Evaluation of heat stress effects on production traits and somatic cell score of Dutch Holstein cows

Jeremie Vandenplas, Mathijs van Pelt, Han Mulder

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000226

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Heat stress

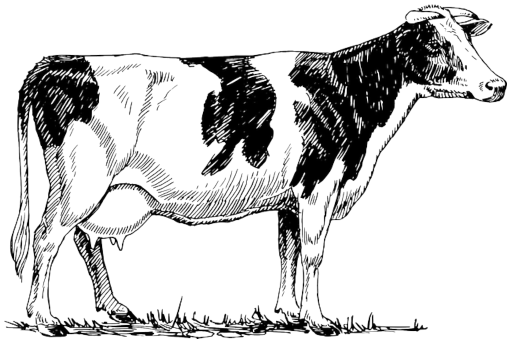
↘ Milk production

↘ Immunity

↗ Disease occurrence

↗ Somatic cell count

↘ Fertility



↗ Body temperature

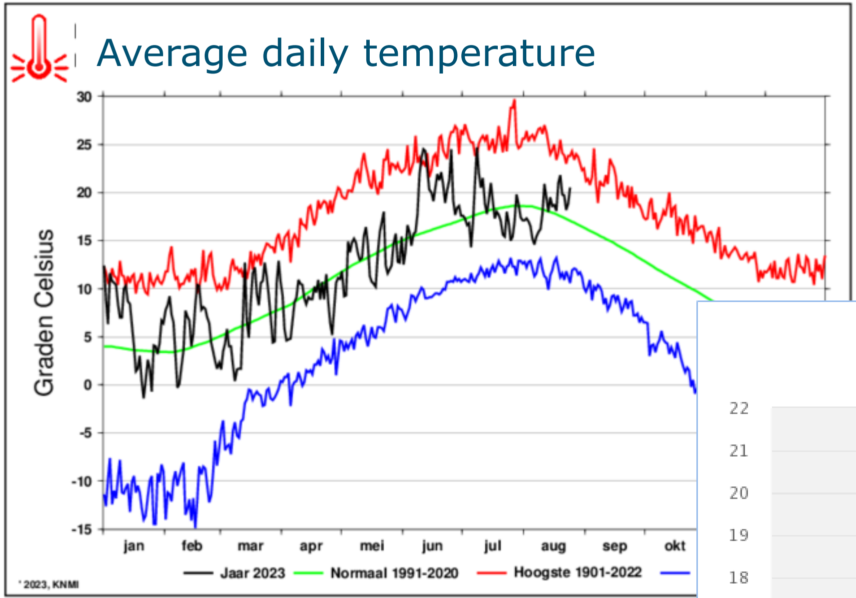
↗ Respiratory rate

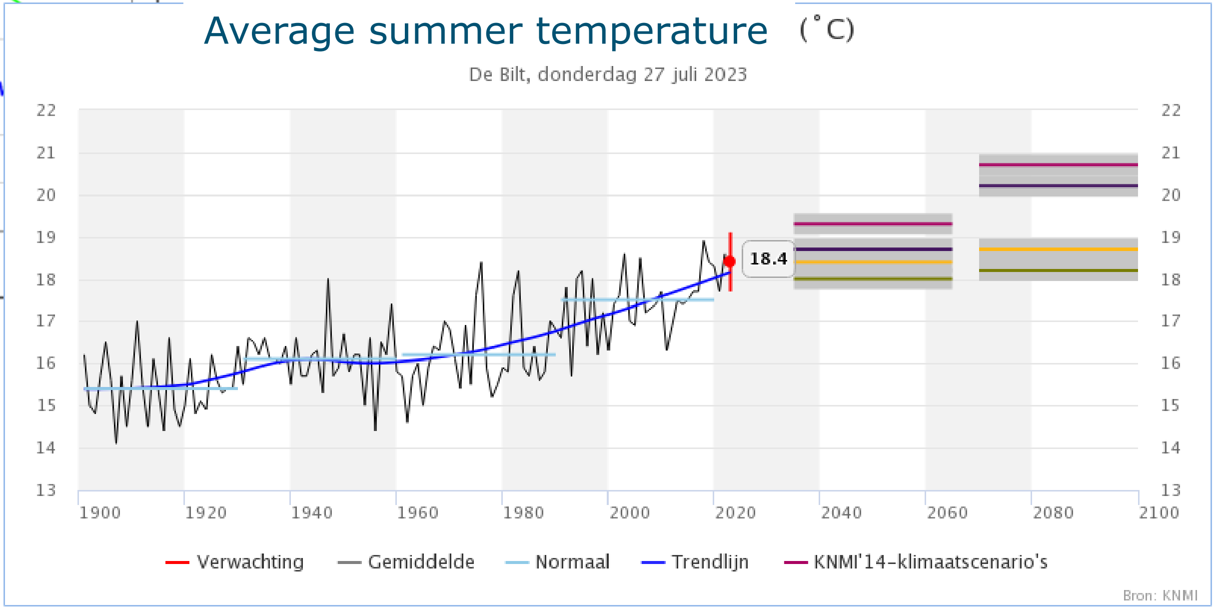
↗ Water consumption

↘ Dry matter intake

↘ Rumination

Heat stress in the Netherlands?





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Koninklijk Nederlands Meteorologisch Instituut
Ministerie van Infrastructuur en Waterstaat

Aim

