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Assessment of methane emission in a Simmental dairy farm

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Introduction

- Methane is the most produced gas in dairy farms
  - 30% of the total emissions of the agricultural sector.
- The production of this gas may be influenced by:
  - Animal individuality (e.g., age, lactation stage, behaviour)
  - Herd management practices (e.g., feeding system, diet)

Need to assess this greenhouse gas

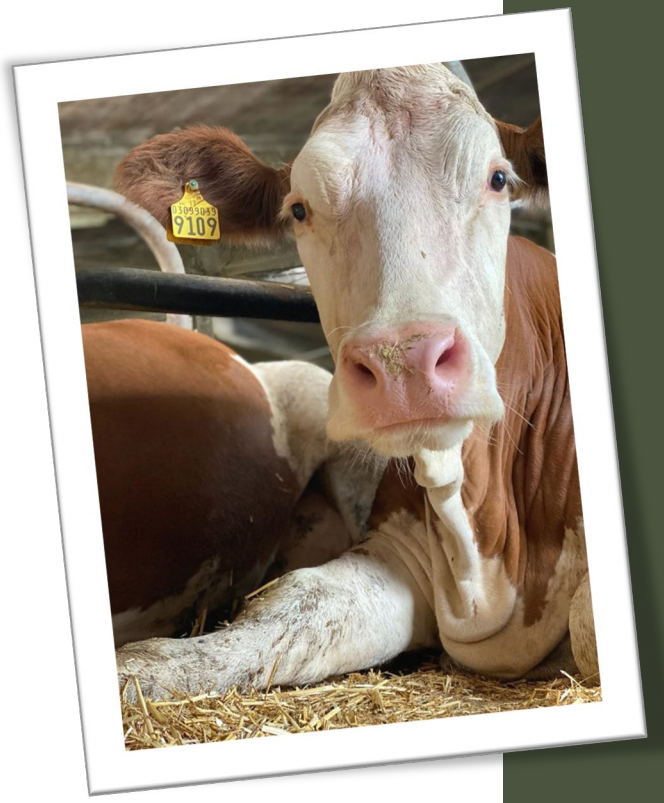
Introduction

- Assessing and measuring methane frequently presents difficulties
  - The existing protocols for gas evaluation are neither entirely clear nor precise
  - Specialized equipment, often expensive, is required

- It becomes necessary to identify methods that can predict methane emissions as closely to reality as possible

Introduction

- Methane production in the rumen is associated with the formation of specific fatty acids that are transferred to the milk and can serve as indicators of CH_4 production.



- Estimation equations based on the fatty acidic profile of milk have sparked interest.

  - A recent review by Massaro et al. (2024) found a total number of 6 equation for the estimation of the methane intensity for kg of fat and protein corrected milk (CM).

Aims

a) Measure methane emissions from Simmental cows of different ages;

b) Estimate methane emissions using one prediction equation that considers milk fatty acids;

c) Compare measured methane emissions (MME) with estimated methane emissions (EME).

