

Impact of alfalfa and fertilizer on pastures:

Methane Production

Introduction

Methane produced by cattle is a greenhouse gas and as such a proven contributor towards global warming. In Canada, methane emissions from cattle represent approximately 3% of the greenhouse gases generated by human activity. In fact, microbes in the rumen of cattle and related species may be responsible for up to 15% of methane production worldwide.

Most of the methane produced by cattle (about 90%) is produced in the rumen, then absorbed into the bloodstream and released in the lungs. Methane is then lost through the mouth during breathing or eructation (belching).

Methane production results from the incomplete use of the energy in feed. Higher methane losses from the rumen mean that cattle are using feed less efficiently to produce meat or milk. Many factors affect methane emissions from cattle, and it may be possible to reduce emissions through feeding and management changes.

To date, there has been limited research on methane production by grazing beef cattle in a Canadian climate. Most research has been on confined beef or dairy animals fed conserved and processed forages. Grazing cattle may produce different levels of methane compared to confined animals because the forage type and amount consumed is different.

Research Study

A collaborative study between the Agriculture and Agri-Food Canada Brandon Research Centre and the Department of Animal Science at the University of Manitoba was conducted in 1995 at the Agriculture and Agri-Food Canada Research Centre in Brandon, MB.

In the spring of 1994, pastures were established on a Souris fine sandy loam. The study used rotational grazing on four combinations of pasture type and fertilizer management. There were two different pasture types (100% grass or mixed alfalfa-grass) and two different fertilizer treatments (no fertilizer, or spring fertilization to full soil test recommendation levels). This resulted in a total of four treatments, shown in Table 1.

The grass only pastures were seeded with 10 lb/acre 'Paddock' meadow brome grass. The mixed alfalfa-grass pastures were seeded with 7 lb/acre 'Paddock' meadow brome grass and 3 lb/acre 'Spredor II' alfalfa. Starting in 1995, fertilizer was surface-applied as a dry blend prior to grazing each spring. The concentration of each nutrient

Table 1. Pasture Types and Fertilizer Treatments used in the Study

1) Meadow brome grass No added fertilizer	3) Meadow brome grass + Alfalfa (78% of biomass) No added fertilizer
2) Meadow brome grass + Fertilizer	4) Meadow brome grass + Alfalfa (78% of biomass) + Fertilizer

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in the blend was based on soil samples collected the previous fall.

The pastures were rotationally grazed by 60 lactating beef cows (Simmental-Angus first-calf cows in early lactation). Out of this larger group, 16 tester cows (4 per treatment) were used to measure forage intake and methane production four times during the grazing season. Each pasture consisted of five paddocks, with two rotations through the paddocks during the grazing season. Information on methane production, forage intake, and forage quality was collected simultaneously as animals entered and exited the third paddock. Grazing ended in mid-August as very dry conditions resulted in a lack of available forage (see Figure 1).

To measure methane losses from the rumen, a tracer gas technique was used. A small tube containing the tracer gas (sulfur hexafluoride) was placed in the rumen of each animal. A gas collection apparatus was used to sample gases released from each animal's mouth and nose. The rate of release of the tracer gas from the tube in the rumen was known before the experiment. By comparing the concentration of methane to the concentration of tracer gas released by the animal, the amount of methane produced from the rumen was calculated.

Study Results

Forage Quality

Cows on alfalfa-grass pastures consumed more forage (that is, they had higher gross energy intake) compared to those on grass only pastures. This was expected, as other research studies have found that legumes have higher digestibility and faster passage rates through the digestive tract than grasses; however, digestibility and passage rates were not measured in this study.

Figures 3, 4, and 5 (next page) show the crude protein, ADF, and organic matter digestibility of forage consumed from each pasture type on the dates that cows entered and exited the third paddock. Organic matter digestibility is similar to TDN – it measures the energy content of forage.

