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

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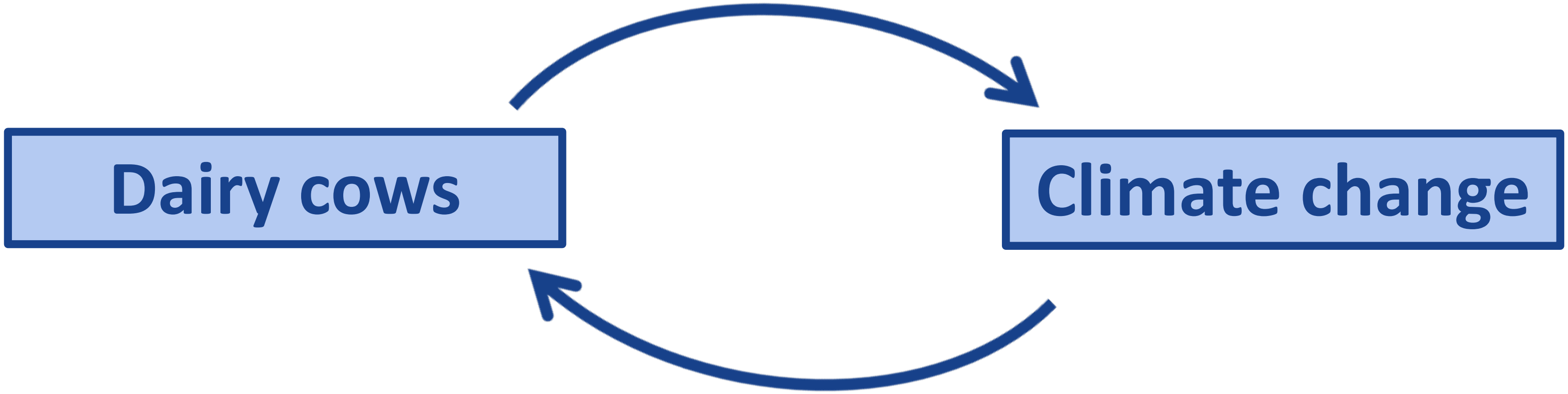
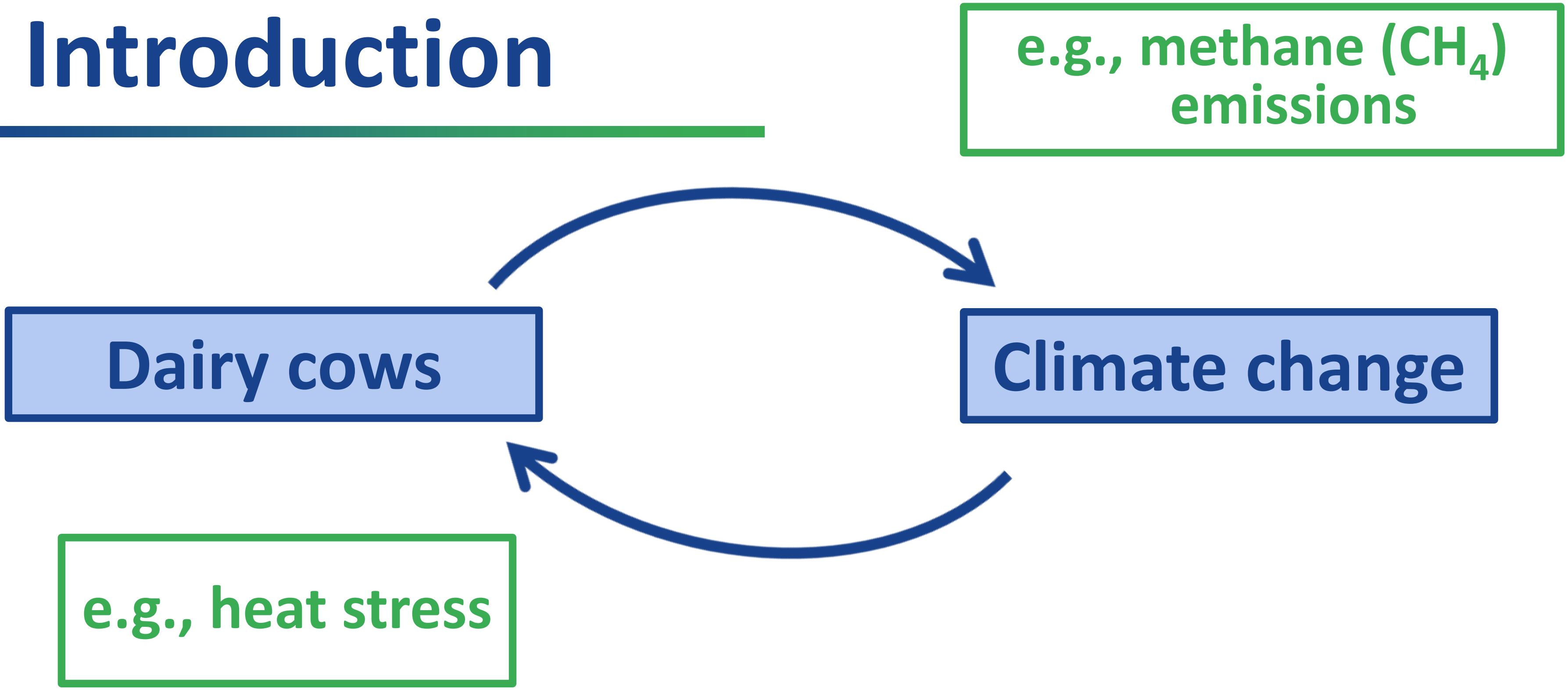
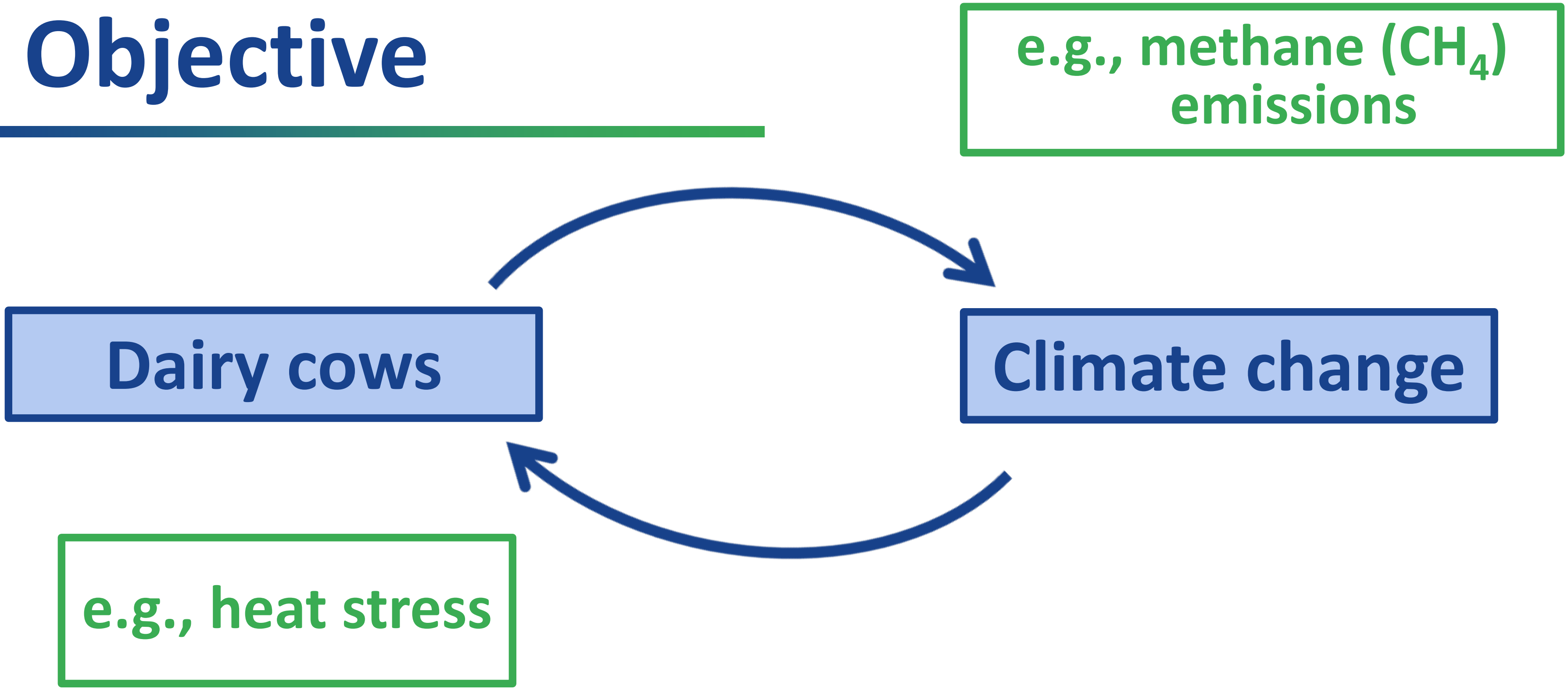
Introduction



