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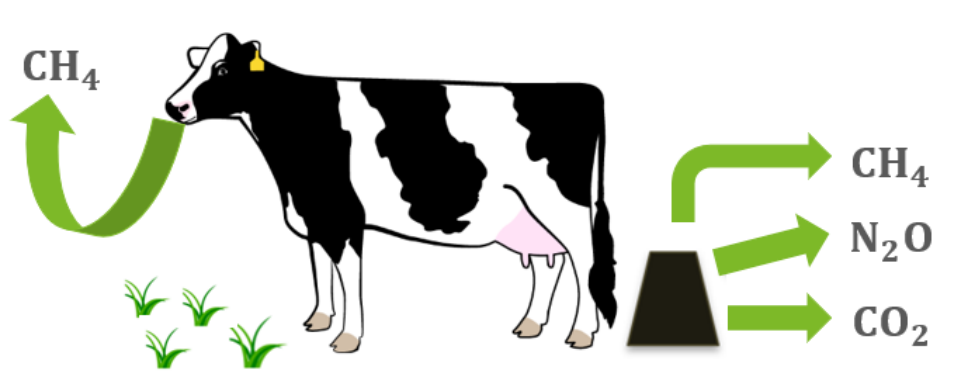
Genetic correlation between methane emissions and nitrogen use efficiency proxies in Walloon dairy cows

H. Atashi, Y. Chen, C. Grelet, A. Vanlierde, F. Dehareng, S. Vanderick, H. Soyeurt & N. Gengler

Greenhouse gases emissions (GHG) in dairy cattle



- ✓ Dairy cattle account for 20% of the global livestock sector's GHG
- ✓ GHG emissions from dairy cattle are in the form of CH_4 (44%), N_2O (29%), and CO_2 (27%)

Reducing CH_4 emissions from dairy cows

✓ CH_4 from cows represents 70% of total CH_4 emissions of agricultural sector

✓ Reducing CH_4 emissions from dairy cows is important at two aspects:

1. Environmental concerns
   Climate change

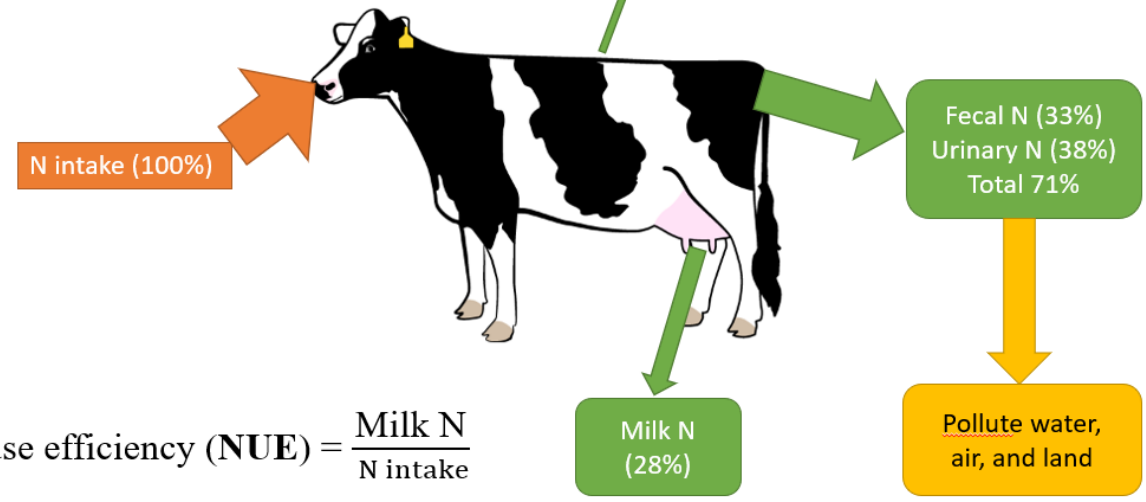
2. Economical perspective
   6% to 10% of gross energy is lost as CH_4

