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Economic and environmental feasibility of beef production in different feed management systems in the Pampa biome, southern Brazil

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ABSTRACT

The economic and environmental sustainability of beef cattle from pasture use and preservation in specific biomes is still not well evaluated. In this context, the study of the feasibility of beef production in the Pampa biome stands out because of its relevance in southern Brazil. Thus, this paper aims not only to know the amount of greenhouse gases emitted in different feeding management systems of beef cattle, but also to evaluate the economic and environmental feasibility of that production. Seven typical production systems in the region were considered, and it was aimed to determine which one would be the most viable in the environmental and economic perspective. To achieve this aim, the paper was developed in two stages: the first considers greenhouse gases emissions calculation in all systems and; the second uses some investment analysis tools, such as the net present value (NPV), the internal rate of return (IRR) and the annualized profitability index (API). According to the results obtained from system production VII it is possible to optimize low greenhouse gases emission of beef production with a significant economic return, under certain feed conditions. Furthermore, the results verified from system production II it is possible to obtain beef production increases without the need of new livestock areas, and contribute to the proper use and preservation of the Pampa biome.

1. Introduction

The Brazilian beef industry has been under pressure from national and international organizations because the global warming issues. Through estimates, it is argued that beef production is responsible for more than half of GHG emissions of the national agricultural sector (Ruviaro et al., 2014a). Besides, the Brazilian beef cattle industry can become one of the key sources of GHG mitigation and improve the Brazilian economy. (Latawiec et al., 2014).

In 2013, Brazil had 211 million heads of cattle distributed on 160 million hectares of pastures. In the same year, 34 million heads were slaughtered, what corresponds to almost 27% of Brazilian agribusiness Gross Domestic Product (GDP). Furthermore, the country was the largest beef exporter, transacting approximately US$ 5359 billion, exceeding 2012, when the amount was of US$ 4495 billion, with an increase of 19.2% (USDA, 2014).

Taking into account cattle importance to Brazil and the rest of the world, a relevant discussion on the environmental impacts of greenhouse gas emissions (GHG) by this sector emerges. GHG global emissions generated by livestock are equivalent to 7.1 gigatons of CO_2 per year, what corresponds to 14.5% of all GHG generated by anthropic sources. From cattle total amount, 41% of GHG emissions are from beef cattle responsibility, indicating this activity importance for economy and its role in global climate changes (Gerber et al., 2013).

Much of the research on GHG has as information source a methodology called product Life Cycle Assessment (LCA). Kramer et al. (1999) highlights how LCA methodology can contribute measuring agriculture impacts, considering an entire agricultural production chain.

Ruviaro et al. (2012) used this method to measure beef cattle environmental impacts in the state of Rio Grande do Sul. However, solely to check which systems types emit more GHG is not sufficient because according to Nabinger et al. (2009), the farmer should receive some remuneration since the production is based on natural pastures which can be considered as an environmental service or a natural resources preservation. Wirsenius et al. (2011) points out that especially in developing countries, there is still

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substantial room for profitable agricultural activity improvement, thus contributing to GHG mitigation.

Currently, due to global warming, it is necessary to examine ways to evaluate and compensate the farmer who opts for a more sustainable beef production management. Veysset et al. (2010) point out that economic and environmental assessments are inseparable in today's farming. In this sense, the objective of this study is to assess seven beef cattle production systems in Southern Brazil, and point the system with the best economic viability, considering its GHG emissions.

1.1. Background

The Pampa biome consists of very old grasslands, covering an area of 178,243 km^2 and covering the whole Uruguay territory, a part of Argentina's and about two-thirds of Rio Grande do Sul state in southern Brazil (Suertegaray and Pires Da Silva, 2009; Overbeck et al., 2007; Hasenack et al., 2007). A meadow mosaic, with small scrub vegetation areas and forests (Overbeck et al., 2009; Behling et al., 2009), characterizes its natural vegetation.

Pampa biome main developed economic activity is extensive livestock farming, since its low fertility soils render agricultural production (Ribaski et al., 2010; Santos and Trevisan, 2009; Thurow et al., 2009). Livestock production is based mainly in *Bos taurus* breeds, such as Hereford, Aberdeen Angus, Simmental and Charolais (Latawiec et al., 2014), in native grassland with continuous and extensive animal grazing, consisting of more than 500 grasses species and 250 legume species (Carvalho et al., 2009; Boldrini, 2006).

From the socioeconomic point of view, low extensive livestock productivity rates result in local economy minimal returns, causing low population density and lower development compared to other regions of the state, especially when comparing indexes, such as GDP *per capita* and job generation (Reis, 2009; Santos and Trevisan, 2009).