Introduction



Objective



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

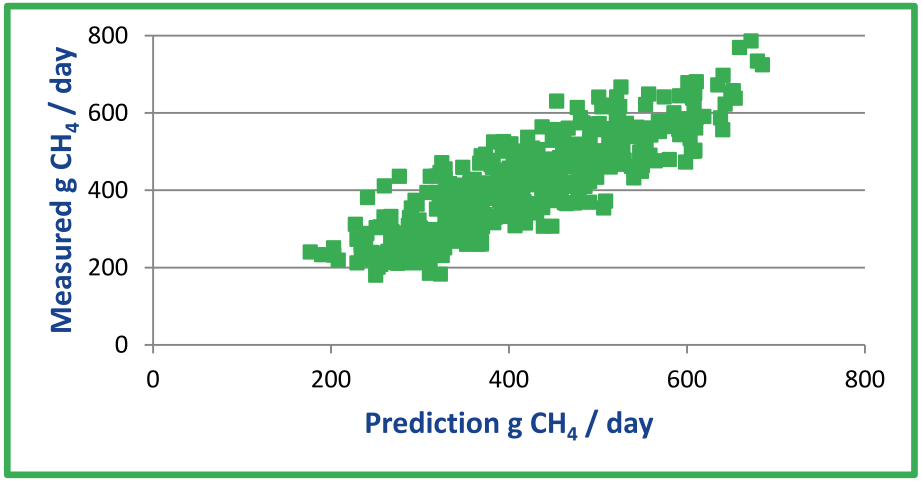
Objective

- 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

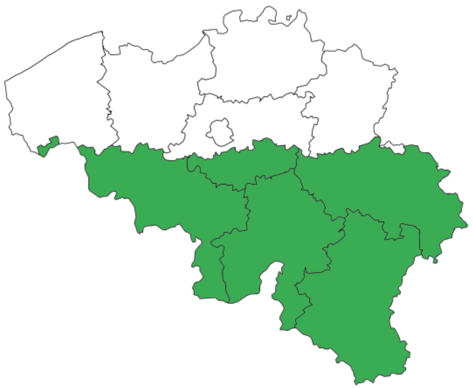
- 257,635 milk test-day (TD) records with MIR predicted CH_4
  - 51,782 Walloon Holstein first-parity cows
  - From January 2007 to December 2010
  - 983 herds
  - ≥ 15 cows / herd
  - ≥ 3 records / cow
- Pedigree
  - 150,399 animals

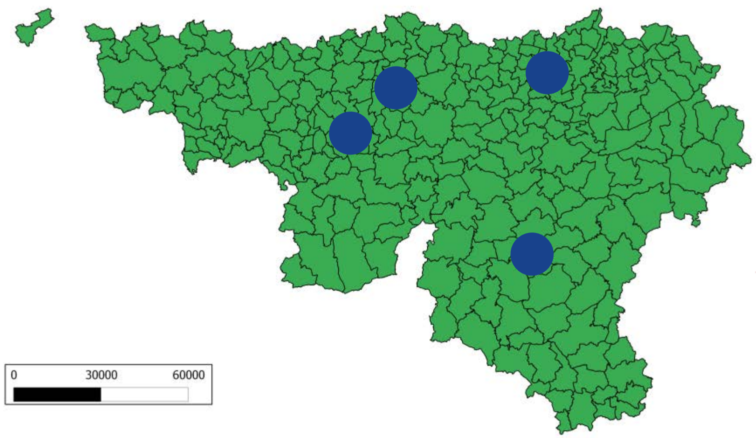
Descriptive statistics of the dataset

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)

