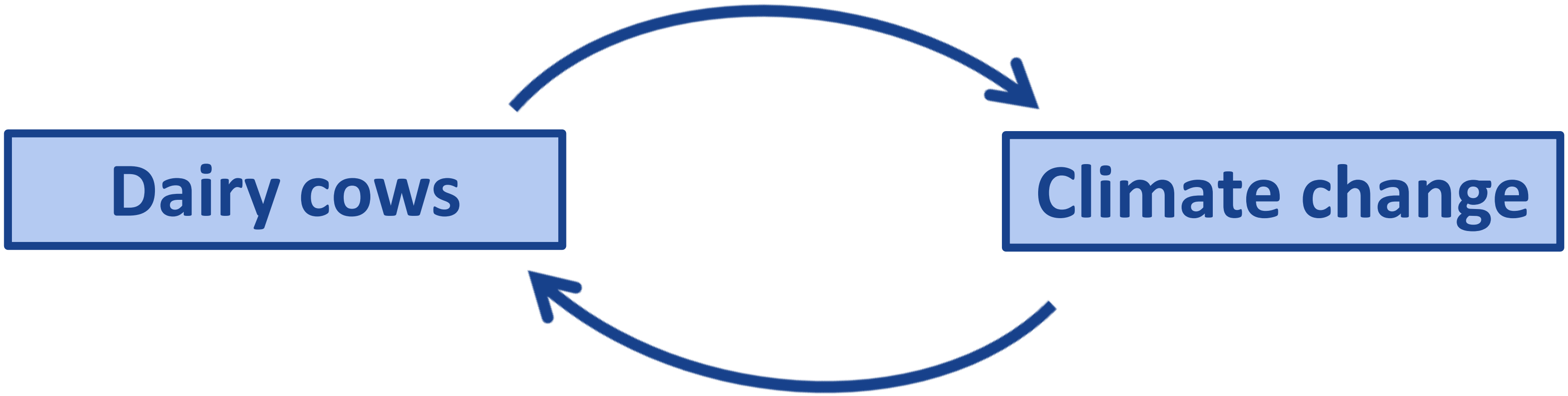
Genetic effects of heat stress on milk yield and MIR predicted methane emissions of Holstein cows

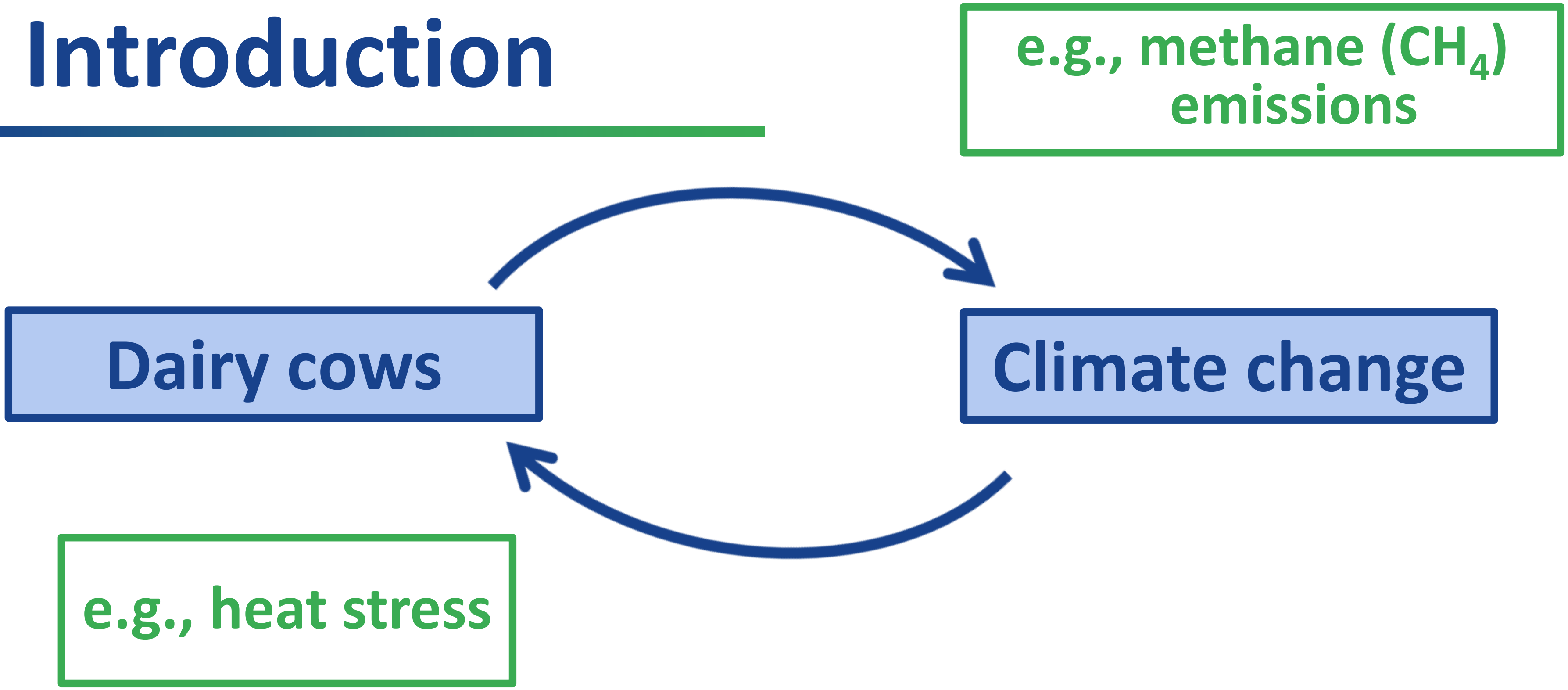
M.-L. Vanrobays[1,*], N. Gengler[1], P.B. Kandel[1],
H. Soyeurt[1] & H. Hammami[1,2]

