Abstract# 2215802

Variation among individual beef cattle in methane measurements with laser methane detector

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FIELD FOREST FOOD

GHG Mitigation strategies

- Animals' GHG reduction relies on different strategies: Management-Nutritional / Genetics Selection
- Individual phenotype collection has to be:
  - Cost effective on large scale
  - Labor non-intensive/ easy to collet
  - Repeatable
- Proxy for CH_4 emission based on milk MIR spectra are very promising for Dairy (Denniger et al.,2024) but are not feasible for Beef cattle

Livestock contribute 14% of CO2-eq at global scale (Fao 2014) in Italy recently estimate an 5.8% (ISPRA)

However, CH_4 has a high GWP and livestock sector contributes to 44% of total anthropogenic CH_4 emission (2/3 from Cattle)

Methods to measure Methane

- Different studies have reviewed the available methods to quantify methane emissions from ruminants (Hammond 2015, Garnsworty 2019)
- Other reviews and technical reports suggested guidelines, protocols or good practices for methane quantification (Chagunda 2013, Bruider et al. 2015, Jonker et al 2020, Sorg 2022)

Method	Purhcase Cost	Running Cost	Labour	Repeatibility	Throughput
Respiration chamber					
SF6					
"Sniffers" FTIR/MDIR					
GreenFeed ®					
LMD					

(Garnworthy et al 2019)

Aims of this study

To evaluate Laser Methane Detector (LMD) in a case study performed on Piemontese young bulls:

- To assess the relationships between emission concentration from LMD, young bull behavior, body weight (BW) and dry matter intake (DMI)
- To test different phenotypes derived from LMD measurements

Experimental Settings

- Ten growing bulls farmed at the Performance Test Station of Piemontese Breeding Association (ANABORAPI, Carrù, Italy) in 2 pens of 20 m^2

- Data collection was carried out on 2 consecutive days for two groups of age (G1, G2) of 5 males each of homogenous but different ages
  - Average ages: 202.2±9.6 days (G1) and 319±10 days (G2)
  - Average BW: 307.4±24.3 kg (G1) and 444.6±62.2 kg (G2)
  - Behavior : Standing, Feeding, Laying Down, Ruminating, Drinking
  - Feeding: Young bulls were fed with concentrate and chopped straw

✓Concentrate pellets from auto-feeder: quasi-*ab libitum* in 6 meal/day: 4.6 (G1) and 6.8 kg DM/day (G2)

✓Straw were always available and weighted *ab libitum*. 0.9 (G1) 1.5 kg DM/day (G2)

Instruments used and protocols

- 2 Pistols , model RLGD-100 (FPI, Hangzhou, PRC)
- 2 operators run the spot measurements

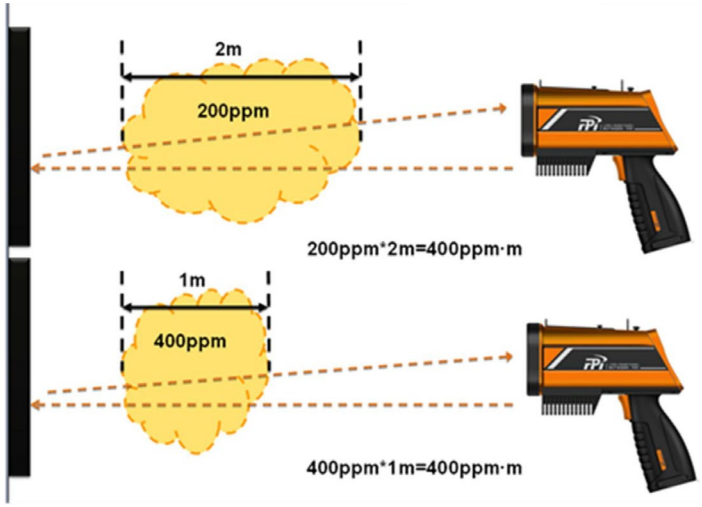
LMD can detect CH_4 concentration in the plume emitted by animals in respiration and eructation events with hand-handled instrument performing highly sensitive IR absorption measurements (Iseki and Miyaji, 2003)

Main Interface

Laser Methane Detector (LMD)

