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Animal production systems and agribusiness

Attractants for automated emission measurement (Greenfeed®) in pasture-based systems

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ABSTRACT - This study aimed to evaluate the frequency and intensity of GreenFeed (GF) use by Nellore steers using different attractants in pastures of integrated systems. The attractant protein supplement and Tifton bermudagrass pelleted hay flavored with vanilla were evaluated over a period of 15 days. The pelleted hay stimulated the animals to stay longer in the equipment (24.23 s), with 8% more visits in intervals longer than 30 s in contrast to protein supplement. This indicates that pelleted hay flavored with vanilla is a potential attractant to encourage Nellore steers to visit GF in grazing systems.

Key Words: beef cattle, enteric methane, greenhouse gases, integrated systems, mitigation, sustainable intensification

Introduction

Agricultural production systems are frequently criticized because of their significant greenhouse gas (GHG) emissions. However, measurements of gas emissions are influenced by several factors such as climate, soil, animal, and type of equipment used in the evaluations.

In this context, researchers in the last decade have evaluated more accurate measurement techniques (Parkin and Venterea, 2010; Zimmerman and Zimmerman, 2012) in an attempt to develop technologies to mitigate GHG emissions from agricultural areas and livestock production (Lal et al., 1998; Beauchemin et al., 2008; Carvalho et al., 2010; Luo et al., 2010; Balbino et al., 2011).

To evaluate the effectiveness of different systems in terms of reducing GHG emissions, accurate measurements of methane emissions are key. There are several methodologies for measuring daily enteric methane production, such as respiratory chambers (Blaxter and Clapperton, 1965; Pinares-Patiño et al., 2013), sulfur hexafluoride tracer (Johnson et al., 1994; Berndt et al., 2014), and, recently developed, the GreenFeed (GF) system (C-Lock Inc., Rapid City, SD, USA).

The GF system determines daily enteric methane emissions using head- and nose-positioned sensors in combination with decision rules to validate the data obtained (C-lock, 2016; Hammond et al., 2015a). Hereby, the animal voluntarily places its head inside the hood where feed is offered in the form of an attractant to ensure prolonged contact with the equipment, allowing methane measurement (Hammond et al., 2016).

However, to date, the knowledge about animal × GF interaction is still limited, especially regarding pasture-based systems. The most suitable type of attractant and the optimal positioning of the equipment in pastures, ensuring accurate measurements, still need to be found. In this context, the objective of this study was to evaluate frequency and intensity of GF use by beef steers maintained in a crop-livestock-forest integrated system as affected by two types of attractants.

Material and Methods

The experiment was carried out in Sinop, MT, Brazil (11º51' S, 55º35' W, elevation of 370 m), in the Amazon biome. Research on animals was approved by the institutional committee on animal use (case number 008/2015). Measurements with GF were carried out during two periods of 15 consecutive days between July

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and August 2016 on animals maintained in crop-livestock-forest integration systems with beef cattle.

The animals used were two uncastrated Nellore steers, with an average initial weight of 301±3 kg maintained in a 2-ha pasture consisting of *Brachiaria brizantha* (syn. *Urochloa brizantha*) cv. Marandu, established annually for use only in the off-season (July-September). The pasture was planted in consortium with maize (second crop) after soybean harvest and planted with triple rows of eucalyptus *(Eucalyptus urograndis* clone H13), in the arrangement of 3.0 × 3.5 m (270 ha^{-1} trees), with 30-m spacing, in a crop-livestock-forest integration system.

Two attractants were evaluated regarding their ability to encourage animals to visit the GF. In the first evaluation period, a protein supplement (35% crude protein) was offered in powder form. This product is commonly used in farms and the animals are well adapted. The equipment was programmed to offer the attractant at 6-h intervals (duration of the feeding period) with up to eight drops of 60 g (feed supply) distributed in 40-s intervals for up to 5 min in each feeding period. Each day, no more than four feeding periods were allowed, totaling a maximum intake of 1,920 g animal^{-1} day^{-1}.