[1] University of Liège, Gembloux Agro-Bio Tech – Gembloux, Belgium
[2] National Fund for Scientific Research (FRS-FNRS) – Brussels, Belgium

Introduction

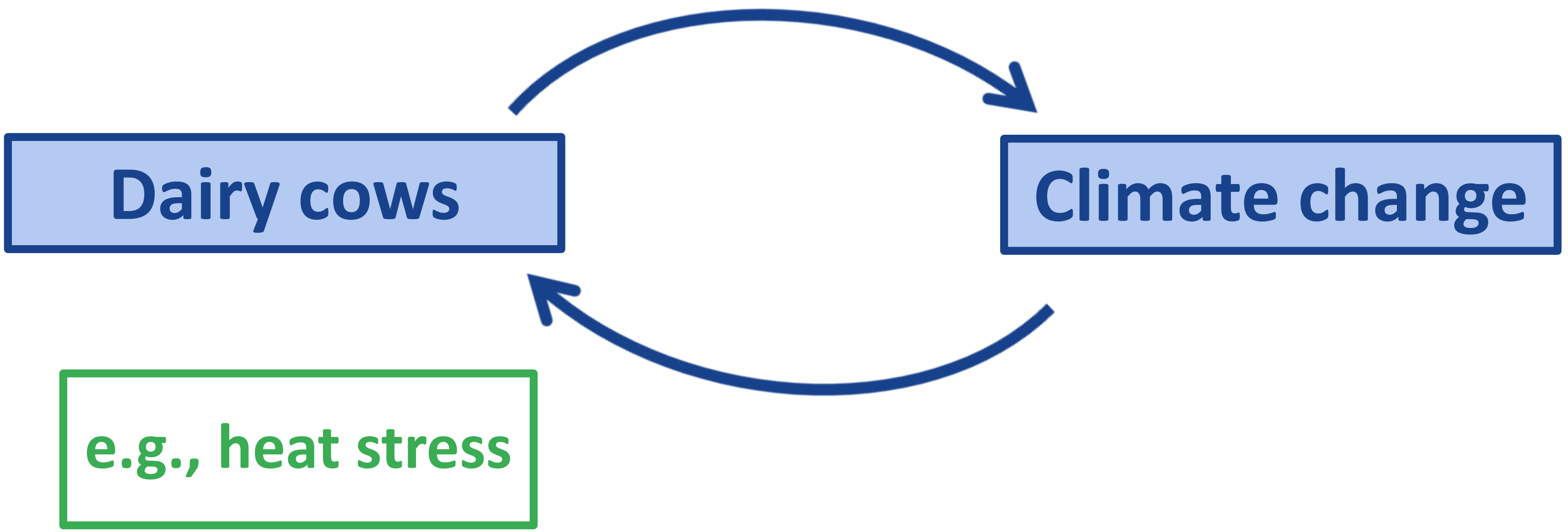


Introduction



Objective

e.g., methane (CH_4) emissions



- **To mitigate these interactions:**
  - **Breeding for heat tolerance**
  - **Breeding for reducing CH_4 emissions**