- Pros of using LMD
  - Agreement between LMD records and RC methods (Chagunda 2013)
  - Low running cost
  - On-farm Flexibility for spot measurements of methane concentration
- Cons of LMD
  - Environmental disturbances
  - Challenges for correct settings & comparability of [CH_4] with the other CH_4 metrics (e.g. daily quantification of individual methane emitted, methane intensity, etc.)
  - Labor intensive (Garnsworty 2019)

Average methane density between the detector and target is displayed in ppm*m. 2 measures/second (120 punctual measures/min)



Working Principle

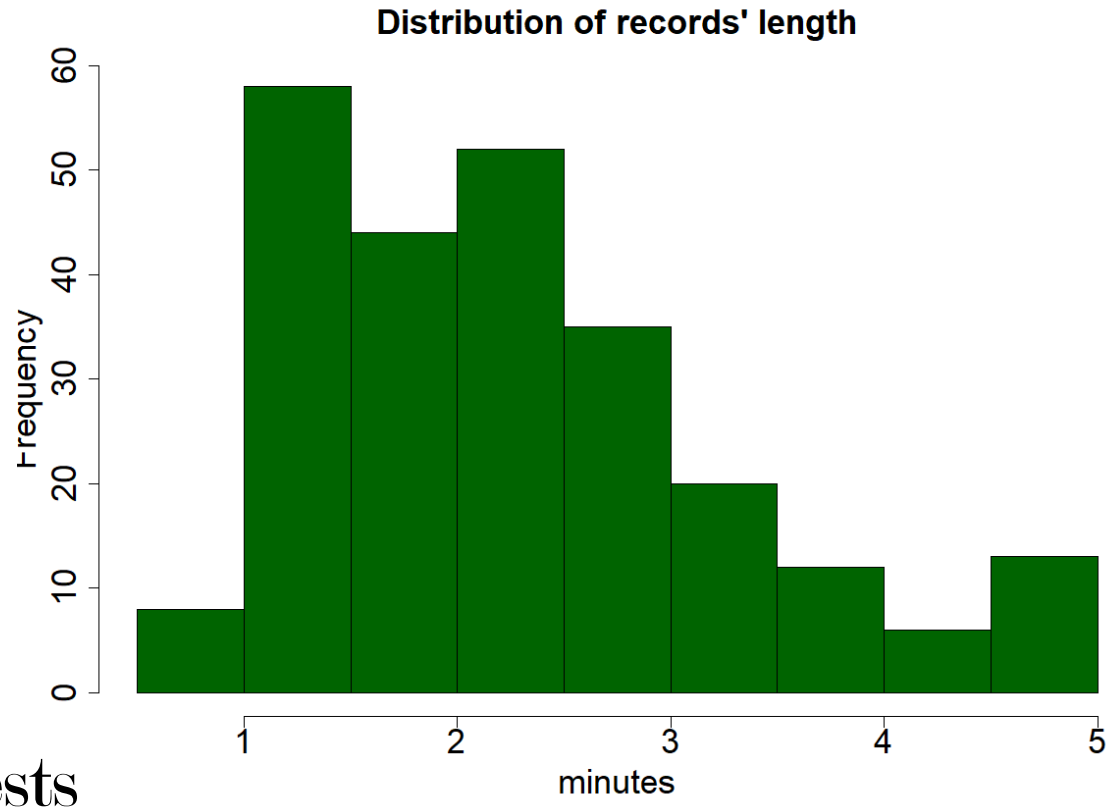
Data Pretreatments

Data and Editing [CH_4]

- 74,944 data points
- Valid records>1 min.
- 67,568 Data points
- Total valid test: N=248

Average test per animal

- n=22.5 tests, min=15 tests , max=41 tests



Statistical Analysis

- Three phenotypes were considered (**Y**)
  - Mean [CH_4] (ppm* m) – **Conc**
  - Mean of $\log_{10}$[CH_4] ($\log_{10}$ ppm* m) – **logConc**
  - Sum of concentration (ppm* m) – **sumConc**