Cattle grazing native pasture is seen as the main conservation tool, as it keeps Pampa biome flora and fauna diversity when preventing agricultural frontier advances (Brandão et al., 2012; Soussana, 2009). However, inappropriate livestock management in this region due to excessive grazing stocking rate during the winter, generates animal weight loss, as well as soil cover negative consequences, contributing to grassland degradation (Overbeck et al., 2009; Carvalho et al., 2009; Soussana, 2009).

Brazilian beef industry has suffered pressure from national and international agencies concerned with global warming, through estimates that beef production is responsible for more than half of the national agricultural sector GHG emissions (Ruviaro et al., 2014a; Gianezini et al., 2014; Ruviaro et al., 2014b). According to Beauchemin et al. (2008), among greenhouse gases, the most important is methane (CH_4).

Livestock GHG emissions come from several processes, such as ruminants enteric fermentation (CH_4) and animal waste (CH_4 and N_2O – nitrous oxide) (Balbino et al., 2011). Enteric fermentation occurs through CH_4 release during animal breathing or belching, due to microbial fermentation occurred in digestion (Cuéllar and Webber, 2008). Methane emissions by enteric fermentation are correlated with animal feed, and may considerably differ between animals subjected to the same feed (Wirsenius et al., 2011). In Brazil, approximately 70% of CH_4 emissions come from cattle, resulting from energy contained in feed inefficient capture physiological process during their digestive process (Ruviaro et al., 2014b; MCT, 2010).

Pastures proper management and animal feed quality improvement in Pampa biome native grasslands allow its conservation, farmers' higher economic returns and GHG production reduce due to decrease in animals' grazing period (Becoña et al., 2014; Balbino et al., 2011; Carvalho et al., 2009). Wirsenius et al. (2011) point out that, in many parts of Europe, cattle and sheep grazing are extremely important for landscape and biodiversity conservation. However, the remuneration received by the farmer is based on natural pastures production and results only from animals' sale, without any financial compensation for natural resources preservation (Nabinger et al., 2009). According to Latawiec et al. (2014), benefits implementation to producers that use sustainable and intensified grazing systems can generate a strong economic incentive to transition from an extensive livestock to intensive activity.

According to Picasso et al. (2014), GHG emission estimations in Uruguay Pampa native grassland production systems are very high, with great potential for emission reduction. The combination of technologies, appropriate management and forage offer optimization can increase animals' productivity and reduce allocated emissions per beef pound (Becoña et al., 2014; Modernel et al., 2013; Soussana, 2009; Bencke, 2009). Consequently, it is expected that feed efficiency would correspond in reduced methane emissions, or vice versa (Åby et al., 2013; Beauchemin et al., 2008). In a recent study on cattle diet optimization in the United States, White et al. (2014) concluded that pasture production improvement through intensification and management reduced GHG emissions per produced unit.

The implementation of rotational grazing techniques with varying intensities, strategic supplemental feeding, soil fertilization and correction, pastures fertilization with nitrogen and animals' genetic improvement generate benefits from different perspectives (Wall et al., 2010; Bustamante et al., 2012; Bencke, 2009; Nabinger et al., 2009; Maraschin, 2009). According to the authors, these practices reduce animals' fattening time, increase farmers' financial return, reduce GHG emissions and preserve the Pampa biome. Thus, Strassburg et al. (2014) points out that sustainable intensification can combine increased agricultural production with natural environments conservation and restoration.

This nature services practice by farmers, especially immediate need practices, such as GHG emissions reduction, open ways for a compensation process called Payment for Environmental Services (PES) (Martinkoski et al., 2013; Tornquist and Bayer, 2009). GHG emissions reduce or mitigation are actions that fall under the PES, generating carbon credits and allowing to remunerate who directly or indirectly preserves the environment (Peixoto, 2011; Tornquist and Bayer, 2009).

Considering that this is a non-spontaneous market, first there is the need to identify and quantify what is the generated externality, who produced it and who benefits from such nature conservation practices (Martinkoski et al., 2013). Environmental services provided by livestock in native pastures in terms of atmospheric CO_2 retention can be estimated by comparing soils organic C storage (Tornquist and Bayer, 2009). Cattle GHG emissions can be quantified and compared between different production systems by its production life cycle assessment (LCA) (Sanders and Webber, 2014; Beauchemin et al., 2010). However, LCA requires more complex appraisement, requiring the analysis to be extended at least to the farm's gate (O'brien et al., 2014).

LCA is an important methodology to assess potential impacts over a product life cycle, from raw materials acquisition to production, use and disposal, including raw materials extraction and processing analysis, as well as product manufacturing, transportation, distribution, use, reuse, maintenance, recycling and waste disposal (ISO, 2006; Guinée, 2001; Finnveden, 1999).

LCA enables the identification of critical points to reduce environmental impacts within the supply chain, resource use forms comparison and different production technologies emissions (Pelletier et al., 2010).

The LCA is regulated by ISO standards (ISO 14040:1997, ISO 14041:1999, ISO 14042:2000, ISO 14043:2000), where principles