ANIMAL BREEDING SUSTAINABILITY

The Italian Holstein experience

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25th Congress ASPA2023
Animal Production Science: innovations and sustainability for future generations
Monopoli (Bari, Italy), June 13-16, 2023

INTRODUCTION

- Dairy cattle is known to be impactful on greenhouse gases (GHG) emissions for **over 10%** of livestock sector emission globally (*Gerber et al., 2013*);

- Methane (CH_4) and carbon dioxide (CO_2) emissions have been shown to be **heritable**, providing the basis for applying genetic selection for their reduction (*Cassandro et al., 2010*);

- **National breeding programs** and the genetic improvement can provide relevant contribution to reduce GHG emissions;

- ANAFIBJ has started to collect **phenotypes** of methane emissions on **Italian Holstein young bulls candidates to the artificial insemination in Italy from 2018** at Genetic Center **.**

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OBJECTIVES

- To set up a **routine recording system and data pipeline** of **biometric measures**, **feed intake, water intake and GHG emissions** from Genetic Center to ANAFIBJ DB;
- Implementation of **experimental protocols** to be applied in **experimental farms**;
- Implementation of **experimental protocols** to be applied in **commercial farms**;
- Evaluate **microbial contribution** to enteric CH_4 emissions;
- Evaluate the reliability of **faeces and buccal swabs as a proxy** of rumen sample.

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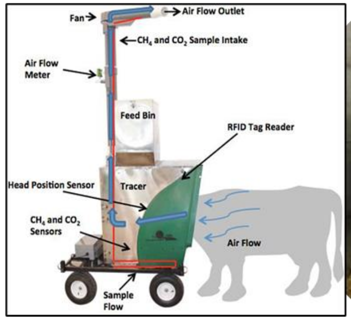
MATERIALS AND METHODS

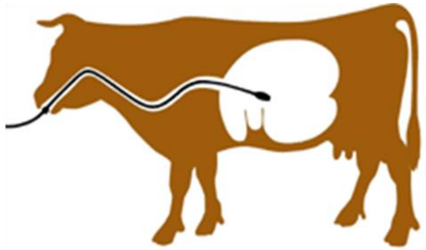
ANIMALS

- 228 genotyped Italian Holstein young bulls (rank98);
- 61,591 SNPs were available after editing;
- 4-12 months of age;
- Free-stall;
- Ad libitum feeding.

EQUIPMENT

- GreenFeed (*C-Lock Inc.,Rapid City, SD,USA*);
- Laser Methane Detector Mini (*Crowcon, Abingdon, UK*);
- Flora Rumen Scoop (*Profs Products*).





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MATERIALS AND METHODS

Data from animals:
- Body weight (WEI);
- Body Condition Score (BCS);
- Heart circumference (HG);
- Height (HEI).

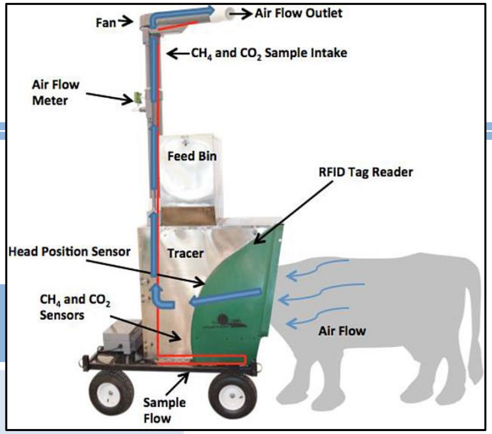
Data from GreenFeed:
- Number of visits (NVG);
- Carbon dioxide daily emissions (CO_2);
- Methane daily emission (CH_4);
- Average airflow (AIR);
- Average time at the GreenFeed (ATG).

Data from Laser Methane Detector Mini:
- Mean of CH_4 peaks (P_MEAN).

Data from metagenomic analysis:
- Relative abundance of OTU (ABU).

MATERIALS AND METHODS

EXPERIMENTAL PROTOCOL - GREENFEED



FACTORS	FREQUENCY
Animals per box	Max. 20 animals/day
Feeding interval	21,600 s = 6 hours
Amount of feed per drop	≈ 60 g
Feed dispense frequency	Max. 6 time / access

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EXPERIMENTAL PROTOCOL – LASER METHANE DETECTOR MINI

FACTORS - Measuring livestock CH_4 emissions with the LMD: a review (Sorg, 2021)	
Distance to the animal	1,5 m
Duration of recording	300 s
Number of consecutive days per measurement	5 + 5
Time of day	8:00 am, 12:00 am, 3:00 pm;
Animal activity	Standing
Pointing angle	180° (front of the animal)

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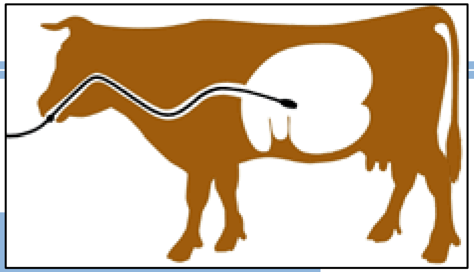
EXPERIMENTAL PROTOCOL – RUMINAL FLUID SAMPLE / BUCCAL SWABS / FAECES



