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Livestock-derived greenhouse gas emissions in a diversified grazing system in the endangered Pampa biome, Southern Brazil

Kaio Vasconcelos[a], Maycon Farinha[b], Luciana Bernardo[c], Vinicius do N. Lampert[d], Miguelangelo Gianezini[e], Jaqueline Severino da Costa[b], Adelsom Soares Filho[f], Teresa Cristina Moraes Genro[d], Clandio Favarini Ruviaro[b,*]

[a] Universidade Tecnológica Federal do Paraná (UTFPR), Departamento de Engenharia Mecânica e de Materiais, Brazil
[b] Faculdade de Administração, Ciências Contábeis e Economia, Universidade Federal da Grande Dourados (UFGD), Rodovia Dourados-Itahum Km 12, Caixa Postal – 364, 79804-970, Dourados, MS, Brazil
[c] Universidade Estadual do Oeste do Paraná, UNIOESTE, Brazil
[d] Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), Bagé, RS, Brazil
[e] Universidade do Extremo Sul Catarinense, Unesc, Brazil
[f] Faculdade de Ciências Humanas, Universidade Federal da Grande Dourados, UFGD, Brazil

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ABSTRACT

Discussions about climate change have repeatedly regarded livestock as responsible for a significant contribution of greenhouse gas emissions. However, proper management schemes for livestock production may contribute to a reduction in emissions and, at the same time, induce optimization of production systems and intensification of food production. In addition, it contributes to the preservation of the local biome, since it promotes the maintenance of services related to the conservation of water resources, pollination, and provision of genetic resources, among others, which help in the development of economic activities. Therefore, this study aims to analyze beef cattle production in the southern region of Brazil, in the western region of Rio Grande do Sul state, focusing on the three most used grass management systems in the Pampa biome: Native Pasture, Fertilized Native Pasture and Improved Native Pasture. Combinations between the systems were made, resulting in different stocking rate/hectare, age, slaughter weights and greenhouse gas emissions of animals. The interpolation between Native Pasture and Fertilized Native Pasture or Improved Native Pasture showed that changes in grazing system lead to a reduction of approximately 29% in equivalent CO_2 emissions per kg of live animal weight. The results point to some possible actions that allow a reduction of the main greenhouse gases arising from livestock production in that biome. Results also evidence that management adaptations contribute to the maintenance of the Pampa biome characteristics.

1. Introduction

Intensive beef cattle production has contributed significantly to the development of the Brazilian beef sector since it favors a rational use of the factors production, potential and genetic diversity in animal and plant life (Alencar and Pott, 2003; Oliveira et al., 2017; Silva et al., 2017). In the Brazilian southern region, specifically in the state of Rio Grande do Sul, there were approximately 13.5 million animals in 2016 (IBGE, 2017), whose feeding is based on natural pastures of the Pampa biome. This biome has a high biodiversity and presents variations in leaf growth rates throughout the year (Behling et al., 2009; Carvalho and Batello, 2009).

The economic activity of beef cattle has contributed to the development of pastures in the Pampa biome because of the adequate animal stock that contributes to the maintenance of the flora. However, the land use change in agricultural activities is a threat to this biome due to the replacement of natural plant composition for agricultural crops with characteristics distinct from those of that biome (Oliveira et al., 2017; Ruviaro et al., 2016).

It was identified that 62% of the territory of the state of Rio Grande do Sul comprises the Pampa biome (IBGE, 2004). Its animal and plant diversity reinforce the importance of ecosystem services provided by it. There are services related to the conservation of water resources, pollination, provision of genetic resources, among others, which help in the development of local economic activities (Pillar et al., 2009). Thus, there is a complex environmental interconnection in this biome (Echer

* Corresponding author.
E-mail address: clandioruviaro@ufgd.edu.br (C.F. Ruviaro).