In the second evaluation period, pelleted Tifton bermudagrass hay (13% crude protein), flavored with vanilla (5 g kg^{-1}), was offered at a maximum quantity of 2,400 g animal^{-1} day^{-1}. This amount could be consumed for up to six feeding periods per day, with a minimum interval of 3 h. At each visit to the equipment, the animal received 50 g of pellets per drop, every 40 s (50 g drop^{-1}), for up to 5 min, with a maximum of eight drops per feeding period.

In each evaluation period, the animals were adapted to the attractant for seven days; access to the GF occurred without any restriction in feeding periods and number of drops. To ensure animal visits at the equipment, the GF was allocated near a resting area. In addition, during the first evaluation period, the protein supplement supply was only provided via the GF and not in troughs, in contrast to the usual practice. During the second evaluation period (pelleted hay), protein supplement continued to be supplied in specific troughs.

The GF recorded each visit of each animal by means of an electronic earring, automatically identifying time and duration of the visit, number of drops offered per visit, and feeding period. Concomitant with these measurements, behavioral assessments were performed to determine the intensity of GF use between 6:00 and 18:00 h. Regardless of the time evaluated, when the animals visited the GF, the time they spent with their heads inside the equipment was measured using a digital timer. At the end of each visit, the times were added, characterizing the GF use at each visit and the sum of these visits during the evaluation period, thereby characterizing the GF use over a period of 12 h.

The design was completely randomized with two treatments (protein supplement and pelleted Tifton bermudagrass hay flavored with vanilla) and two sample units (animal) repeated on time (15 days) per treatment (n = 60). Time in the feeder (equipment), number of drops per day, and number of drops per feed period were analyzed using the mixed model method, using the MIXED procedure of the statistical software SAS (Statistical Analysis System, version 9.4) (Littell et al., 2006), considering attractants as fixed and animal as random effects. To choose the covariance matrix, the Akaike information criterion was used. The means of treatments were estimated using LSMEANS; treatments were performed using the probability of difference ("PDIFF") with a significance level of 5%.

Results

For all variables, the greatest values were obtained for pelleted hay. This attractant provided 2.30 feeding periods, with 5.66 s more feeding time compared with the protein supplement (Table 1), which represents an increase of 30% in time for the quantification of methane emission. The intake of drops (day) and drops per feeding period were 163 and 70%, respectively, greater for pelleted hay.

Evaluating the number and percentage of visits to the GF in relation to the length of the stay with head in the feeder, the number of visits shorter than 30 s was greater when the attractant was protein supplement (Table 2). The use of pelleted hay with vanilla increased the number of visits longer than 30 s by 283% compared with protein supplement.

The time each animal remained at the GF, without necessarily keeping the head in a position suitable for methane measurement, was longer for the pelleted hay (138 s) in relation to the protein supplement (70 s) (Figure 1). In addition, over 12 h of evaluation, the frequency of GF use was greater for pelleted hay (738 s) than for the protein supplement (352 s). Equipment use was greatest between

Table 1 - Frequency of GreenFeed use by beef steers in response to two attractants in a crop-livestock-forest integration system

Variable	Protein supplement	Pelletized hay	P-value	CV (%)
Feed time (s)	18.57b	24.23a	0.0032	33.30
Feeding period (number/day)	1.63b	2.30a	0.0031	43.07
Drops (day)	5.63b	14.83a	<0.0001	57.47
Drops per feeding period	3.63b	6.19a	<0.0001	41.42

CV - coefficient of variation.

7:00 and 8:00 h and between 13:00 and 15:00 h, regardless of the attractant.

Discussion

The pelleted hay with vanilla contributed to longer ingestion times of each drop, evidenced by longer feeding times and feeding periods (Table 1). This probably occurred because this attractant, compared with protein supplement, may have contributed to the greater intake (more drops) and number of visits. This is evidenced by the number of feeding periods per day with the use of vanilla (Table 1). As the nutritional composition of the pellets was similar to that of the diet of the animals, the supply of this feed without vanilla would, most likely, not be sufficient to stimulate GF visits because the nutritional requirement could be met by the intake of green forage in the pasture.

