the area from 2020/2021 season, the land saving effect would be around 5.22 million hectares. With the successful adoption of ICLS by farmers, the Brazilian government, in the new edition of the ABC Plan, called ABC+ Plan, proposed as a new target for 2030, an increase of another 10 million hectares with ICLS (Brazil, 2021b). In this article, we will discuss the importance of ICLS in GHG mitigation and the prospects for reaching zero-carbon balance, with a focus on beef cattle.

Carbon in the context of beef cattle farming

Beef emits GHG, considering the production process, within the farm, major emissions are enteric methane, animal waste, the use of nitrogen fertilizers and liming, soil management, dry feed and of fossil fuels. However, grazing cattle also make an important contribution to carbon removal, as pastures have great potential to accumulate carbon in the soil, in addition to ICLS with trees, which expand the possibilities of carbon sequestration in the trunk. Another important point to consider for Brazil is that the country has robust environmental laws, called the new Forest Code (Brasil, 2012), which determines areas for protection of native vegetation on rural properties, called Legal Reserve. Its proportions vary depending on biome, being 80% reserve in the Legal Amazon area, 35% in the Cerrado within Amazon boundaries and 20% for the rest of the country. In this context, the Legal Reserve surplus can contribute for reducing carbon footprint of agricultural products, such as beef, or even be a reason for paying environmental services and opportunities for carbon compensation and generation of carbon credits.

For technical-scientific support to the ABC Plan, the Brazilian Agricultural Research Corporation (Embrapa) was responsible for coordinating a large research network, with partner institutions from Brazil and abroad, to study the dynamics of GHG in agricultural production systems in the six Brazilian biomes, the Pecus Network. Regional ICLS were evaluated within the scope of this Network, with results indicating the socio-environmental viability of these systems, in addition to emission factors for Brazilian conditions (Brazil, 2021a). In 2015, Embrapa created the first trademark/brand for a carbon-related livestock product, Carbon Neutral Brazilian Beef (Alves et al., 2017), with the subsequent development of a production protocol, resulted in the launch of this brand for the Brazilian market in 2020, in partnership with Marfrig Global Foods (Cipriano et al., 2020). This protocol was developed for use in ICLS with the presence of planted trees, responsible for removing carbon to compensate emissions from animals in the system (Alves et al., 2017). Studies with brands continued and led to the development of another production protocol, called Low Carbon Brazilian Beef (Almeida & Alves, 2020), for use in pastoral systems and in ICLS without trees, where the soil is responsible for C-sequestration, mitigating system's emissions. Both protocols are associated with an MRV process with third-party certification, involving good agricultural practices, traceability and for use in consolidated areas, without deforestation and without the use of fire.

Silva et al. (2016), in a modeling study on livestock systems in the Brazilian Cerrado, indicated that with the increase in demand for beef, cattle systems tend to be more intensive and efficient, increasing soil carbon stocks, reducing either per kilogram beef or total emissions. Oliveira et al. (2023), in a systematic review on ICLS in the Brazilian Cerrado, observed higher rates of soil carbon accumulation for ICLS without trees, in the 0.00-0.10 m depth layer, with values of 0.59 ± 0.66 Mg ha^{-1} yr^{-1} and, for ICLS with trees, in the 0.00-1.00 m depth layer, 1.00 ± 1.47 Mg ha^{-1} yr^{-1}.

A study by FGV (2019) evaluated the carbon footprint of Brazilian beef exported to the European Union, with data from 23 farms located in five states in the country (GO, MG, MS, MT and SP). The carbon footprint ranged from 27 to 99 kg CO_2e per kg boneless beef, with emissions related to land use change (deforestation) reaching values between 11 and 59 kg CO_2e per kg boneless beef, representing up to 60% emissions in some cases. Among GHGs, enteric methane contributed 34 to 83% of farm emissions. On farms in non-deforested regions, the carbon footprint of meat was 27 to 45 kg CO_2e per kg boneless beef.

Estevam et al. (2023), evaluating the carbon footprint of "China Beef" produced in Brazil, slaughtered up to 30 months old, and considering carbon removal through pasture, observed values of

24 kg CO_2e per kg boneless beef. These values are close to the value presented by beef produced in New Zealand (whose production systems are pasture-based, similar to Brazil), of 23.1 kg CO_2e per kg boneless beef, according to a study carried out by the Meat Industry Association (MIA, 2022).

Figueiredo et al. (2017), estimated the carbon footprint of beef in well-managed pasture and in ICLS with trees (eucalyptus), in Brazil, for a period of 10 years, at 9.4 and 12.6 kg CO_2e per kg LW, respectively. When soil and tree removals were factored in, the carbon footprint of beef was reduced to 7.6 and -28.1 kg CO_2e per kg LW, respectively.

Cusack et al. (2021) carried out a systematic review on reducing the climate impacts of beef production in different regions of the world, based on life cycle analysis studies. For Brazil, they observed that management strategies for carbon sequestration and improving system efficiency reduced GHG emissions from beef by 57%. Among the strategies studied, Integrated Field Management, which includes ICLS, was the most effective, reducing GHG emissions per unit of beef by 62 ± 9% and reducing GHG emissions from beef per unit of land by 112 ± 39 %, being the only promising strategy for producing beef with zero or negative net emissions, with 73% of studies in this category being from Brazil, according to the authors.

Werner et al. (2014) related the nutrient density of various foods to their GHG emission and observed that the lowest index was that of beef (0.06), compared to pork (0.33), cod (0.35), eggs (1.10), poultry (1.19) and beans (2.17), among others. Emissions from beef were the highest, however, it also had the highest nutrient density among the foods studied, indicating another approach to be considered with the issue of GHG emissions from beef.

Closing comments

Brazil has technologies, environmental legislation and public policies aimed at productive beef cattle farming with low carbon emissions, with a focus on net zero carbon balance. Greater effort is needed to fight illegal deforestation and to continue encouraging cattle systems improvement. The area with integrated systems in Brazil has been growing since the last decade and tends to continue, mainly, over areas of degraded pastures with good climate and soil potential, contributing to a lower environmental impact of agriculture, promoting land-saving, and reducing need for clearing native vegetation.

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