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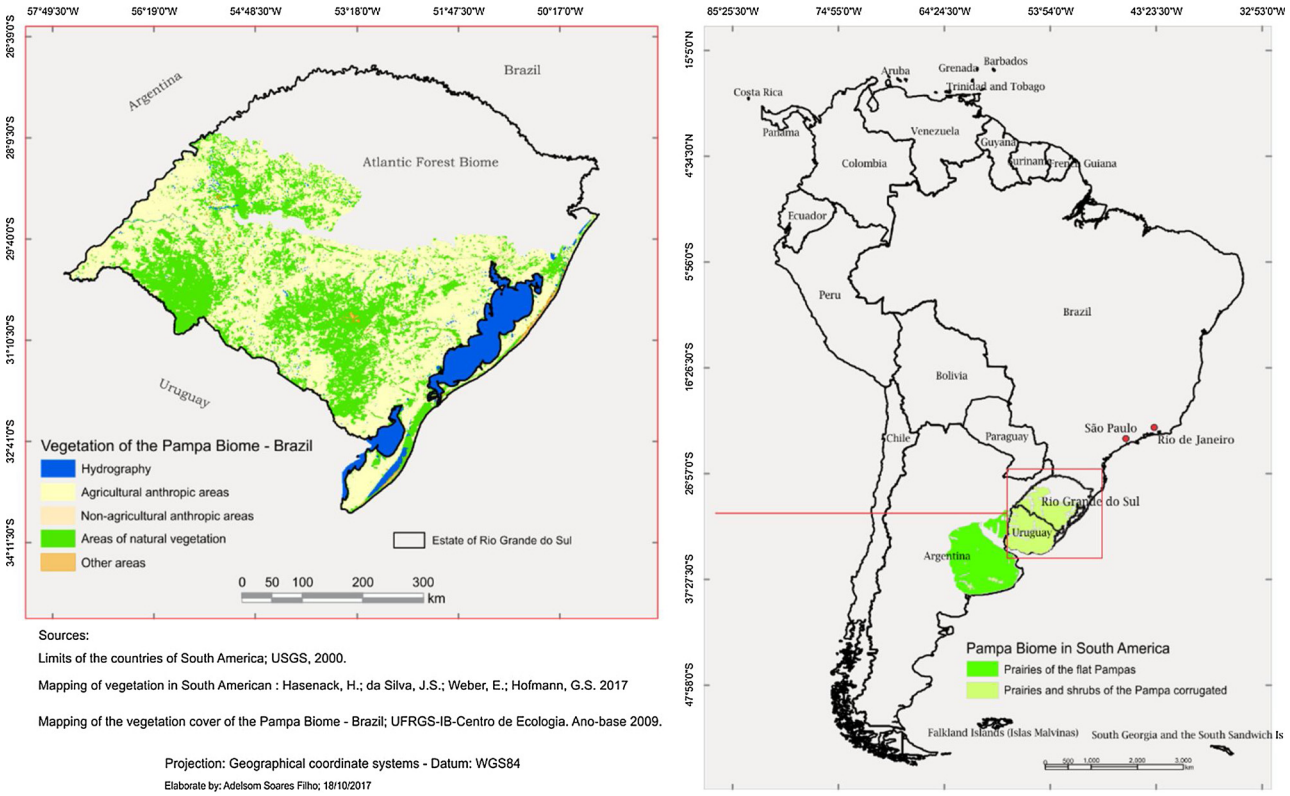

Fig. 1. Location of the Pampa Biome in the state of Rio Grande do Sul, Brazil.

et al., 2015).

A predominance of the grassland ecosystem in the Pampa biome is observed, in which grasses form the preponderant vegetation. Near to water resources, the vegetation is denser, with the presence of trees. In addition, there are mainly flooded areas in regions closer to the coast. In relation to the climate, considered subtropical, the thermal amplitude allows the occurrence of frosts outside winter, and a summer temperature of 35 degrees Celsius (MMA, IBAMA, 2011).

The characteristic of the vegetation makes the biome relevant for beef cattle breeding in the Rio Grande do Sul, considering that the feeding of animals is based on a combination of fodder and/or concentrated inputs to reach an appropriate nutritional balance in order to optimize its performance. For example, the Pampa biome has summer cycle subtropical species that are able to promote weight gains of up to 1 kilo per animal per day during the period of high forage production (Ferreira et al., 2011), as in the spring and summer. However, during autumn and winter, there is a low production and a low nutritional quality of natural pastures, and it may be necessary to use dietary supplementation (Ruviaro et al., 2015). Another benefit of beef cattle production based on natural pasture in the Pampa biome, compared to the confined system, is the high concentration of linoleic acid, which has antioxidant and anti-catabolic properties when ingested by humans. The meat of calves raised in natural pastures in the south of Brazil, slaughtered at two years, is lean (47 mg of cholesterol per 100 g of meat) and has a low concentration of oleic acid (fatty acids) when compared to confined animals (Lobato et al., 2014).

However, the enteric fermentation of ruminants contributes to global warming due to methane emission. It is estimated that, on a global scale, it accounts for between 20 and 25 percent of anthropogenic methane emissions (Thorpe, 2009). On the other hand, it is noted that in the last years, a sense of ecological responsibility permeates the context of agricultural production due to climate changes that have occurred in the last decades. Thus, the need to rethink practices and attitudes in such production systems is pressing in order to minimize the impacts of humans and their activities on the planet (Dick et al., 2015aa,b).

Thus, we analyzed beef cattle breeding in Rio Grande do Sul from an environmental perspective considering the three most used grazing systems in the Pampa biome: Native Pasture (NP), Fertilized Native Pasture (FNP) and Improved Native Pasture (INP).

2. Materials and methods

In this study, we used Life Cycle Assessment (LCA), which is a tool to measure possible environmental impacts caused by the production and use of a given product. Life cycle refers to all stages of production and use of a product regarding the extraction of raw materials, production and distribution, up to consumption and final disposal, also contemplating recycling and reuse when applicable (ISO, 2009).

While much is stated about climate change and carbon dioxide emissions (CO_2), they are not the only types of possible environmental impacts during a production process. The production of any product may reach the environment in different ways. In this sense, the flows of matter and energy involved in the life cycle of a product are measured, and related to various categories of environmental impacts. In the end, it is possible to understand what the damages or benefits are using a specific process or product (UNEP, 2011).

Moreover, the methodology is fundamentally quantitative, which allows results to reflect categories of impact and even comparisons between similar products or processes. This makes it possible to identify critical points in the life cycle of a product, and thus promote improvements in production processes. In addition, it is a multidisciplinary methodology since it covers several areas of knowledge. It is also multi-criteria, since it provides an evaluation of many categories of impact at a same time.

The main representative systems of cattle production used in the Pampa biome were evaluated by LCA, as well as the interaction between them. Primary data were collected in areas belonging to Embrapa (CPPSul Unit, Bagé - RS), and at the Experimental Station of the Federal University of Rio Grande do Sul (UFRGS, Eldorado do Sul,