Nitrogen use efficiency in dairy cattle

✓ Protein is the most expensive part of a diet

✓ Feed protein is mainly metabolized into different forms of nitrogen in the cow's body

A example: cow in the US



$$\text{N use efficiency (NUE)} = \frac{\text{Milk N}}{\text{N intake}}$$

(Adapted from Spek et al., 2013)

✓ Nitrogen use efficiency of dairy cows ranges from 20% to 44%

Improving nitrogen use efficiency of dairy cows

✓ N_2O is 310 times more powerful greenhouse gas than CO_2

✓ Improving nitrogen use efficiency of dairy cows is important at two aspects:

1. Environmental concerns
   Climate change

2. Economical perspective
   > 50% intake nitrogen is not used

Regulation of CH_4 emissions and nitrogen use efficiency of dairy cows

- ✓ Improvement of feeding strategies
- ✓ Genetic selection
  - ✓ cost-effective
  - ✓ permanent strategy
- ✓ For genetic selection, traits need
  - ✓ to be well defined
  - ✓ to be recordable (milk MIR predicted)
  - ✓ to be genetically variable and heritable

Research Objectives

The aims of this study were to estimate

✓ **Genetic parameters** of two MIR-based "proxies" for CH_4 features

✓ **Genetic correlations** of the CH_4 features with nitrogen use efficiency proxies

Material and Methods

Methane emissions traits:

✓ **Milk MIR spectra were used to predict CH_4 emissions (PME, g/d)**
Vanlierde et al. (2021)

✓ **Log-transformed CH_4 intensity (LMI) was defined as log of PMI**
CH_4 intensity (PMI) defined as PME per kg of milk yield (kg/d)

Material and Methods

✓ **Data and model for CH_4 traits:**

- ✓ 1,529,282 test-day records in first parity
- ✓ Random regression test-day model

✓ **EBV and its relibility for Predicted nitrogen use efficiency (PNUE) and losses (PNL)**

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Research

Estimation of genetic parameters for predicted nitrogen use efficiency and losses in early lactation of Holstein cows

Y. Chen [1], S. Vanderick [1], R.R. Mota [1], C. Grelet [2], GplusE Consortium *, N. Gengler [1]

Material and Methods

✓ **Approximate genetic correlation by EBV of selected bulls**

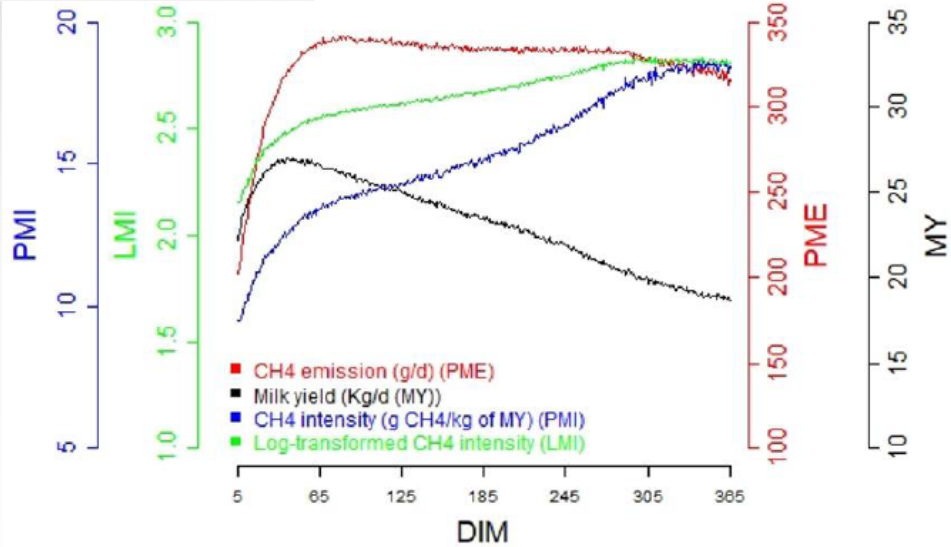
$$\hat{\rho}_{aa'} = \frac{\sqrt{(\sum b_i)(\sum b_i')}}{\sum b_i b_i'} \, r(EBV, EBV')$$

b_i is the reliability of EBV for trait a (Blanchard et al. ,1983)