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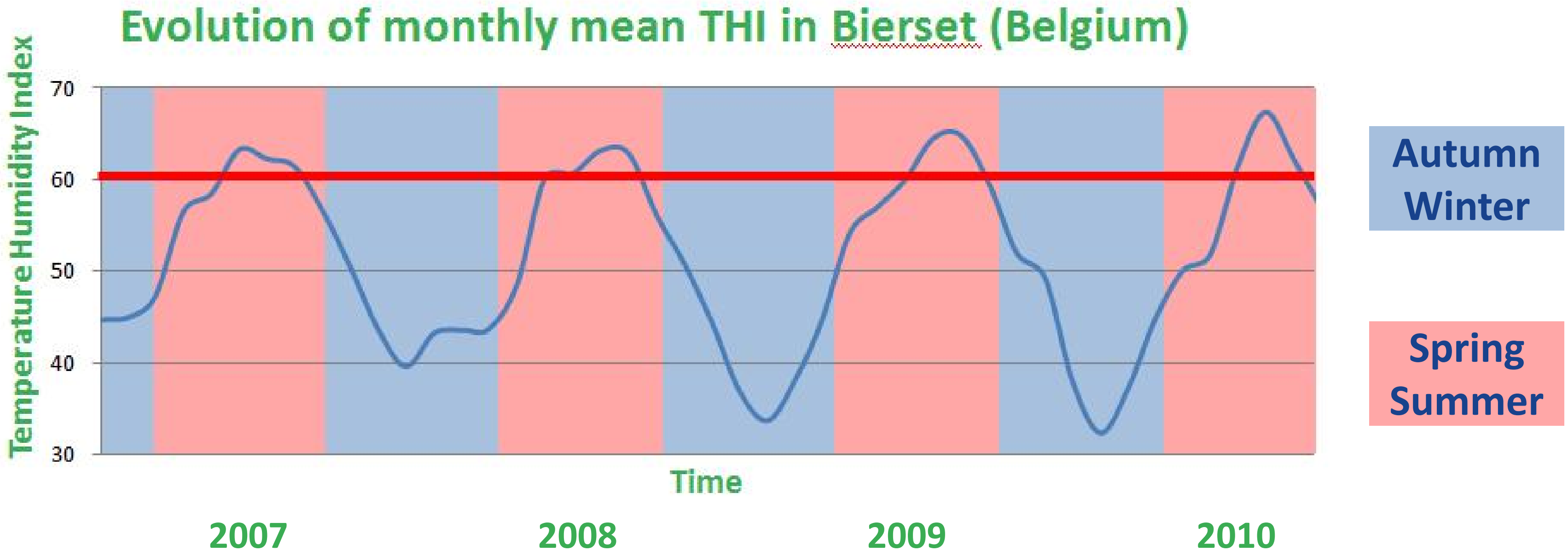

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Mean THI of the previous 3 days before TD record

→ **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

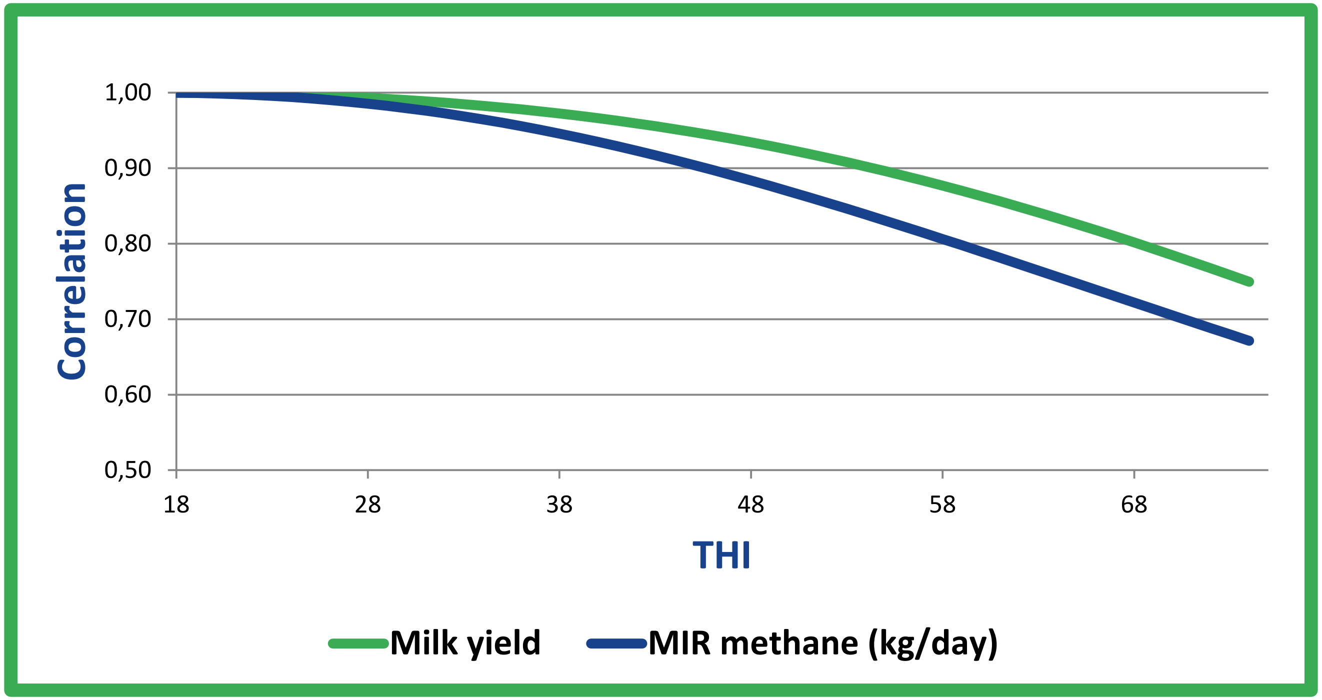
- **Genetic variances (σ^2) & correlations (r) estimated for milk (MY) & MIR predicted CH_4 by bivariate analysis**

