Effect of stocking method and grazing intensity in methane emission by lambs in integrated crop livestock system

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The objective in this study was to evaluate how strategies for pasture management can influence animal production and emission of methane in areas of crop-livestock integration. Were used lambs from crossing between Texel and Ile de France. The experimental design was randomized blocks, with a factorial arrangement (2x2) with three replicates. The treatments consisted of two stocking methods (continuous and rotational) and two grazing intensities: herbage allowance of 2.5 (moderate) and 5 (low) times the potential intake of dry matter (DMI) animals. The DMI (g animal^{-1} day^{-1}) was higher for the lambs on continuous stocking. The emission of CH_4 (g animal^{-1} day^{-1}) did not differ ($P>0.05$) between treatments, with a mean of 22.7±1.0. Methane production (g kg DMI^{-1} and GEI%) did not differ between treatments ($P>0.05$), with a mean of 19.5±0.4. The variable kg CH_4 ha^{-1} day^{-1} was affected by grazing intensity, with a higher value in the moderate grazing, while the variable g CH_4 kg GPV^{-1} day^{-1} was higher in rotational stocking method, regardless of grazing intensity ($P<0.05$). The moderate grazing intensity has higher methane emissions per area, the continuous stocking system is the most efficient, as it has lower methane emissions per kg of live weight gain of lambs.

Introduction

Among the various sources with a potential negative impact on the environment, methane emissions of animal origin have been highlighted for the agricultural sector. In Brazil, according to data from the Second National Communication of Brazil to the convention - the United Nations Framework on Climate Change (2010), the agricultural sector is most responsible for emissions of CH_4 (70.5% in 2005). The main issue is due to enteric fermentation of ruminant livestock (63% of total CH_4 emitted in Brazil), almost all for the bovine herd, the second largest herd in the world. In the agricultural sector in particular, annual emissions from enteric CH_4 were estimated at 11.49 Tg, 94% of total CH_4 emissions from the sector. Studies on means to mitigate these emissions, and understand how integrated crop and livestock production systems may contribute to the reduction of greenhouse gases, are essential for the creation of public policies for environmental preservation. The objective in this study was to evaluate how strategies for pasture management can influence animal production and emission of methane by lambs in areas of integrated crop-livestock system.

Methods

The study was conducted in Southern Brazil region (30°05'22"S, 51039'08'W). The experimental protocol has been carried out since 2003, consisting of in integrated crop-livestock system (ICLS), where in summer soybeans and/or corn are sown in a no-till system. In winter, pastures of Italian ryegrass (*Lolium multiflorum* Lam.) are established by self-seeding. The experiment was a grazing period of 122 days, stated in June 18 and ended in October 24, 2011. The number of days in each grazing cycle was established as follows: 36, 36, 28 and 22 days. Were used lambs from crossing between Texel and Ile de France, with an average age of eleven months and average live weight of approximately 35.0±4.0 kg. The experimental design was randomized blocks, with a factorial arrangement (2x2) with three replicates. The treatments consisted of two stocking methods (continuous and rotational) and two grazing intensities: herbage allowance of 2.5 (moderate) and 5 (low) times the potential intake of dry matter (DMI) animals. The live weight gain (LWG, g animal^{-1} day^{-1}) was calculated as the difference between final and initial weights of tester animals, divided by the number of days in the trial period. Weight gain per area (LWGHA kg LW ha^{-1}) was obtained by multiplying the average stocking rate, expressed in animals ha-1, by LWG of the tester animals and by the number of grazing days. To determine the DMI three tester animals from each experimental unit were monitored, using the n-alkanes technique. To quantify methane emission (CH4) the technique of tracer sulfur hexafluoride (SF6) described by Johnson et al. (1994) was used. Statistical analysis was performed using mixed models (SAS Inst. Inc., Cary, NC, USA, 2011) with fixed effects for methods, intensities and blocks and random effect for interaction. When differences between means were detected, the treatments were compared using the Tukey's test at a significance level of 5%.

Results

There was no interaction between stocking methods and grazing intensities (P>0.05) for all variables (Table 1). The DMI (g animal^{-1} day^{-1}) was higher for the lambs on continuous stocking. The emission of CH_4 (g animal^{-1} day^{-1}) did not differ (P>0.05) between treatments, with a mean of 22.7±1.0. Methane production (g kg DMI^{-1} and GEI%) did not differ between treatments (P>0.05), with a mean of 19.5±0.4. The variable kg CH_4 ha^{-1} day^{-1} was affected by grazing intensity, with a higher value in the moderate grazing, while the variable g CH_4 kg GPV^{-1} day^{-1} was higher in rotational stocking method, regardless of grazing intensity (P<0.05).

Table 1. Dry matter intake (DMI) and methane emission by lambs grazing Italian ryegrass at different stocking methods (continuous and rotational) and grazing intensities (low and moderate).

Variables	Continuous		Rotational		Mean±MSE	P_I	P_M	P_{IxM}
	Low	Moderate	Low	Moderate				
DM intake								
g animal^{-1} day^{-1}	1368.7a	1322.3a	1244.3b	906.7b	1210.5±71.1	0.110	0.035	0.210
CH_4 emission								
g animal^{-1} day^{-1}	24.5	22.7	23.7	20.7	22.7±1.0	0.298	0.531	0.794
g kg DMI^{-1}	19.5	19.3	19.5	19.5	19.5±0.4	0.945	0.979	0.912
% GEI	5.9	5.5	5.9	6.0	5.8±0.2	0.757	0.587	0.699
kg ha^{-1} day^{-1}	0.661b	0.854a	0.668b	0.883a	0.746±0.04	0.018	0.784	0.865
g kg LWG^{-1}day^{-1}	183.0b	159.3b	240.3a	285.3a	220.1±17.5	0.562	0.001	0.091

DM=dry matter; %GEI=gross energy intake; LWG=live weight gain; MSE=mean standard error; P_I=probability for grazing intensity; P_M=probability for stocking method; P_{IxM}=probability of interaction between grazing intensity and stocking method.
Means followed by lowercase letters on line differ by F test (P<0.05).

Discussion

The highest DMI observed in the rotational stocking method is explained by a greater chance of selecting the diet of the animal. The literature also reports data that varies between 19.3 and 35.5 g CH_4 animal^{-1} day-1 (; Ulyatt et al., 2005; Hammond et al., 2011; Sun et al., 2012) for sheep fed different pastures, most of these results similar to those found in the present study. This study sought to investigate the best production system, in other words, the stocking method and/or grazing intensity in terms of more efficient emission of CH4 animal in integrated crop-livestock system. Values of 8.4, 6.4 and 1.3 kg CO_2 eqv. LWG-1 were described by Phetteplace et al. (2001) for beef cows, grazing cattle after weaning and feedlot cattle, respectively. In our study we observed similar or even smaller values, represented by averages of 3.93 and 4.74 kg CO_2 eqv. LWG^{-1} for continuous and rotational stocking, respectively. This means that the rotational stocking method provides, on average, emissions 17.08% greater than the continuous stocking method. These results show the greater efficiency (kg CO_2 eqv. LWG^{-1}) of sheep production, compared to the production of beef cattle in grazing system.

Conclusion

In integrated crop-livestock system, the moderate grazing intensity has higher methane emissions per area. The continuous stocking system is the most efficient, as it has lower methane emissions per kg of live weight gain of lambs, regardless of grazing intensity.

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