Forage quality of both the grass only and the alfalfa-grass pastures generally declined between the cows entry into the paddock and their exit from the paddock. Methane production also changed between the entry

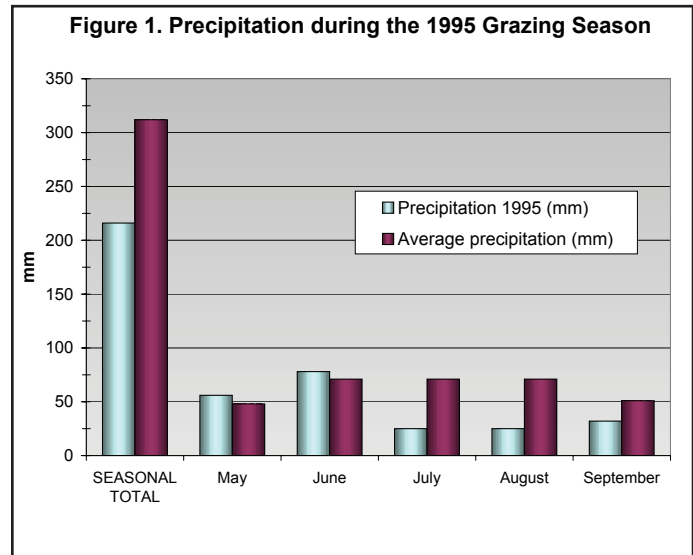
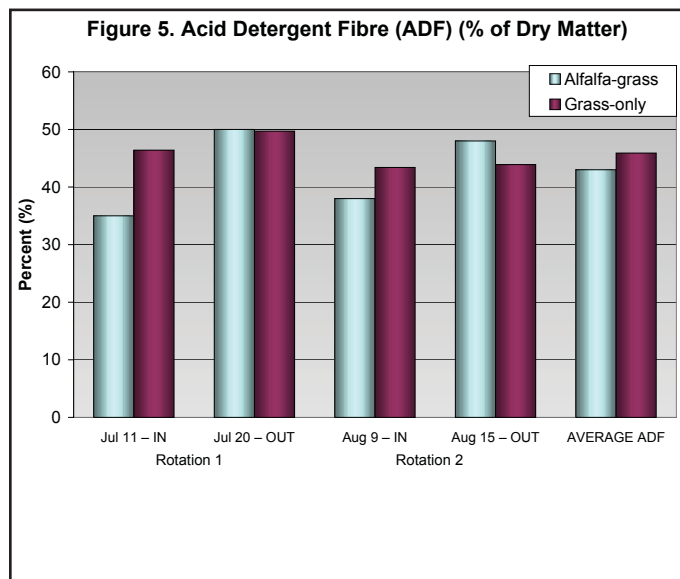
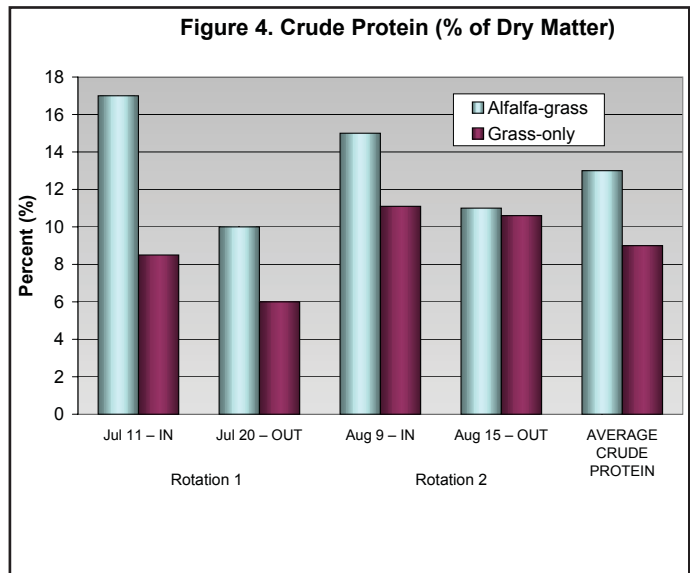
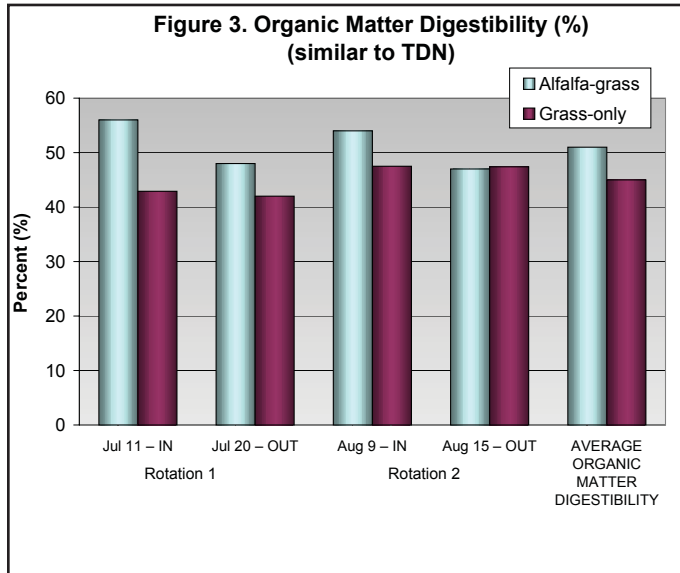


