Methane Emissions from Ruminants on Integrated Crop-Livestock Systems

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Presenter Information

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Introduction

Ruminant livestock produce ~80 million tonnes of methane (CH_4) annually, accounting for ~33% of global anthropogenic emissions of CH_4 (Beauchemin *et al*. 2008). CH_4 is a powerful greenhouse gas, with global warming potential of 25 (Eckard *et al*. 2010), and represents a significant loss of dietary energy (2 to 12% of gross energy of feeds; Patra 2012) in the ruminant production system. Despite greenhouse gas (GHG) emissions have become an increasingly important topic worldwide, there is still a high variability around the estimated values of these emissions, mainly about emissions attributable to livestock (range from 8 to 51%; Herrero *et al*. 2011). This variability creates confusion among researchers, policy makers and the public, particularly in tropical/sub-tropical regions due substantial uncertainties. Therefore, using rigorous and internationally accepted protocols, a Brazilian national project was established in order to contribute for the estimates of GHG emissions attributable to livestock in Brazilian ruminant production systems. Moreover, enteric CH_4 emissions are a major challenge for research, in order to develop technologies and strategies for sustainable ruminant production systems in the future (Eckard *et al*. 2010).

In recent years, integrated crop-livestock systems (ICLS) have gained interest due to, for example, the abatement of methane from livestock production: directly through a reduction in CH_4 per unit of animal products resulting from the increase on feed quality and animal welfare (i.e. improved environmental temperature for ICLS with trees), and indirectly through reduction of area submitted to land use changes (*i.e.* leading to a loss of soil C stocks). This paper deals with the preliminary results from CH_4 emissions by beef heifers grazing in two ICLS (*i.e.* production system that integrates corn or soybeans crops, during the warm season, and cattle grazing on a cool season pasture, on the same area and in the same cropping year, with or without trees), how these findings contributes to determine the soil C balance and mitigation measures.

Materials and methods

A field experiment was carried out at the Agronomic Institute of Paraná, Ponta Grossa-PR (25°07’22’’S; 50°03’01’’W), *i.e*. a subtropical area in southern Brazil. The effect of two nitrogen fertilization treatments (90 and 180 kg/ha) and two integrated crop livestock systems (ICLS; *i.e.* with and without trees) were investigated in a complete randomized block design, with four treatments and three replicates each (a total of 12 paddocks of 0.99±0.231 ha each). In 2006, three tree species (eucalyptus, *Eucalyptus dunnii;* pink pepper, *Schinus molle;* silver oak, *Grevillea robusta*) were planted at 3 x 14 m spacing (237 trees/ha), on six of the 12 paddocks. In May 2012, a mixture of black oat + ryegrass (*Avena strigosa* + *Lolium multiflorum*) was sown for cattle grazing during the cool season.

The paddocks were managed in order to maintain a target surface sward height of 20 cm by adjusting the number of grazing animals weekly (put and take approach). In August 2012, a gas collection campaign was performed over five days in order to quantify CH_4 emissions by cattle. CH_4 production was estimated by the sulphur hexafluoride (SF_6) tracer technique (Johnson *et al*. 1994) for two animals per paddock (total of 24 Purunã beef breed heifers). Animals were selected based on their liveweight (LW, 286 ± 6.70 kg on average), measured prior to SF_6-campaign, so that CH_4 emissions could be expressed on a LW basis. The experimental data were statistically analyzed using ANOVA with the Statgraphics (Magnugistics, USA) package. Prior to ANOVA, data were normalized using the log transformation. CH_4 budget per unit ground area was calculated by multiplying the average CH_4 emission rate per kg of LW (CH_4 /day/kg LW) with number of days and animals per area.

Results and discussion

There were no significant treatments effects for the CH_4 emissions per unit LW (P>0.05). CH_4 emissions ranged from 0.32 to 0.93 g CH_4/day/kg LW, but tended to be lower for livestock with tree shelter than without (Fig. 1). Variation coefficients were 28% and 35% for the systems with and without trees, respectively, which may explain the limited treatment effect, and underline the need to increase the sampled animals’ number equipped with SF_6 collection device or the number of measurements campaigns

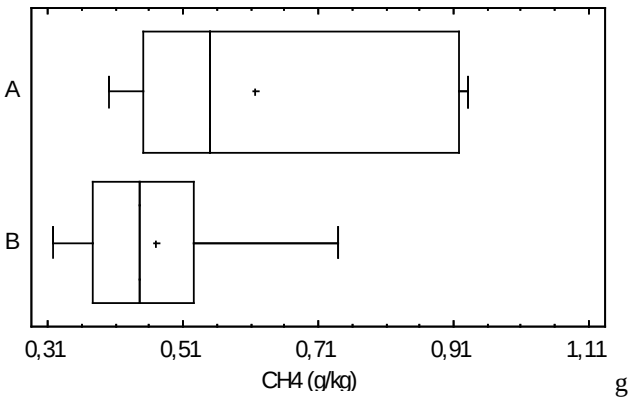

Figure 1. Ranges of CH_4 (g/kg of liveweight) emissions from ruminants under two integrated crop-livestock systems: A, without trees and B, with trees.

throughout the year. A range from 0.36 to 0.52 CH_4 /day/kg LW was observed by Allard *et al*. (2007) in eight measurement campaigns in temperate semi-natural grassland. Similar results (0.30 – 0.53 g CH_4/day/kg LW for beef steer) were reported for beef steer in a recent review published by Eckard *et al*. (2010). These results highlighted a likely major CH_4 emission in our system when compared to the values cited above. Since in species-rich grasslands animals cope with diverse combination of plant species and parts, methane production could be reduced by feeding forage with better quality than communities containing only few grass species. Annual emissions of CH_4 from enteric fermentation, using values per unit ground area (using means of two years, *i.e*. 1030 kg LW/ha), was 5.54 g CH_4/m^2/year. However, this value was obtained assuming a grazing period around 100 days per year on areas with ICLS. The ICLS described here can be used for finishing animals. On the other hand, summer pastures, associated to winter species, could be used in order to supply forage throughout the year. Accordingly, a diversity of integrated systems is possible making it hard to estimate annual CH_4 production by animal. Additional research efforts will be required to make further progress in our current understanding of methane emissions per unit of animal products of such integrated systems.

Conclusions

Presence of trees tended to reduce methane emissions by cattle in integrated crop-livestock systems. Additional methane measurement campaigns are planned for the cool-season grazing of 2013 in an attempt to provide more detailed insights into the underlying processes.

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