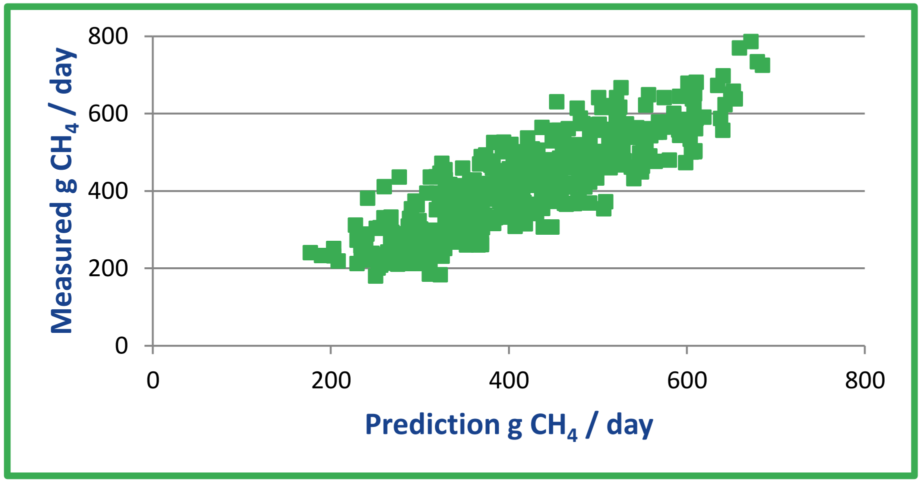
Objective

- Genetic parameters of
  - Milk yield
  - CH_4 emissions predicted by milk mid-infrared (MIR) spectra

→According to a Temperature Humidity Index (THI)

Data

- **Prediction of daily CH_4 emissions of cows**
  - **From milk MIR spectra**
  - **R^2 of cross-validation = 0.70**



(Vanlierde et al., 2013, Presentation 2, Session 4, EAAP, Nantes)

Data

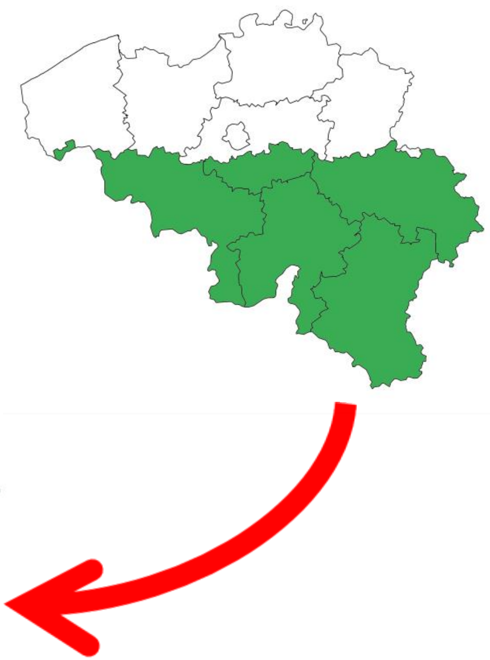
- 257,635 milk test-day (TD) records with MIR predicted CH_4
  - 51,782 Walloon Holstein first-parity cows
  - From January 2007 to December 2010
  - 983 herds
  - ≥ 15 cows / herd
  - ≥ 3 records / cow
- Pedigree
  - 150,399 animals

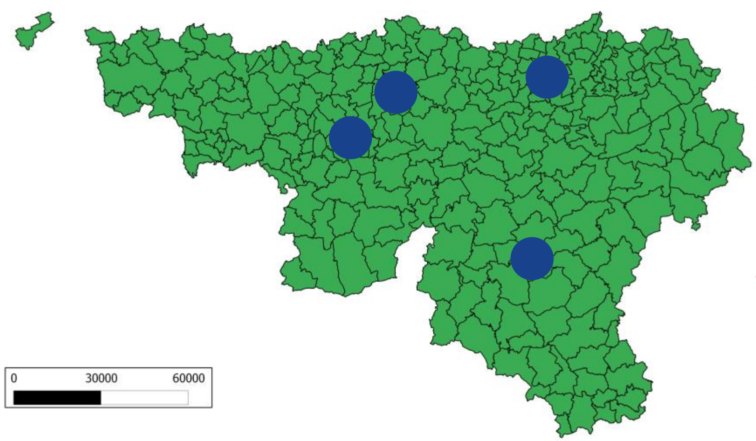
Descriptive statistics of the dataset

Traits (N=257,635)	Mean	SD
Milk (kg/day)	23.42	5.89
MIR CH_4 (g/day)	558.05	89.89