FACTORS	FREQUENCY
Position of the animal	Standing with head locked
Frequency of sampling	2 times in 100 days
Time interval between sampling	≈ 80 days
Storage condition	- 80°C
Instrumental analysis	Shotgun Metagenomic Sequencing 16SrRNA

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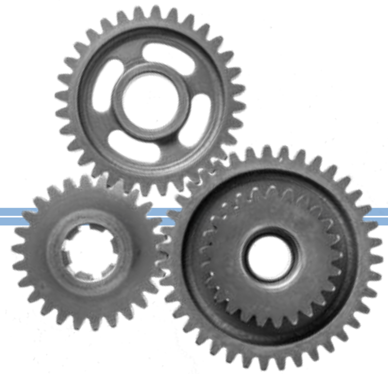
RESULTS



AUTOMATIC DATA PIPELINE

- Animal data
- Weight
- BCS
- Biometric Measures
- GreenFeed data
- Feed Intake data
- Water Intake data

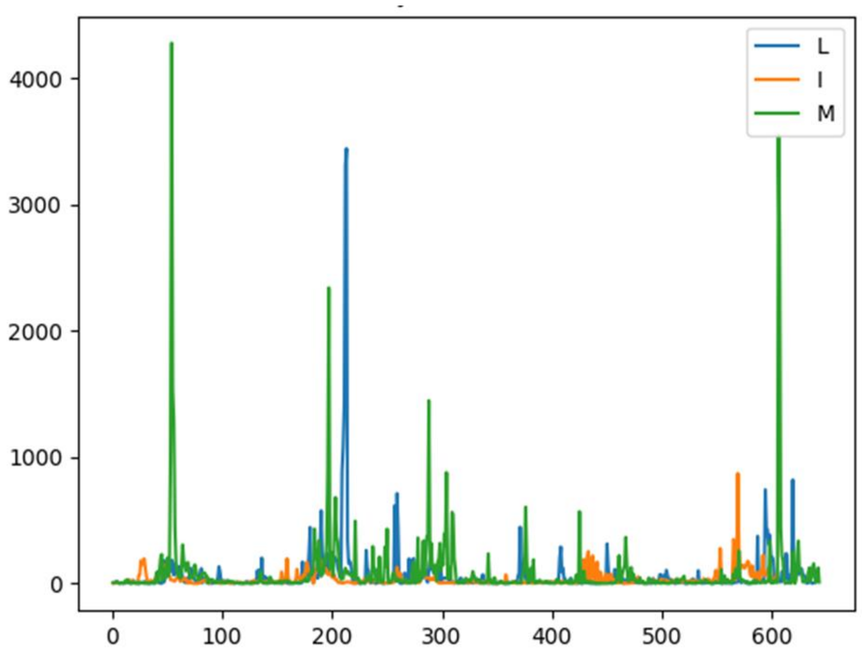
Daily updated

ANAFIBJ DB

RESULTS

LMD TESTING TRIAL

	peak_mean_M	raw_mean_M	peak_mean_I	raw_mean_I	peak_mean_L	raw_mean_L
Giorno 1	66.13	29.04	64.28	31.51	100.53	36.40
Giorno 2	75.44	32.69	45.83	20.41	139.98	43.98



- LMD are **not reliable** and repetable;
- **No correlation** between LMD and GreenFeed.

- Small sample size?
- Short time interval?

RESULTS

Trait	Metric	N	Mean	SD
WEI	kg	885	309.3	77.5
BCS	score	849	3.0	0.3
HG	cm	715	157.3	14.2
HEI	cm	714	125.5	7.7
«GREEN TRAITS»				
NVG	count	2,817	3.9	1.7
CO_2	g/d	2,817	6198.2	1103.9
CH_4	g/d	2,817	223.6	51.8
AIR	L/s	2,817	29.2	4.0
ATG	s	2,817	329.3	87.5

Trait	h^2
WEI	0.45 (0.24)
BCS	0.51 (0.20)
HG	0.44 (0.25)
HEI	0.39 (0.23)
NVG	0.36 (0.11)
CO_2	0.48 (0.21)
CH_4	0.40 (0.17)
AIR	0.45 (0.09)
ATG	0.24 (0.11)

A selection index to reduce GHG emissions can be set up **without compromising growth, BCS, height and feed intake**.

	WEI	BCS	HG	HEI	NVF	AIF	NVG	CO_2	CH_4	AIR
WEI		0.84	0.75	0.64	0.95	0.99	0.93	0.92	0.92	0.94
BCS	0.84		0.72	0.55	0.90	0.98	0.97	0.93	0.93	0.95
HG	0.75	0.72		0.11	0.90	0.98	0.94	0.90	0.90	0.94
HEI	0.64	0.55	0.11		0.90	0.97	0.95	0.92	0.92	0.95
NVF	0.95	0.90	0.90	0.90		0.75	0.73	0.63	0.67	0.69
AIF	0.99	0.98	0.98	0.97	0.75		0.67	0.55	0.58	0.61
NVG	0.93	0.96	0.94	0.95	0.73	0.67		0.70	0.77	0.92
CO_2	0.92	0.93	0.90	0.93	0.63	0.55	0.70		0.81	0.81
CH_4	0.92	0.93	0.90	0.92	0.67	0.58	0.77	0.81		0.83
AIR	0.94	0.95	0.94	0.95	0.69	0.61	0.92	0.81	0.83	

CONCLUSION

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THANK YOU!

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