To evaluate the impact of heat stress on milk production traits and somatic cell score (SCS) of Dutch Holstein cows

1) To evaluate heat threshold and heat stress effects

2) To estimate genotype-by-THI interactions and the magnitude of the individual variability

Dutch phenotypic and meteorological data

- First and second parities
- Test-day records: milk, fat and protein yields, SCS

- Average distance (herd, weather station): 14.6km
- Temperature-humidity index (THI; NRC, 1971)

$$THI = (1.8 * T + 32) - [(0.55 - 0.0055 * RH) * (1.8 * T - 26)]$$

Data

Population response

- From 2010 until 2022
- 1582 herds
- 494 thousand cows
- 3.9 million TD records

Individual response

- From 2016 until 2022
- 1579 herds
- 259 thousand cows
- 1.9 million TD record

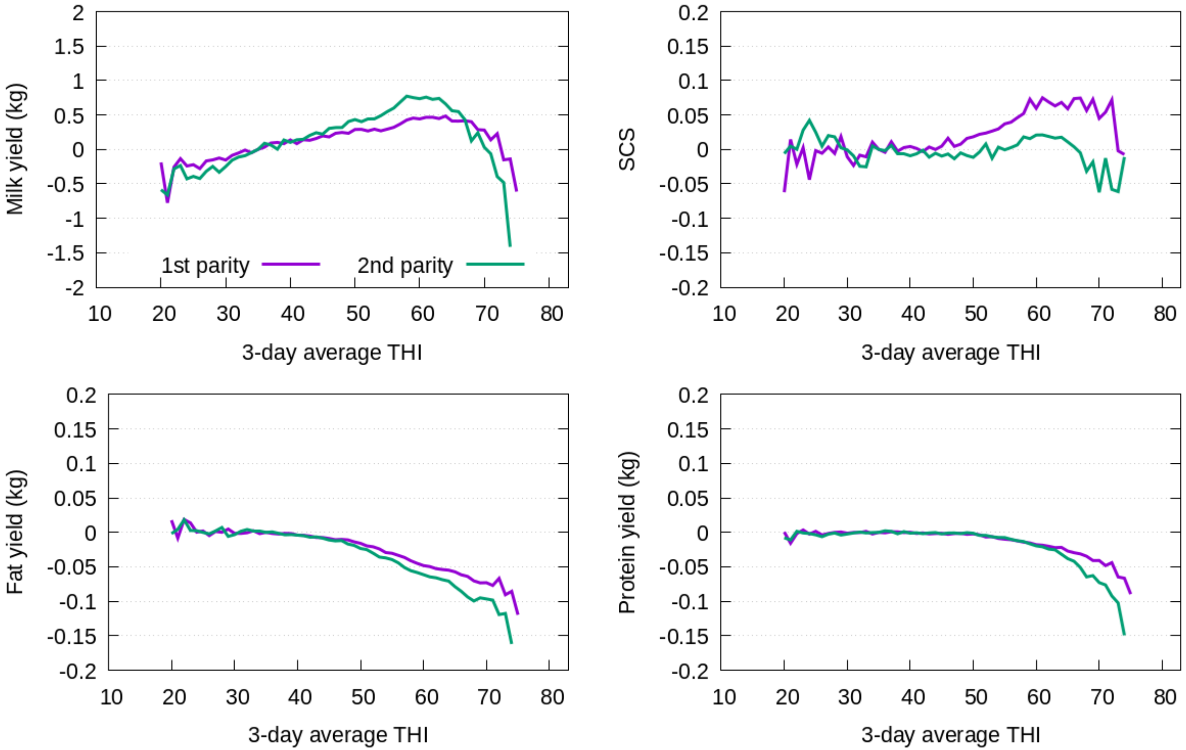
Range 3-day THI: 20 (~-9 ⁰C; 80% RH) - 75 (~ 25 ⁰C 80% RH)