Figure 2. Apparatus for Collecting Methane Gas



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into and the exit from the paddock, probably because of changes in forage quality. Forage quality normally affects methane production, however, in this study, a wide variation in quality throughout the grazing season meant that it was not possible to make predictions about how specific quality characteristics affected methane production.

Methane Production

Methane production was calculated in three different ways: 1) per day, 2) per pound of cow body weight, and 3) as a percentage of the cow's gross energy intake. Adding inorganic fertilizer had no effect on methane production. Regardless of how methane production was measured, it was lower on

alfalfa-grass pastures compared to the grass only pastures (Table 2). This demonstrates improvements in digestive efficiency in the legume-containing pastures.

Improving pasture quality by adding legumes such as alfalfa may reduce methane production by approximately 10% per animal. In addition, calf growth rates on alfalfa-grass pastures were 11%

Table 2: Average Methane Production by Grazing Cattle

	Alfalfa-grass pastures	Grass-only pastures
Methane production – <i>Litres per day</i>	374 L/day	411 L/day
Methane production – <i>Litres per pound of body weight (BW)</i>	1.6 L/lb BW	1.8 L/lb BW
Methane production – <i>Percentage of gross energy intake (GEI)</i>	7.1 % of GEI	9.5 % of GEI

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higher in this study, resulting in more efficient beef production per unit of methane produced. Taken together, the result is approximately 22% higher gain per calf for each unit of methane produced. Therefore, on mixed alfalfa/grass pastures, less methane was produced for every pound of calf gain. An example of this is shown in Table 3.

Methane production can be reported either on a per animal basis or on a per acre basis. Adding alfalfa to pastures increases digestive efficiency and reduces methane production as a percentage of gross energy intake per animal, however, including alfalfa in unfertilized pastures also increases the carrying capacity by approximately 25%. An increase in carrying capacity means that methane production per acre increases, even though less methane is produced per animal. An example of this is shown in Table 4.

Conclusion

Including alfalfa in pastures slightly reduces methane emissions from beef cattle while increasing animal productivity and pasture carrying capacity.

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Sources:

McCaughy, W.P., K. Wittenberg, and D. Corrigan. 1999. Impact of pasture type on methane production by lactating beef cows. *Canadian Journal of Animal Science* 79:221-226.

Kopp, J.C., W. P. McCaughy, and K. M. Wittenberg. 2003. Yield, quality and cost effectiveness of using fertilizer and/or alfalfa to improve meadow brome grass pastures *Canadian Journal of Animal Science* 83: 291-298.

Table 3. Sample Calculation of the Efficiency of Beef Production per Unit of Methane Produced

	Alfalfa-grass pastures	Grass-only pastures
Average daily calf gain – (Pounds per day)	2.2 lb/day	2.0 lb/day
Methane production per cow – (Litres per cow per day)	374 L/day	411 L/day
Methane production per lb of calf gain (Litres per pound of calf gain)	170 L/lb	206 L/lb

Table 4. Sample Calculation of the Effect of Carrying Capacity on Methane Production per Acre

	Alfalfa-grass pastures	Grass-only pastures
Methane production per cow – (Litres per cow per day)	374 L/day	411 L/day
Carrying capacity – (Cow-days per acre)*	66	52
Total methane production per acre – (Litres per acre)	24,822 L/ac	21,290 L/ac

*Source: Kopp et al. (2003)

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This technical bulletin is part of a series that have been developed as a result of this collaborative study.