✓ **Conditions for selecting bulls**

Reliability of EBV for used traits $>$ 0.30

Results 1 — Data description



Traits	Mean	SD	Peak value	Peak time
MY	23.57	6.13	27.02	42
PME	326.82	67.65	341.62	80
PMI	14.97	5.70	18.65	344
LMI	2.64	0.35	2.83	344

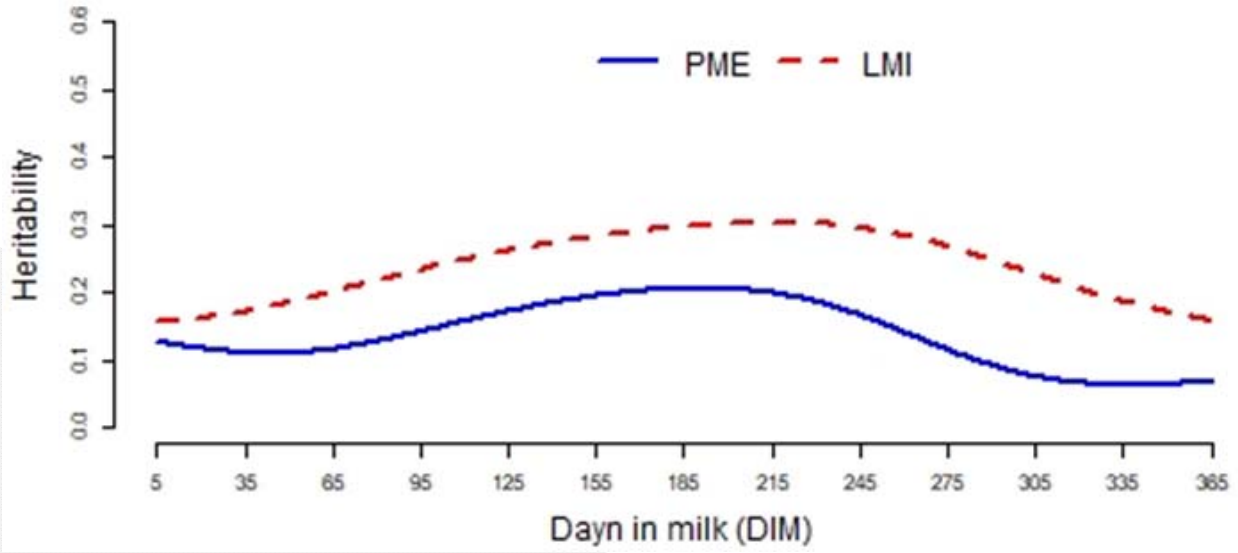
Results 2 — Heritability

Range of daily heritability for

- ✓PME → 0.07 — 0.21
- ✓LMI → 0.16 — 0.30

Mean (SD) daily heritability for

- ✓PME → 0.14 (0.05)
- ✓LMI → 0.24 (0.05)



Results 3 – Selected Bulls

A total of 420 bulls were used to estimate approximated genetic correlation (AGC)

137 (USA) 111 (NLD) 52 (CAN) …

	PME	LMI	PNUE	PNL
Mean reliability (SD)	0.84 (0.16)	0.84 (0.16)	0.48 (0.15)	0.49 (0.15)