Population response - model

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Za} + \mathbf{Wp} + \mathbf{e}$$

- Fixed effects $\mathbf{b}$:
    - **THI**
    - Herd - year of test
    - Days-in-milk
    - Age at calving - year - season of calving
    - Age at calving - year - season of calving - lactation stage
- Random effects:

Population response



THI thresholds

- MY: ~60-65
- FY, PY: ~50
- SCS: unclear

Individual response – reaction norm model

$$\mathbf{y} = \mathbf{X}\mathbf{b} + \mathbf{Z}\mathbf{Q}\mathbf{a} + \mathbf{W}\mathbf{Q}\mathbf{p} + \mathbf{e}$$

- Fixed effects $\mathbf{b}$
  - Herd – test-day
  - Days-in-milk
  - Age at calving - year - season of calving
  - Age at calving - year - season of calving - lactation stage
  - Stadium of gestation

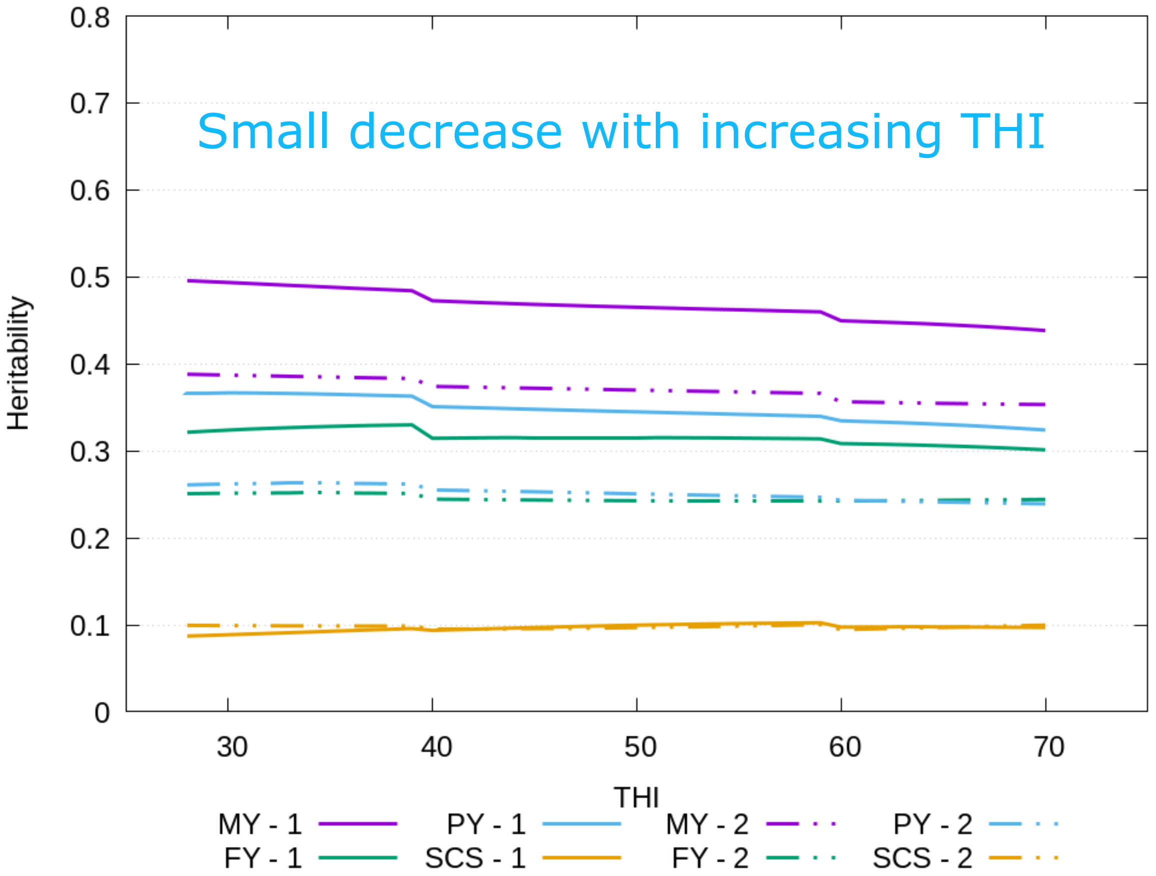
Individual response – reaction norm model