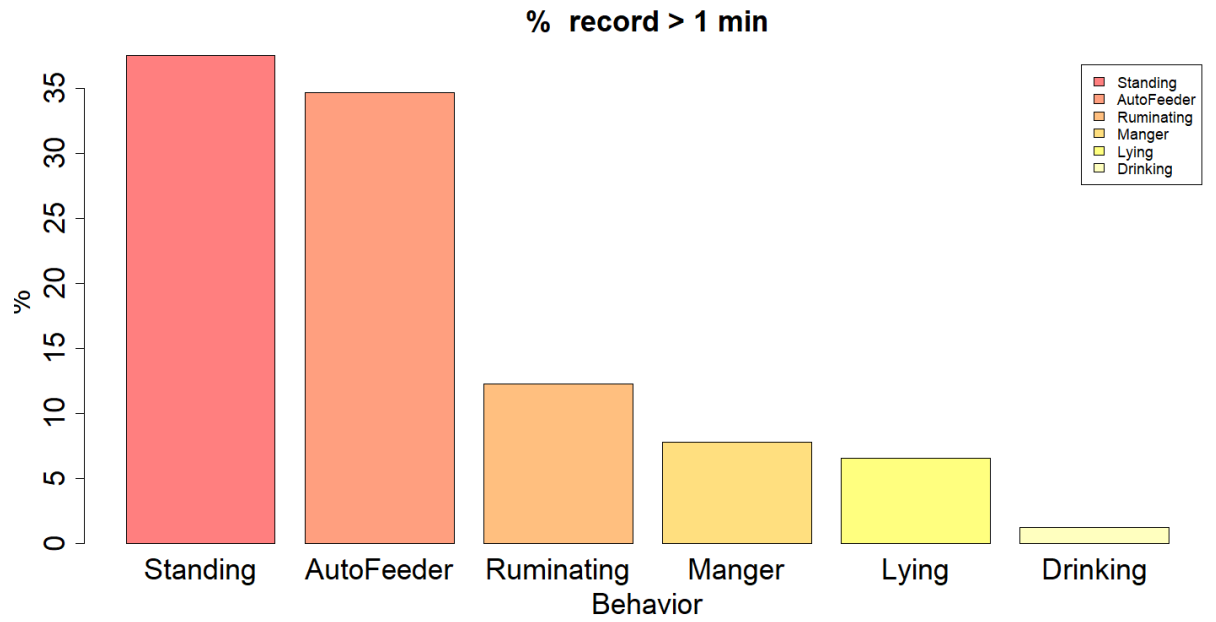
  For each animal and for each test summation of all the data points were computed
- Statistical Analysis (PROC Mixed of SAS)

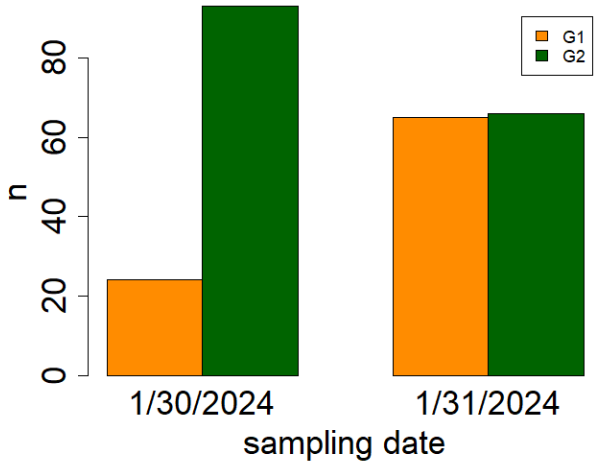
$$Y_{ijk} = Age_i + Behav_j + Date_k + Age_i \times Beheav_j + e_{ijk}$$

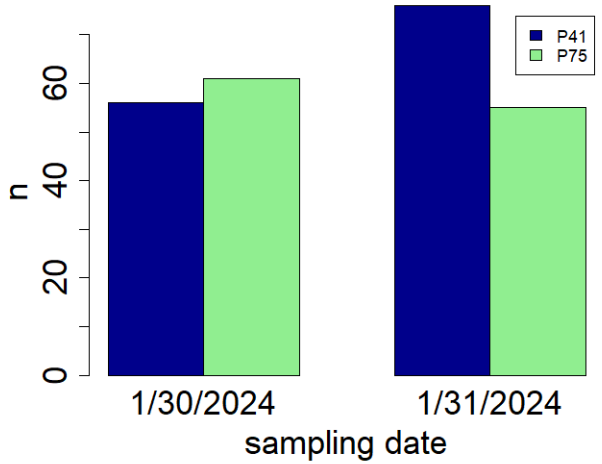
- Mixed linear model with no. of minutes of recording as weighting factor
- LS means for different Behav were separated at $p<0.05$ with Tukey adjustement for post hoc comparisons
- Pairwise-Spearman rank correlation between RESIDUALS of three Y (Conc, logConc, sumConc)
- Correlation and Regression analysis of [CH_4] on DMI and Body Weight