Meteorological data

- **Daily meteorological data**
  - **4 public weather stations in the Walloon Region of Belgium** (IRM)
    - **Dry Bulb Temperature (T_{db})**
    - **Relative Humidity (RH)**





Temperature Humidity Index

$$THI = (1.8 \times T_{db} + 32) - [(0.55 - 0.0055 \times RH) \times (1.8 \times T_{db} - 26)]$$

where T_{db} = Dry Bulb Temperature (°C) & RH = Relative Humidity (%)

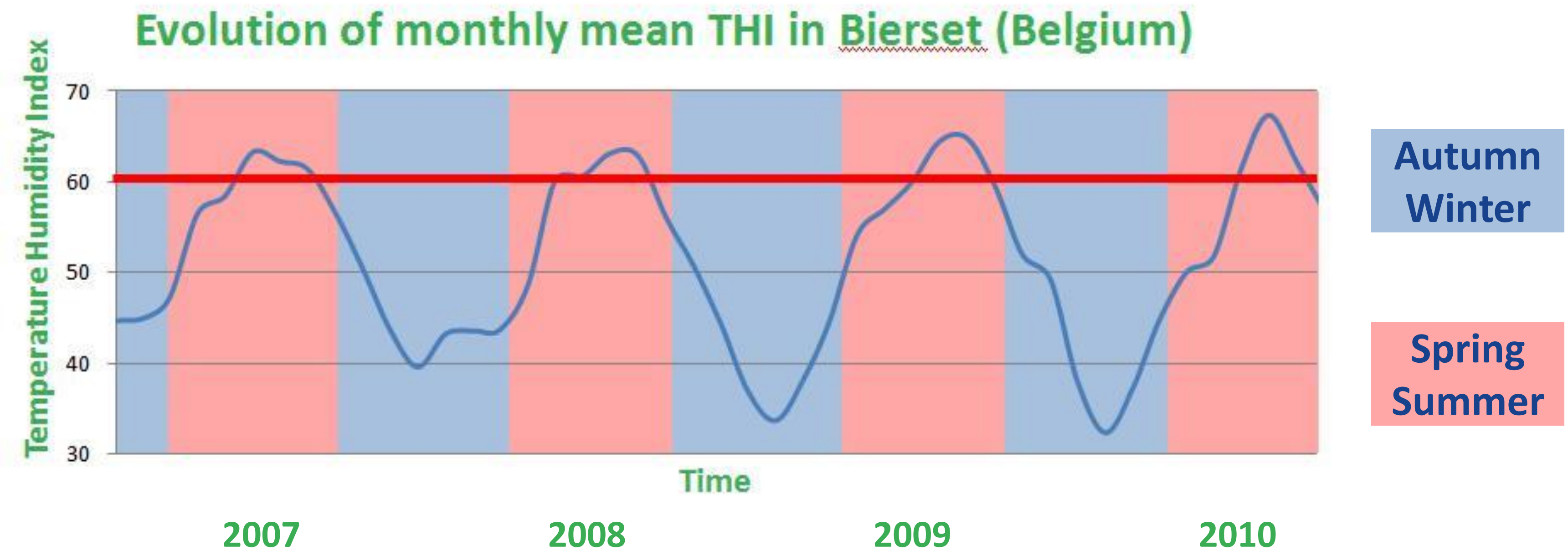
(NRC, 1981)

Temperature Humidity Index

$$THI = (1.8 \times T_{db} + 32) - [(0.55 - 0.0055 \times RH) \times (1.8 \times T_{db} - 26)]$$

where T_{db} = Dry Bulb Temperature (°C) & RH = Relative Humidity (%)

(NRC, 1981)



Temperature Humidity Index

$$THI = (1.8 \times T_{db} + 32) - [(0.55 - 0.0055 \times RH) \times (1.8 \times T_{db} - 26)]$$

where T_{db} = Dry Bulb Temperature (°C) & RH = Relative Humidity (%)