The results of this experiment are not in agreement with those observed by Hammond et al. (2016), who indicated that salt could be considered a desirable substitute for pelleted supplement since it does not directly contribute to energy intake and has no direct effects on methane production.

On average, the feeding period per day in feedlot systems was 2.66 (Hammond et al., 2015a; 2015b; Huhtanen et al., 2015), while it was 1.4 in pasture systems (Hammond et al., 2015a; Waghorn et al., 2016). The data obtained in this experiment (Table 1) are close to the values obtained for animals evaluated in feedlots, showing the potential of pelleted hay as an attractant in GF systems in a pasture-based beef cattle production system.

Table 2 - Visits of beef steers at the GreenFeed in response to two attractants in a crop-livestock-forest integration system during 15 days

Length of stay with the head in the feeder (s)	Protein supplement		Pelletized hay	
	Number of visits	% of total number	Number of visits	% of total number
0-30	174	85	408	77
31-60	21	10	78	15
61-90	6.5	3	21	4
91-120	3.5	2	11	2
> 121	0	0	9	2

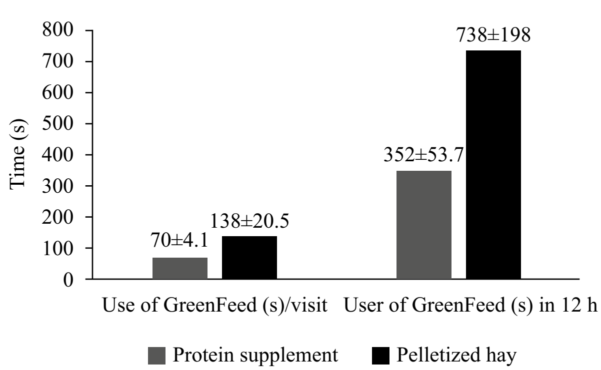

Figure 1 - Intensity of GreenFeed use by beef steers in response to two attractants during 12 h in a crop-livestock-forest integration system.

The recommended minimum time for methane reading by GF is around 30-40 s to reduce (or avoid) the impact of wind speed and direction in the gas sampling (C-lock, 2016). Pelleted hay with vanilla increased by 3.84 times the number of visits over 30 s. This may contribute to more reliable results on methane emissions due to the increased samplings throughout a day (Table 1) and the increased length of stay in the equipment (Table 2).

The physical form of the pelleted hay and the use of flavor could have stimulated the animals to remain longer in the GF (Figure 1). However, in pastoral environments, the number of GF visits are lower than in feedlot systems (Cottle et al., 2015; Gunter and Bradford, 2015; Hammond et al., 2015a). This is explained by the fact that in feedlot systems, much of the diet is provided through the equipment, which encourages animals to visit the GF. However, in grazing systems, the forage is the feed to be evaluated, and any feed offered via the GF system is understood as an attractant to enable enteric methane measurement, which reduces visit frequency.

An alternative to overcome difficulties of methane emission measurement in a grazing production system would be the extension of evaluation periods, thereby increasing the frequency of GF visits. Waghorn et al. (2016), evaluating methane emissions of lactating cows with two stocking rates in perennial ryegrass (*Lolium perennial*) pastures, found that the frequency of GF visits increased by 47% when the evaluation period increased from 1 (8%) to 4 (55%), in which each period corresponded to three weeks of evaluation. This had a positive impact on accuracy and precision of the enteric methane measurement via the GF system.

Conclusions

The use of pelleted hay of Tifton 85 bermudagrass with vanilla is an alternative attractant to encourage Nellore steers to visit GreenFeed systems and may contribute to achieve accurate methane emission measurements in pasture-based systems.

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