Dataset overview

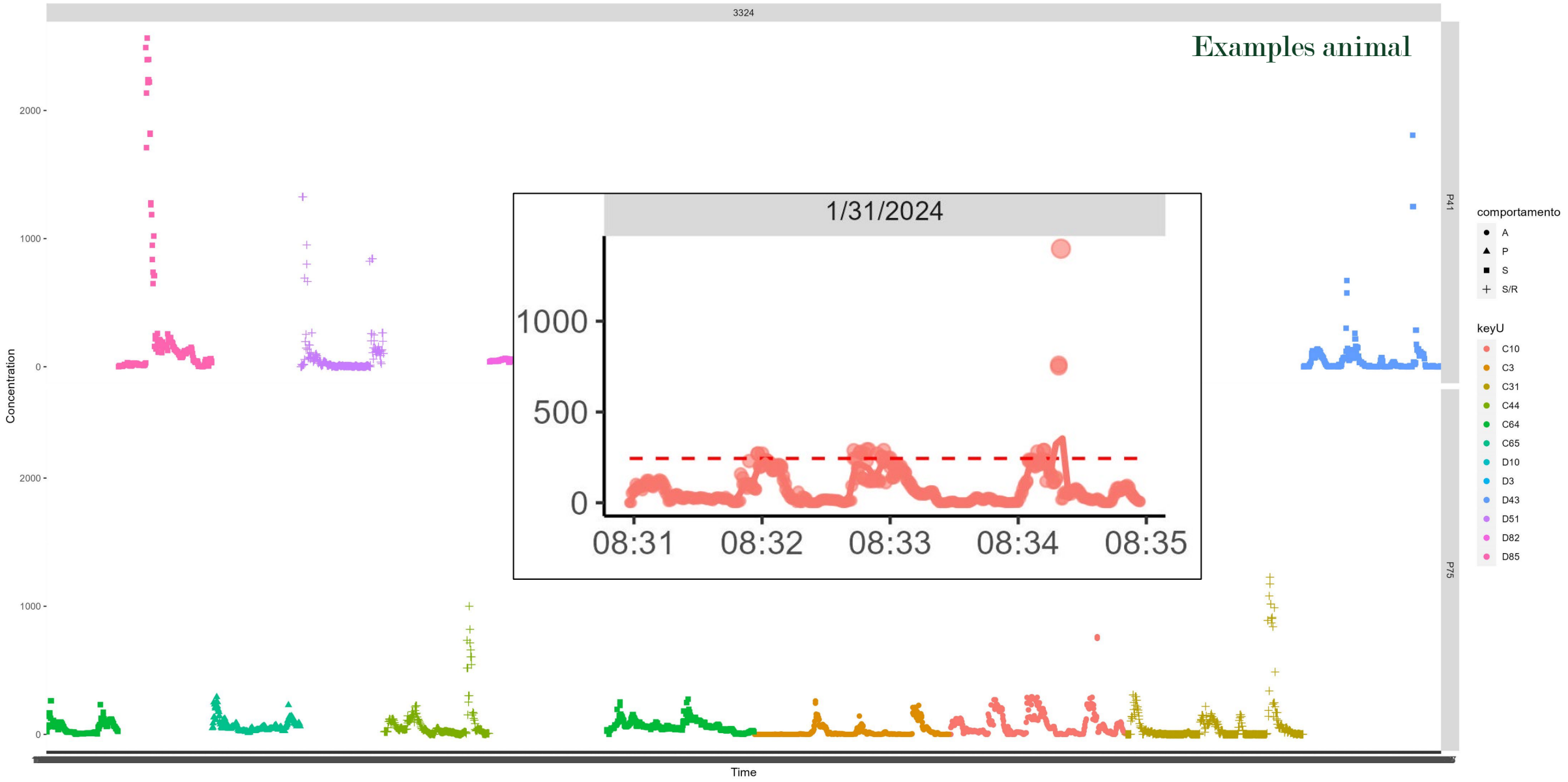
Behavior	Datapoint › 1 min	Average recording (min)	sd
Auto-feeder	25038	3.01	1.25
Drinking	659	1.82	0.16
Manger	4017	2.03	0.77
Standing	21440	2.15	0.70
Laying down	5578	3.28	1.16
Ruminating	10702	3.25	0.90
--	134	1.10	-
Overall (used)	67568 (67434)	2.72	1.12