$$\mathbf{y} = \mathbf{Xb} + \mathbf{ZQa} + \mathbf{WQp} + \mathbf{e}$$

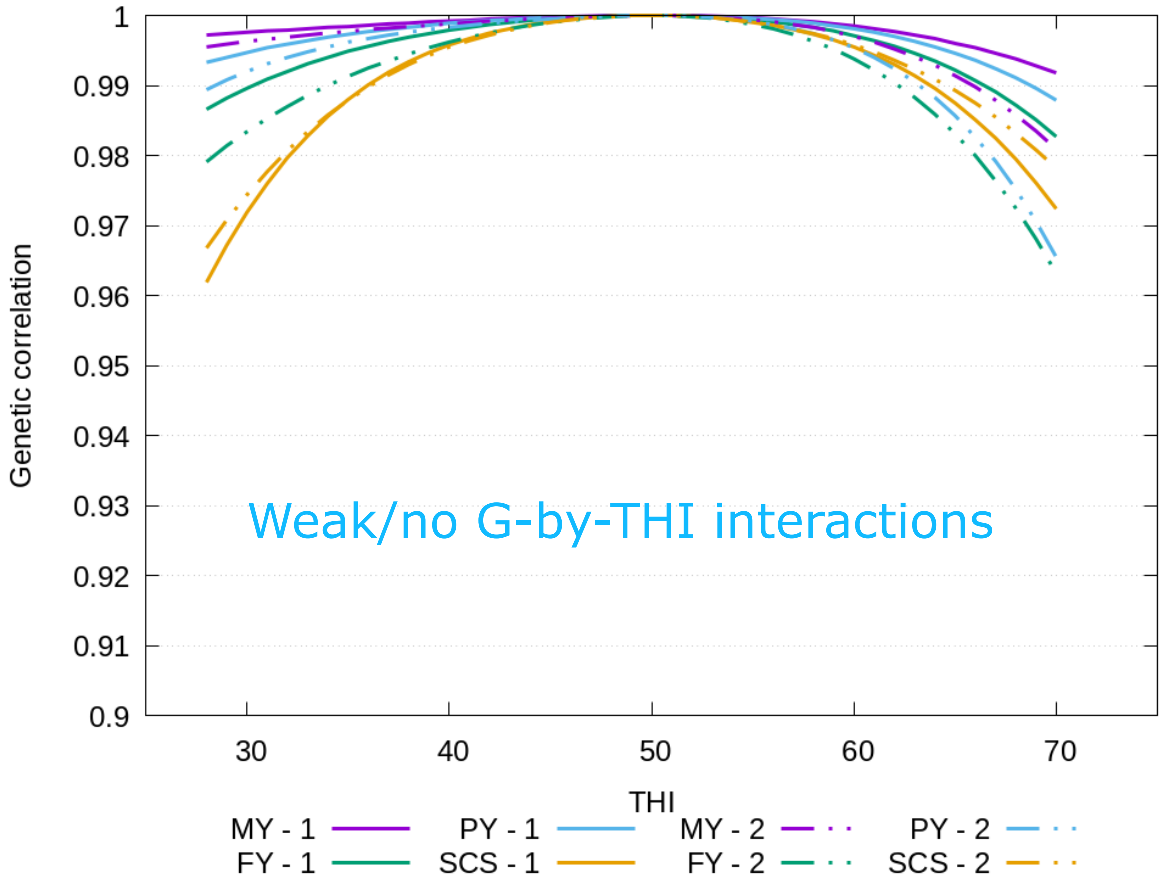
- Random effects:
  - Animal ($\mathbf{a}$), Permanent environment ($\mathbf{p}$), Residual ($\mathbf{e}$)

- Standardized Legendre coefficients $\mathbf{Q}$:
  - Intercept
  - DIM: first and second order
  - THI: first and second order

Individual response – heritabilities (150-DIM)



Individual response – genetic correlations



Individual response – genetic correlations

- Low/moderate genetic correlations between
  - Production at DIM = 150 and THI = 50
  - Slope of decay (first derivative) at THI = 68

	1st parity	2nd parity
Milk yield	-0.37	-0.33
Fat yield	-0.08	-0.01
Protein yield	-0.13	0.01
SCS	-0.01	-0.10

Conclusions

- THI thresholds
  - MY: ~60-65
  - FY, PY: ~50
  - SCS: unclear
- No/weak G-by-THI interactions
- Low/moderate negative genetic correlations between production level and slope of decay

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