	$\sigma^2_{MY_0}$	$\sigma^2_{MY_{hs}}$	$\sigma^2_{CH_{40}}$	$\sigma^2_{CH_{4hs}}$
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			

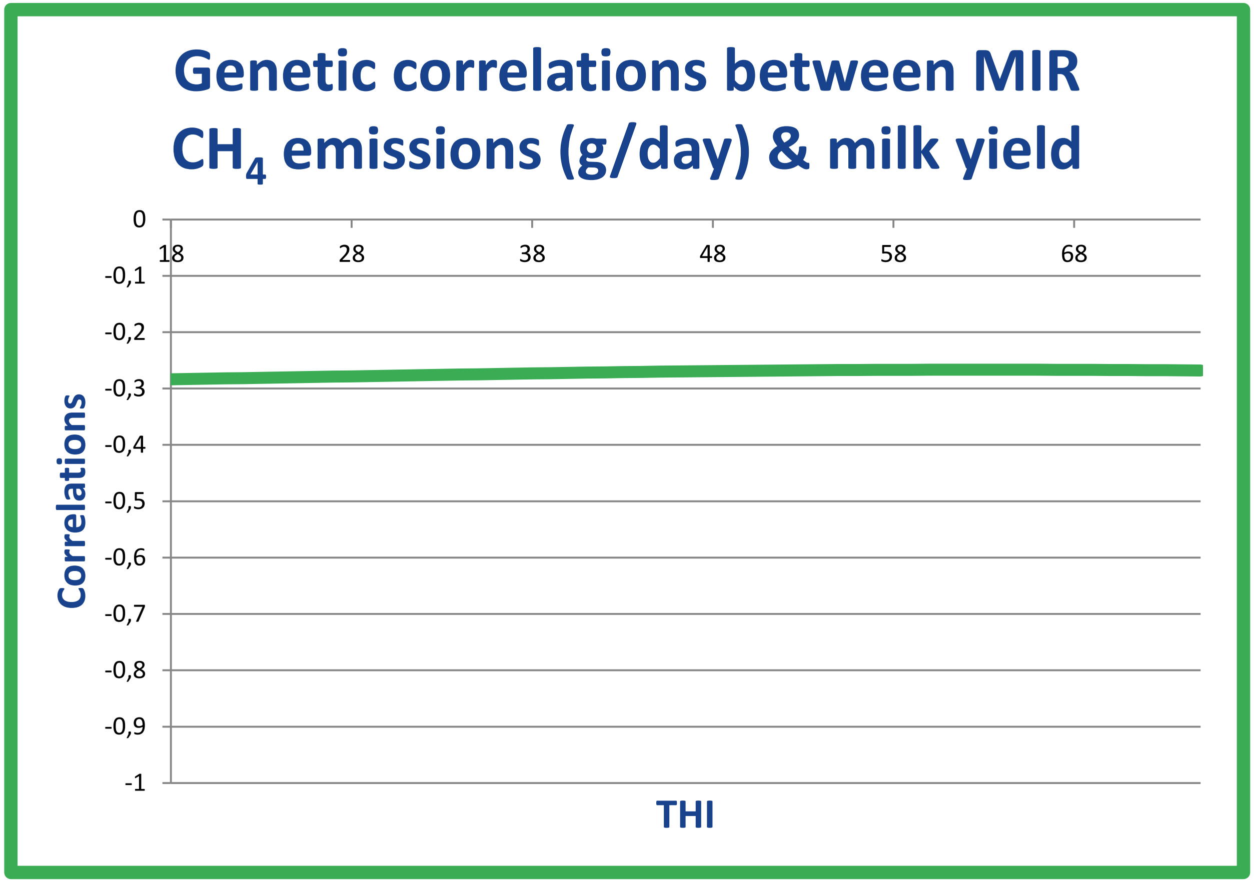
Subscript (0) means the intercept (regular) & (hs) is the slope (heat tolerance)