Results 4 – Approximated genetic correlation

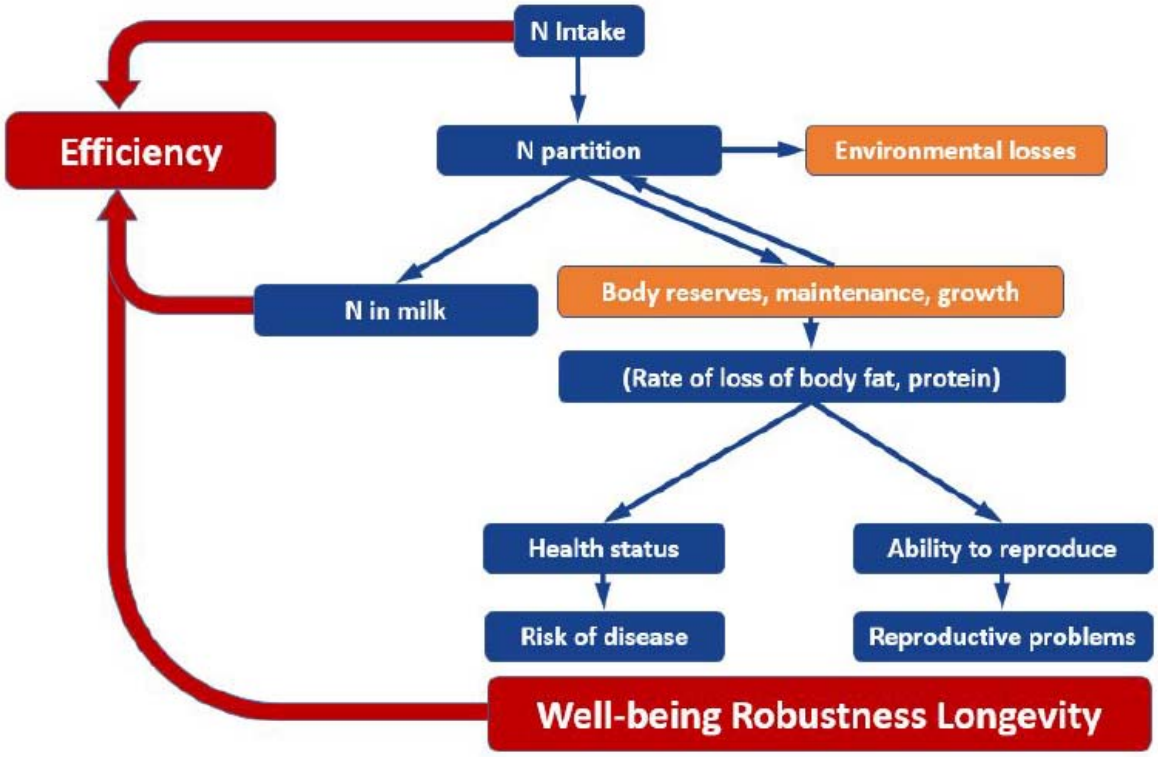
Approximated genetic correlation between four traits in the first parity (SE, n=420)

	Predicted nitrogen use efficiency	Predicted nitorgen losses
PME	-0.33 (0.07)	0.43 (0.08)
LMI	-0.60 (0.07)	0.32 (0.08)

Conclusions

- ✓ Two MIR-based "proxies" for CH_4 features were validated to be genetically variable and heritable ➔ Genetic selection
- ✓ Genetic selection ➔ CH_4 emissions↘ + N loss ↘ + Nitrogen use efficiency ↗ in dairy cows ➔ simultaneously selection
- ✓ Before introduction of these traits in a selection index, further studies needed:
  - ✓ Genetic correlation between these proxies (index traits) and direct trait (breeding objective trait)
  - ✓ Evaluate effect of inclusion in selection index on all traits already present in the current one

Future perspectives



(Chen et al., 2021)

Holistic breeding goals

- ✓ CH_4
- ✓ Nitrogen use effciency
- ✓ Resilience
- ✓ Longevity
- ✓ … …

Thank you for your attention!

Questions?

Hadi.Atashi@uliege.be
Yansen.chen@uliege.be
Nicolas.Gengler@uliege.be