GENETIC PARAMETERS OF GROWTH, FEED EFFICIENCY AND GREENHOUSE GASES EMISSIONS IN ITALIAN HOLSTEIN YOUNG BULLS

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INTRODUCTION

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

- Methane (CH_4) and carbon dioxide (CO_2) emissions are heritable, providing the basis for applying genetic selection for their reduction (*Cassandro et al., 2010*).

- Genetic selection and **national breeding programs** can provide relevant contribution to reduce GHG emissions in two ways:
    - **Directly** using **breath measurements**;
    - **Indirectly** using indicator traits related to **feed efficiency**.

- Since 2018 ANAFIBJ has started to record methane emissions and feed intake at Genetic Center on Italian Holstein young bulls candidates to artificial insemination (AI) in Italy.

OBJECTIVE

- Description of the **collection protocol** for growth, feed efficiency and greenhouse gases (GHG) emissions in Italian Holstein young bulls;

- **Estimation of genetic parameters** to verify the feasability (direct and/or indirect) of selection for greenhouse gases (GHG) reduction in Italian Holstein population.

MATERIAL AND METHODS

ANIMALS

- 218 genotyped Italian Holstein young bulls candidates to artificial insemination (AI) in Italy and undergoing progeny test at ANAFIBJ Genetic Center;
- 171 – 541 days of age (growing animals);
- 61,591 SNP data available after imputation.

EQUIPMENT

- Roughage Intake Control system units (*RIC; Hokofarm Group, Voorsterweg, The Netherlands*);
- Automated Head-Chamber System (*AHCS; GreenFeed C-Lock Inc.,Rapid City, SD,USA*).

MATERIAL AND METHODS

ANIMALS DATA

- Body weight (WEI,kg);
- Body Condition Score (BCS,score);
- Heart girth (HG,cm);
- Height (HEI,cm).

FEED INTAKE DATA

- Visits at the feeder per day (NVF,count);
- Average intake at the feeder (AIF,kg);
- Average time at the feeder (ATF,s).

GREENFEED DATA

- Number of visits (NVG,count);
- Carbon Dioxide daily emissions (CO_2,g/d);
- Methane daily emissions (CH_4,g/d);
- Average airflow (AIR,L/s);
- Average time (ATG,s).

STATISTICAL ANALYSIS

$$Y = Xb + Z_d d + Z_p p + Z_a a + e$$

Y = phenotypic records;

X = incidence matrix of solutions for **fixed effects (age at phenotyping, date of birth);**

b = vector of solutions for fixed effects (age at phenotyping, date of birth);

Z_d = incidence matrix for the **date of recording** uncorrelated random effect;

d = vector of solutions for the date of recording uncorrelated random effect;

Z_p = incidence matrix for the animal **permanent environmental** uncorrelated random **effect**;

p = vector of solutions for the animal permanent environmental uncorrelated random effect;

Z_a = incidence matrix for the animal **additive genetic** random **effect** (with genomic relationship matrix);

a = vector of solutions for the animal additive genetic random effect (with genomic relationship matrix);

E = **random residuals.**

RESULTS

DESCRIPTIVE STATISTICS AND HERITABILITIES

TRAIT	METRIC	N	MEAN	SD	h^2
GROWTH TRAITS					
WEI	kg	885	309.3	77.5	0.45 (0.24)
BCS	score	849	3.0	0.3	0.51 (0.20)
HG	cm	715	157.3	14.2	0.44 (0.25)
HEI	cm	714	125.5	7.7	0.39 (0.23)
FEED INTAKE TRAITS					
NVF	count	7150	26.0	11.6	0.31 (0.12)
AIF	kg	7150	0.3	0.1	0.17 (0.15)
ATF	s	7150	317.0	117.1	0.29 (0.18)
GREENFEED TRAITS					
NVG	count	2817	3.9	1.7	0.36 (0.11)
CO_2	g/d	2817	6198.2	1103.9	**0.48 (0.21)**
CH_4	**g/d**	**2817**	**223.6**	**51.8**	**0.40 (0.17)**
AIR	L/s	2817	29.2	4.0	0.45 (0.09)
ATG	s	2817	329.3	87.5	0.24 (0.11)