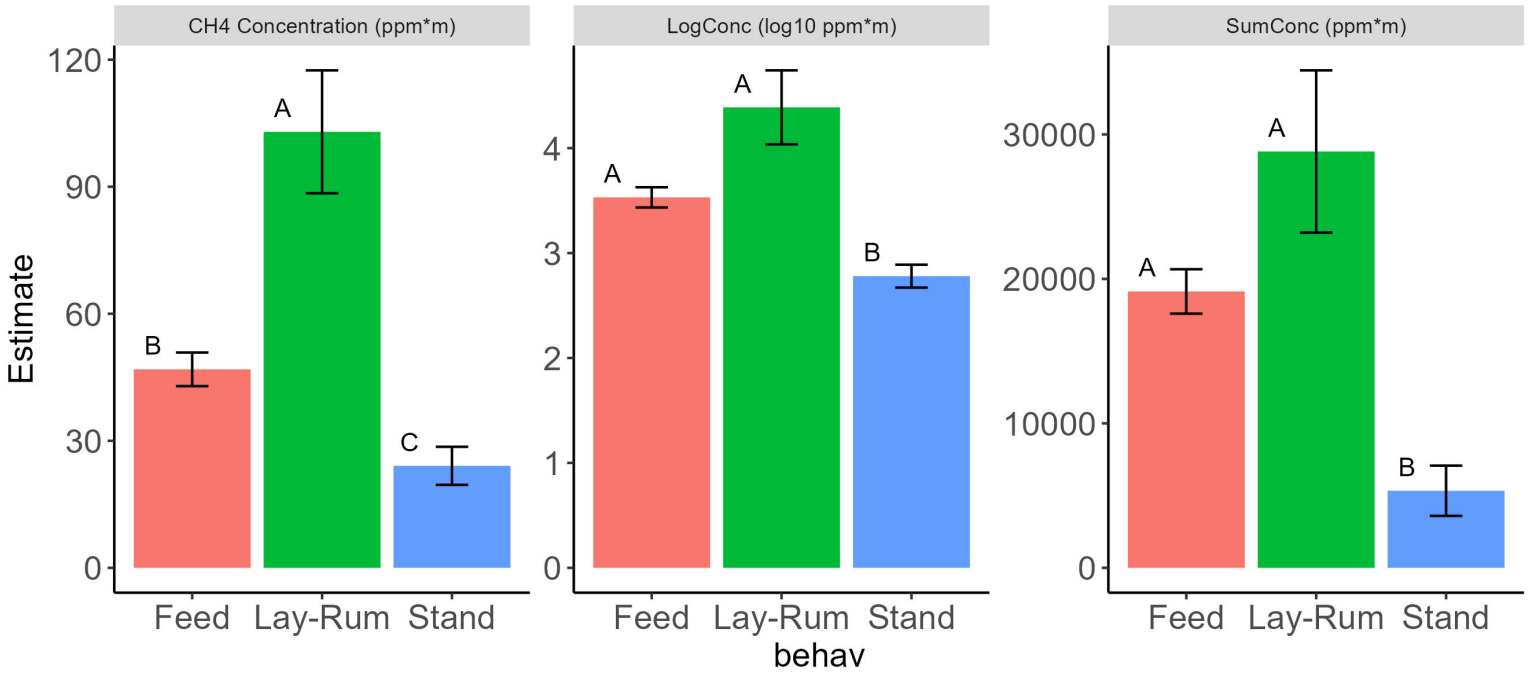




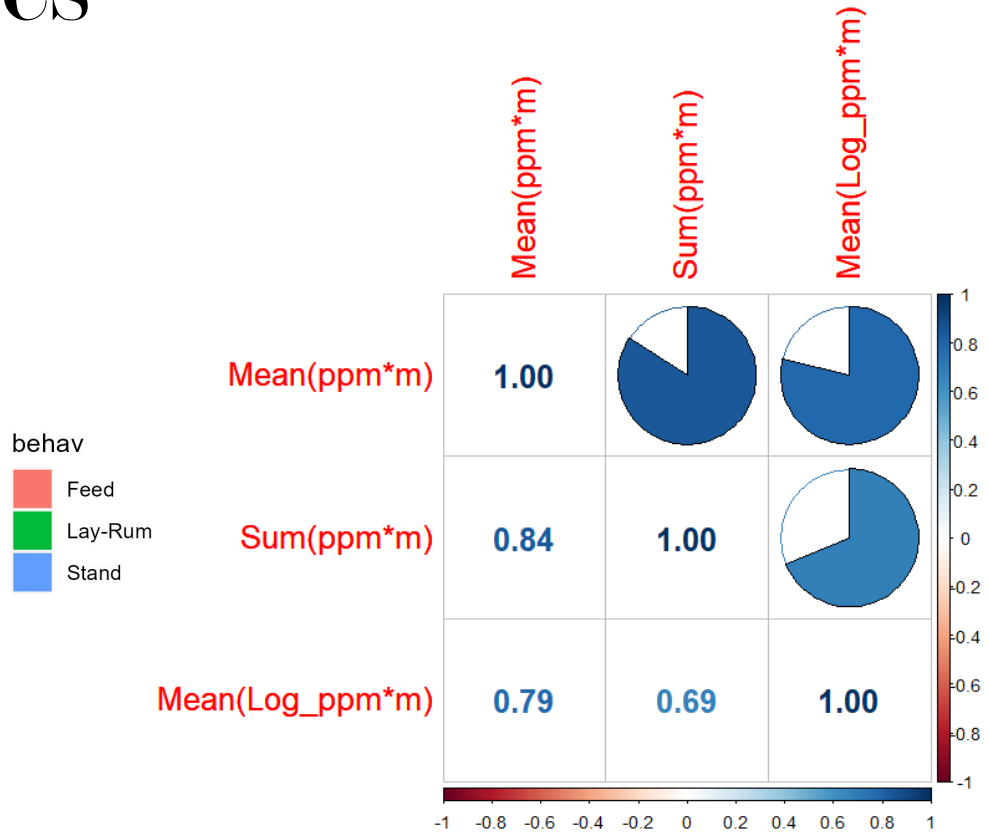
Examples animal



Behaviors and phenotype types

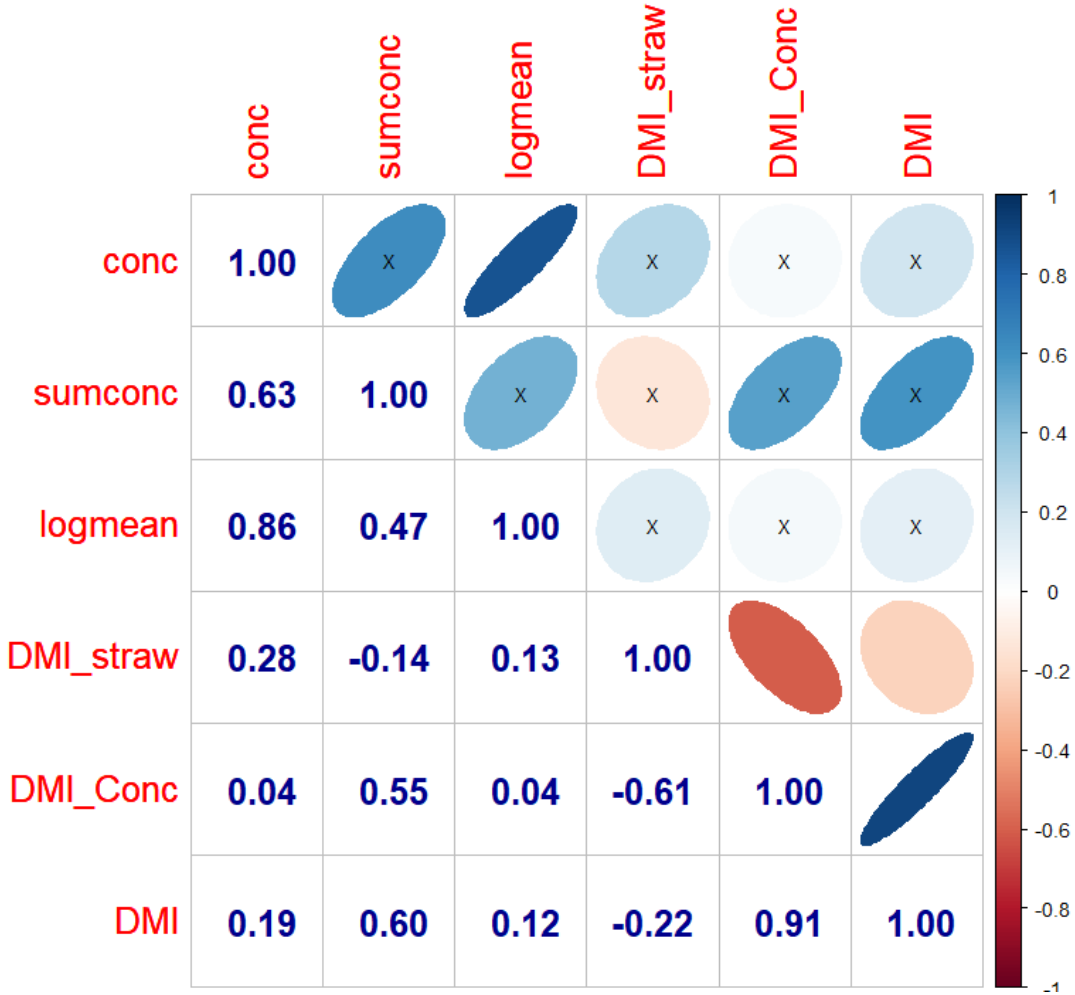


LS means for tree CH4 concentration Trait for Feeding, Laying Down - Ruminating

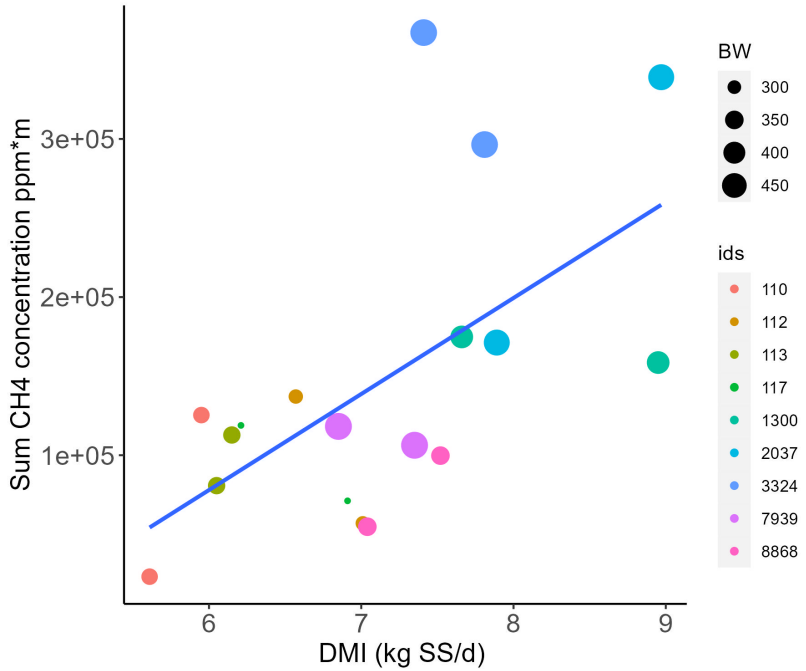


Pairwise-Spearman rank correlations between resisuals considering different phenotypes

Correlation and regression analysis



x = not significant



Variabile	estimate	se	Valore t	Pr › |t|
Intercept	-362289	157986	-2.29	0.0378
DMI_straw	65.19	45.55	1.43	0.1743
DMI_Conc	29.43	23.88	1.23	0.2381
Body Weight*	662.04	301.38	2.20	0.0454

Conclusions I

- LMD were applied for detecting individual methane concentration in 10 young bulls of Piemontese Breed
- Estimated CH4 concentration were significantly different when young bulls were running different behavior, but …
- … different animal rankings were observed according to phenotype considered

Conclusions II

- No significant correlation (0.60) of [CH4] with DMI were recorded but significant association with BW were observed
- The main limitations of this study is due to small number of monitoring days/animals, however …
- LMD measure shows variability among animals and - opportunely validate - may be further explored to correctly rank animal on emitting pattern in beef animals under Farm condition

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Thank you for your attention

Any Question?

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