Economic and Environmental Performance Assessment of Beef Cattle Production Systems on Natural Grassland in Southern Brazil

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Introduction

Starting in the last decade, studies and debates about the contribution of beef cattle production to greenhouse gases have intensified, mobilized by different institutions; among them, universities, farmers associations, public figures, the media in general, as well as the Intergovernmental Panel on Climate Change (IPCC). Some recent studies have demonstrated that higher or lower methane production depends fundamentally on the conditions of the production system (Genro et al., 2014; Moscat, 2015).

In addition, the interest sparked by this topic has fostered the necessity for mitigation systems evaluations that integrate economic and environmental performance. These evaluations have the goal of determining if systems that are capable of mitigating the emission of greenhouse gases are also economically feasible. The tools and strategies that are expected to be utilized by producers should be economically sustainable; otherwise, they run the risk of not being implemented (Berndt, 2010).

The objective of this study was to analyze the economic and environmental performance of pasture production systems with different levels of intensification in backgrounding and finishing cattle in southern Brazil. This information will be able to provide important guidelines for farmers making decisions on greenhouse gas mitigation systems.

Material and Methods

The experiment was conducted in an area belonging to Embrapa South Livestock, located in Bagé, Rio Grande do Sul--under the purview of Pecus Network-- during 2013. Economic analysis used current (May 2015) fat cattle prices (C$2.04 kg LW^{-1}; approximately 1 CAD = 2.50 BRL) and costs. Nine paddocks, approximately seven hectares in size, located in a grassland area were used. Three paddocks were assigned to each of three treatments: natural grassland field (NG); natural grassland with nitrogen fertilizer (NGF); natural grassland with nitrogen fertilizer and overseeding of two hibernal species: ryegrass (*Lolium multiflorum*) and red clover (*Trifolium pratense*) (NGFS). In all the treatments, the pasture was managed in order to maintain the fodder supply at 12% (12 kg of dry matter/100 kg live weight). For this, three Hereford steers were used in each paddock, where methane emission evaluations were conducted. In addition, sufficient animals were used to maintain the forage supply at 12%. The average annual capacity of the paddock, including the regulator animals, was nine animals (NG), 12 animals (NGF) and 13 animals (NGFS). Methane emissions by the animals were measured using the sulphur hexaflouride marker technique, over a five day period, in all seasons of the year (starting on January 21, June 5, July 22, and October 28). Methane samples were collected in the proximity of the animals' noses with the assistance of regulatory air intake valves, and stored in stainless steel tubes. Data relative to pasture management and animal health conditions were collected in the same fashion during the experimental period. The economic analysis of the emissions was obtained by relating the gross margin and the methane emission per hectare.

This emission/benefit relation allowed for the measurement of economic return for each gram of methane emission in each of the three studied systems, taking into consideration the effective operational costs and payments to outsourced mechanized services.

Results and Discussion

Lower methane emissions by area occurred in the NF system with lower meat production per hectare, with a value of 97.32 kg of CH_4/ha/year. However, if we analyze the methane production per kilo of live weight gain (LWG), the lowest observed value was in systems with higher intensification (Table 1). This demonstrates that methane emission per kilo of LWG is lowered with system intensification (Genro et al., 2014).

Table 1. Stocking rate values (kg LW ha^{-1}), live weight gain per area (kg LW ha^{-1} $year^{-1}$), methane emission by live weight gain (g CH_4 kg LWG^{-1} day^{-1}), gross margin per area (C$ ha^{-1} $year^{-1}$), and benefit/emission relation (C$ g CH_4^{-1} kg LWG^{-1}) in each of the three systems.

	Stocking rate (kg LW ha^{-1})	Weight gain (kg LWG ha^{-1} $year^{-1}$)	CH_4 emission (g CH_4 kg LWG^{-1} day^{-1})	Gross Margin (C$ ha^{-1} $year^{-1}$)	Benefit/emission relation (C$ kg CH_4^{-1})
NG	423	123	0.79	41.56	0.43
NGF	583	228	0.49	80.60	0.72
NGFS	628	310	0.43	166.40	1.25

The improvement in environmental performance obtained with intensification also resulted in an improvement in economic performance. There was an increase in economic return per hectare with fertilization and enhancement of natural grassland as compared to NG. The relation between financial benefit and the emission of one kg of methane was C$0.43, C$0.72, and C$1.25 for the NG, NGF, NGFS systems, respectively. If a farmer sought the same profit, but decided not to invest in increasing productivity, on average, this decision would double the amount of methane emissions for the same meat production. It should be noted that the advantages of intensification may be even greater when the soil carbon balance is considered in the economic analyses (Berndt, 2010).

Conclusion

The use of fertilization and the introduction of hibernal species to native grasslands has been shown to be sustainable both in terms of methane emission per kilo of live weight, as well as in productive and economic terms per hectare and in terms of the cost/benefit relation of emissions.

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