Genetic parameters

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

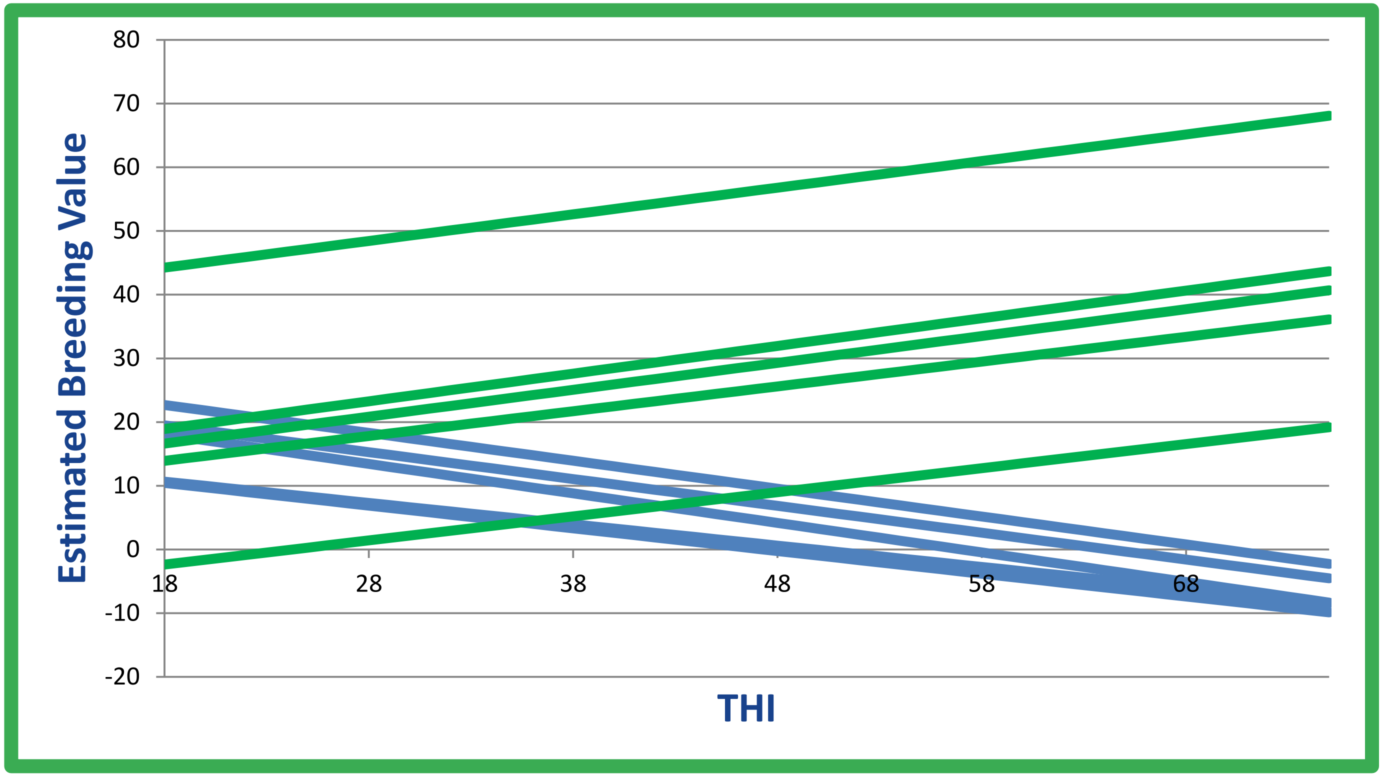


Correlations with milk yield



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

Thank you for your attention

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