Material and Methods

14 Simmental dairy cows:

- 7 primiparous (P)
- 7 multiparous (M): third and later parities

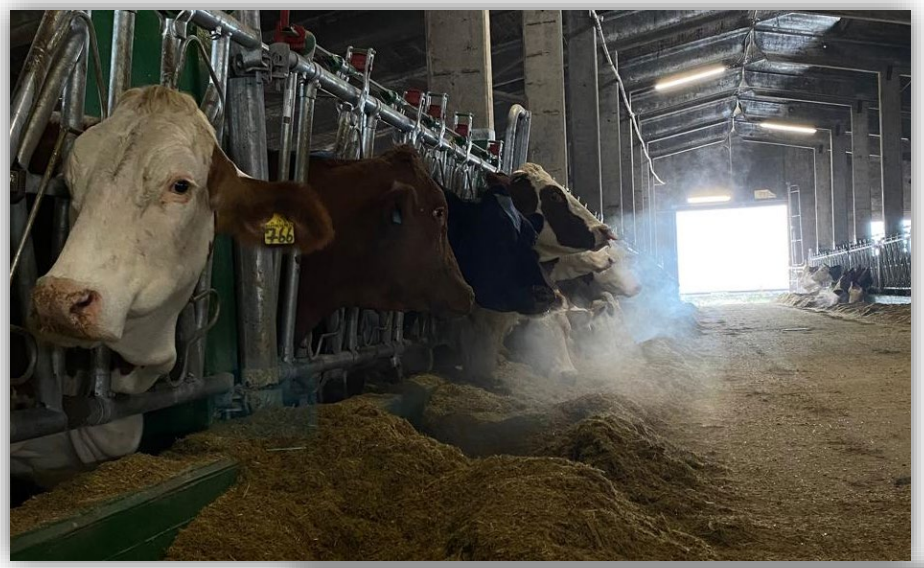
Days in milk: 90-215

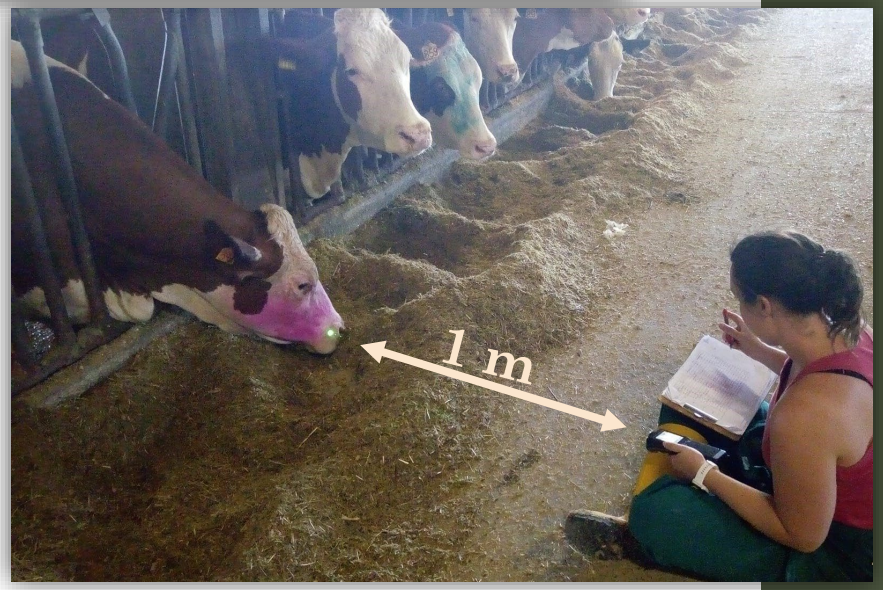
Characteristics of the groups did not display significant differences (P>0,05)

	Body Condition Score	Dry Matter Intake (kg/day)	Milk (kg)	% Protein	% Fat
P	3,61 ± 0,3	21,6 ± 1,9	28,8 ± 2,2	3,3 ± 0,34	4 ± 0,07
M	3,61 ± 0,3	25,6 ± 1,9	27,9 ± 2,9	3,4 ± 0,2	3,9 ± 0,8

Methane Measurement

- The trial lasted for 3 days
- CH_4 concentration (ppm-m) in breath was measured twice a day with the LaserMethaneSmart®
- 5 minutes at 1 m distance
- During feeding
- The conversion of methane ppm-m to g/day was carried out using the formula by Sorg et al. (2019).





Fatty Acids analysis

- Milk samples at the third day of measurements
- Determine the fatty acid profile (FA) Feng et al. (2014):
  - Lipid extraction from cream
  - Extracted FA were methylated to convert into fatty acid methyl esters (FAME)
  - FAME were detected in GCMS equipped with HP-88 (100 m).

- **Prediction equation:**

$$\frac{CH_4(g)}{Corrected\ Milk\ (kg)} = 21{,}13 - 1{,}38 * C4{:}\,0 + 8{,}53 * C16{:}\,iso - 0{,}22 * C18{:}\,1c9 - 0{,}59 * C18{:}\,1t10 + t11$$

(Van Lingen et al. 2014)

- **Fatty acids:**
  - C4:0 Butyric acid
  - C16:iso Palmitic acid
  - C18:1c9 Oleic acid
  - C18:1t10+t11 Elaidinic acid

- **Statistical analysis:**
  - One-Way ANOVA: compare variables
  - Shapiro-Wilk test: normality of data
  - Pearson correlation: relationship between variables

Results

Means and Standard Error of the FA of the two experimental groups (%)

	Primiparous		Multiparous	
	Mean	**SE %**	**Mean**	**SE %**
C4:0	4,32	0,14	4,45	0,08
C16:0 iso	0,25	0,02	0,30	0,02
C18:1 trans10	0,49	0,04	0,45	0,05
C18:1 trans11	0,98	0,05	1,10	0,13
C18:1cis9	18,56	0,58	18,80	1,04

- Informative FA similar between P and M
- No significant difference (P> 0,05)

MME

	Primiparous		Multiparous	
	Mean	**SE**	**Mean**	**SE**
Corrected milk (kg)	33,4	1,7	38,3	2,0
CH_4 g/day	314,5	10,4	304,2	20,7
CH_4 g/kg CM	9,5	0,5	8,0	0,5

- Average of methane yield per cow 309,3 ± 41,9 g/day
- Average of methane per kg of CM 8,76 ± 1,45 g/kg
- Similar emissions between groups (P>0,05)

EME

	Primiparous		Multiparous	
	Mean	**SE**	**Mean**	**SE**
Corrected milk (kg)	33,4	1,7	38,3	2,0
CH_4 g/day	412,1	25,2	478,3	25,1
CH_4 g/kg CM	12,3	0,3	12,5	0,3

- Average of methane per kg of CM 12,42 ± 0,85 g/kg
- Average of methane yield per cow 445,2 ± 72,5 g/day
- Similar emissions between groups (P>0,05)

MME vs. EME

	MME		EME	
	Mean	**SD**	**Mean**	**SD**
g CH_4/ kg CM	8,8	1,4	12,4	0,9
g CH_4 / day	309,3	41,9	445,2	72,6

NO CORRELATION between the variables ($r=0,24$; $P>0,05$)

Mean difference EME and MME
135,91 g/day (CI from 96,51 to 175,31 g/day)

SIGNIFICANT DIFFERENCE between EME and MME

Conclusions

- There is no correlation between the EME and MME
- There is a significant difference between EME and MME, with EME consistently higher than MME
- The results indicates that the relationship between the two variables should be further investigated to have definitive results

Take-home messages

- It is preferable to consider measured data rather than data derived from predictions
- It is necessary to develop equations that more closely approximate actual methane production
- Measurement and conversion protocols for methane should also be reviewed, reassessed, and made accessible and adaptable to different categories of animals of different ages

THANK YOU FOR THE ATTENTION

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