(NRC, 1981)

Mean THI of the previous 3 days before TD record

→ Used as THI reference for that record

Model

- **Bivariate random regression TD model**
  - **With random linear regressions on THI values**

$$y = Xb + Q_1 (Wh + Zp + Za) + e$$

- **Fixed effects: Herd x Test-day, Lactation stage, Gestation stage & Age at calving x Season of calving x Lactation stage**
- **Random effects: Year of calving x Herd, Permanent environment & Additive genetic**
  - ✓ **Regressions modelled with 1st order Legendre polynomials**

Model

- Bivariate random regression TD model
  - With random linear regressions on THI values

$$y = Xb + Q_1 (Wh + Zp + Za) + e$$

  - Estimation of variance components
    - REMLF90 (Misztal, 2012)
  - Estimation of breeding values
    - BLUPF90 (Misztal, 2012)

Genetic parameters

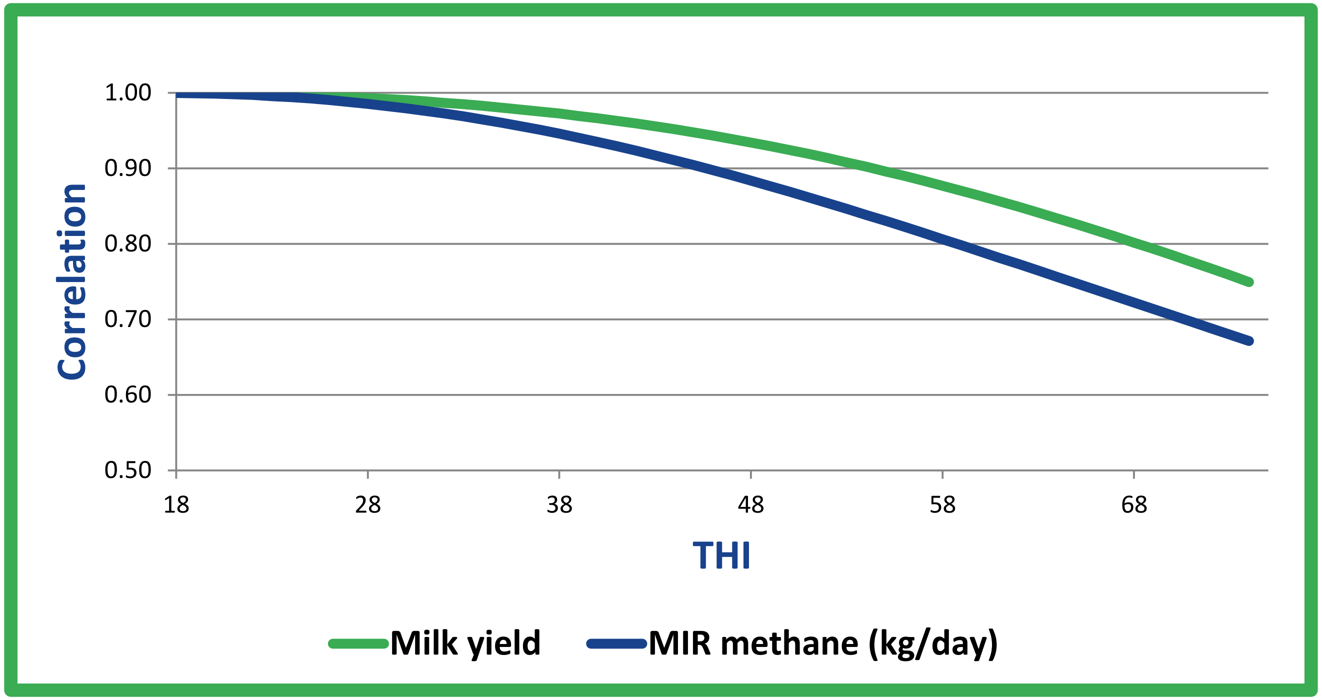
- Genetic variances (σ^2) & correlations (r) estimated for milk (MY) & MIR predicted CH_4 by bivariate analysis

	$\sigma^2_{MY_0}$	$\sigma^2_{MY_{hs}}$	$\sigma^2_{CH_{40}}$	$\sigma^2_{CH_{4hs}}$
Variances	3.28	0.16	438.4	29.44
$\sigma^2_{a_{hs}} / \sigma^2_{a_0}$	0.05		0.07	
$r_{a_0, a_{hs}}$	-0.24		0.19	
$r_{MY_0, CH_{40}}$	-0.27			
$r_{MY_{hs}, CH_{4hs}}$	-0.29			