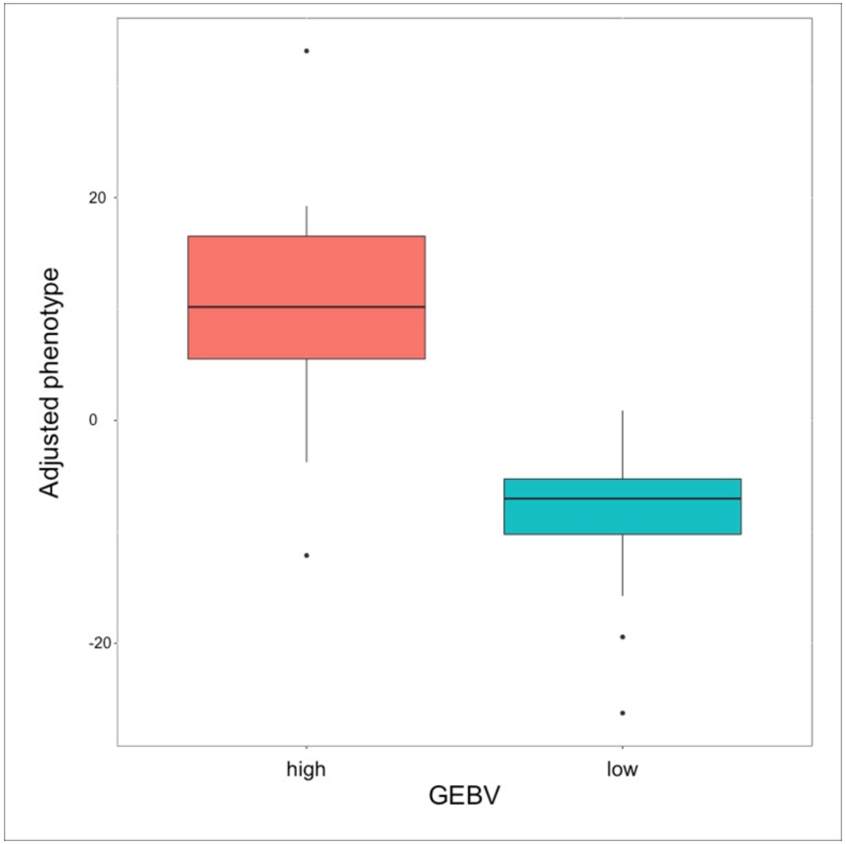
RESULTS

GENETIC CORRELATIONS

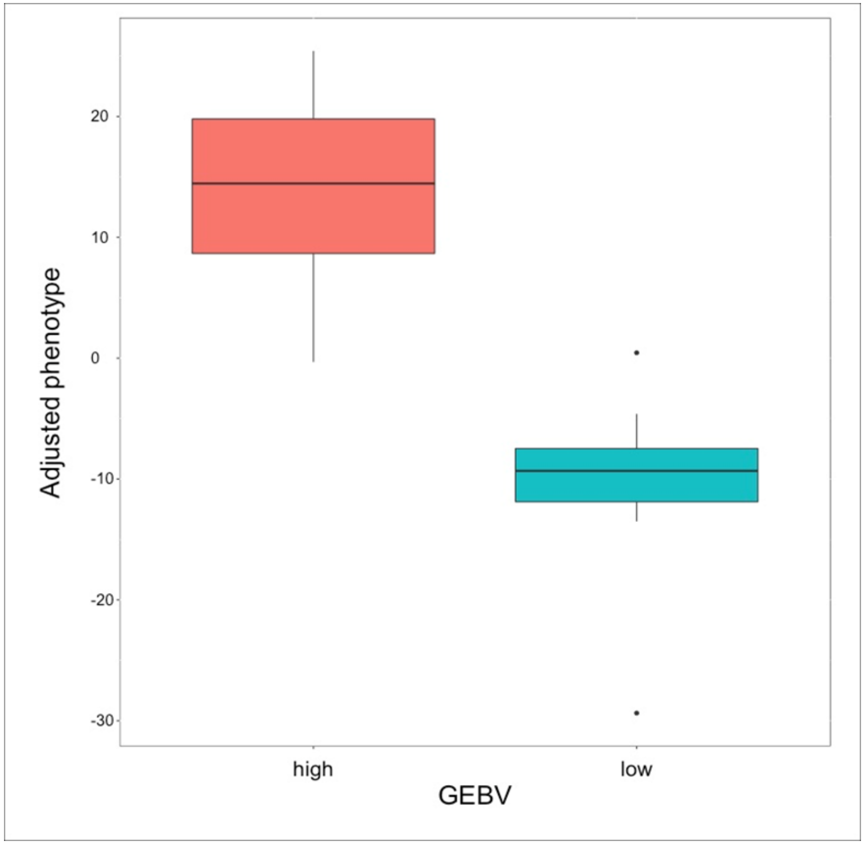
	WEI	BCS	HG	HEI	NVF	AIF	NVG	CO_2	CH_4	AIR
WEI		0.84	0.75	0.64	0.95	0.99	**0.93**	**0.92**	**0.92**	**0.94**
BCS	0.84		0.72	0.55	0.90	0.98	**0.97**	**0.93**	**0.93**	**0.95**
HG	0.75	0.72		0.11	0.90	0.98	**0.94**	**0.90**	**0.90**	**0.94**
HEI	0.64	0.55	0.11		0.90	0.97	**0.95**	**0.92**	**0.92**	**0.95**
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	

RESULTS

CH_4



CO_2



DISCUSSIONS

- We used daily records.
- We could have used:

SINGLE VISIT RECORDS		OVERALL PERFORMANCE TEST AVERAGE	
PROS	**CONS**	**PROS**	**CONS**
Possibility to reduce noise.	Animals with more visits get more records.	All animals have the same number of observations.	Average value might contain noise.

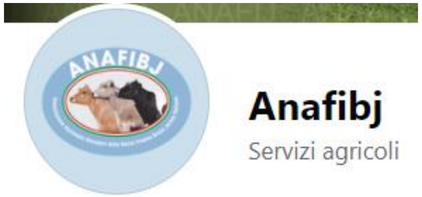
CONCLUSIONS

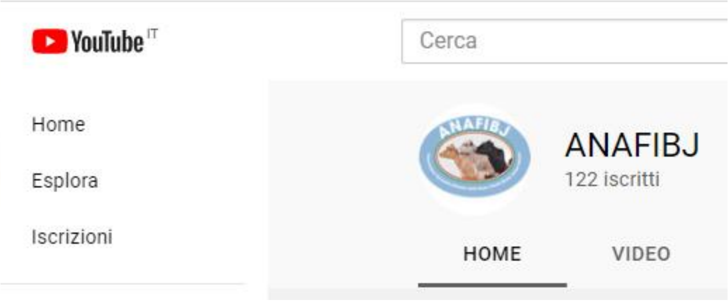
- Selection index could be built in order to reduce GHG emissions **without compromising growth, BCS, height and feed intake**.

Further steps:

- **Feed efficiency and GHG emissions** need to be **adjusted by growth, size and production records** from cows that are sibs of the tested bulls;
- Test some daughters of these bulls and **re-estimate genetic correlations between bulls and cows;**
- **Implementation of the model with other effects** as herd origin and sire origin.

THANKS FOR THE ATTENTION!





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