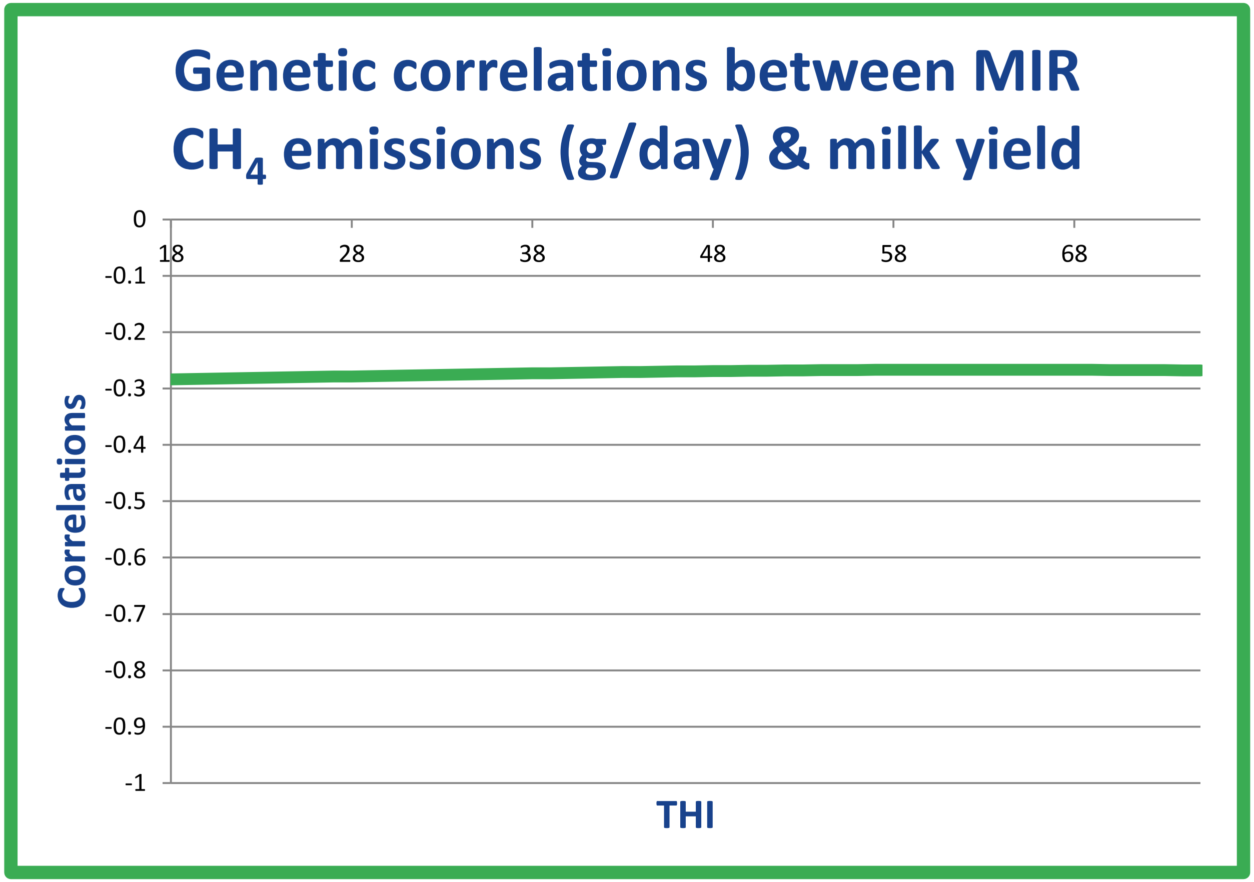
Subscript (0) means the intercept (regular) & (hs) is the slope (heat tolerance)

Genetic parameters

- **Genetic correlations between THI value of 18 & other THI values**

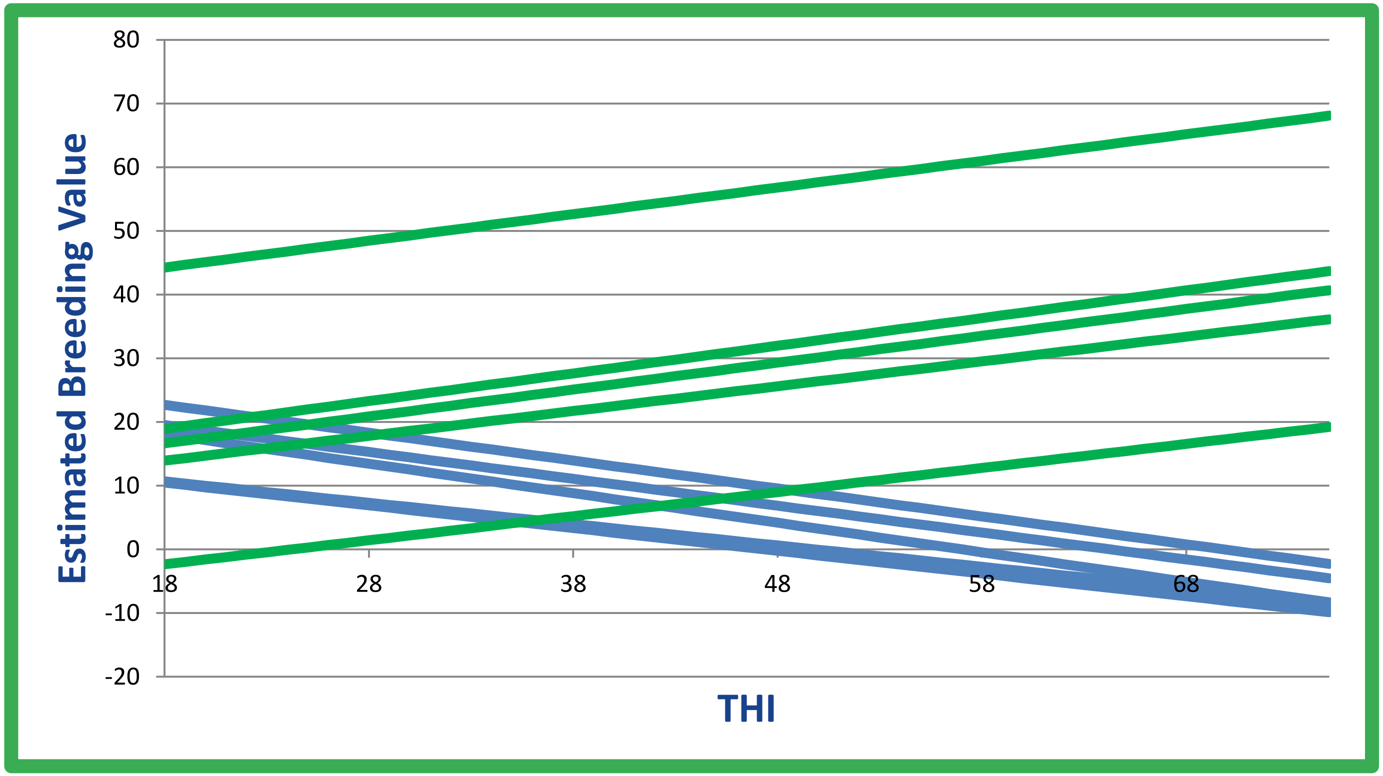


Correlations with milk yield



EBV – MIR CH_4 (g/day)

- **EBV of bulls with at least 30 daughters**



Bulls with the largest slopes
Bulls with the smallest slopes

Conclusions

- Influence of THI on MIR CH_4 emissions of cows
- Expression of genetic potential according to THI for studied traits
- THI affected on a similar scale milk yield & CH_4 trait
- Selection for heat tolerance & reduced CH_4 emissions seems to be possible

Université de Liège

gembloux agro bio tech

fnrs
LA LIBERTÉ DE CHERCHER

Wallonie | SPW Service public de Wallonie

DGO 3

SEVENTH FRAMEWORK PROGRAMME

GREENHOUSE MILK

cra-w

Thank you for your attention

Acknowledgments for financial support:

- **Public Service of Wallonia (SPW-DGO3; project D31-1304)**
- **National Fund for Scientific Research**
- **University of Liege**
- **The GreenHouseMilk project**

The GreenHouseMilk project is financially supported by the European Commission under the Seventh Research Framework Programme, Grant Agreement KBBE-238562. This publication represents the views of the authors, not the European Commission, and the Commission is not liable for any use that may be made of the information.

Corresponding author's email:
mlvanrobays@ulg.ac.be