



ICAR2026
VERONA ITALY



Prediction of dairy cows' heat stress response from milk mid-infrared spectra for detection and genetic selection

P. Lemaître¹, K. Wijnrocx¹, C. Grelet², F. Dehareng², H. Soyeurt¹, M. Schroyen¹, N. Gengler¹

¹Gembloux Agro-Bio Tech, University of Liège, Gembloux, Belgium.

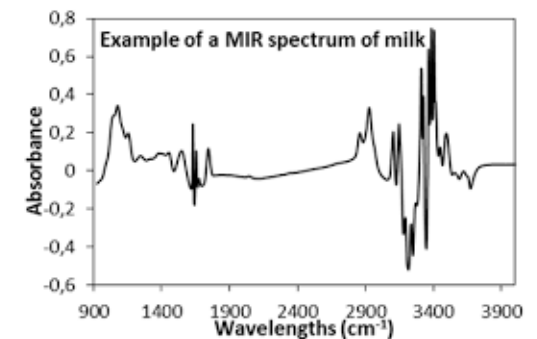
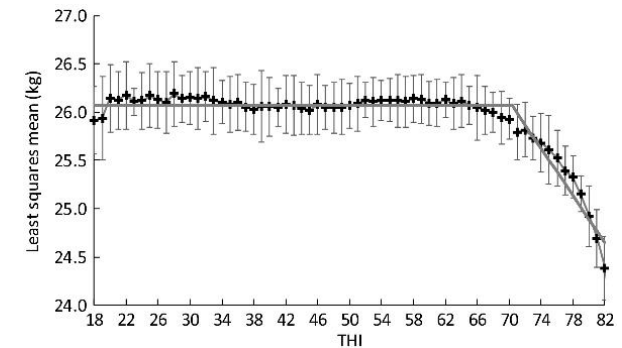
²Wallon Agricultural Research Center (CRA-W), Gembloux, Belgium.

Introduction



- ▶ Heat stress → production ↓, health ↓, fertility ↓, welfare ↓ ...
- ▶ Large-scale studies → decrease of performances with temperature and humidity index (THI)
- ▶ MIR spectra also available in routine
→ Prediction equation for the heat stress response

Objective: Development of the prediction + validation



Data



- 5 farms → 2 visits : heat wave and thermoneutral periods
- Milk recording + IR images of the udder



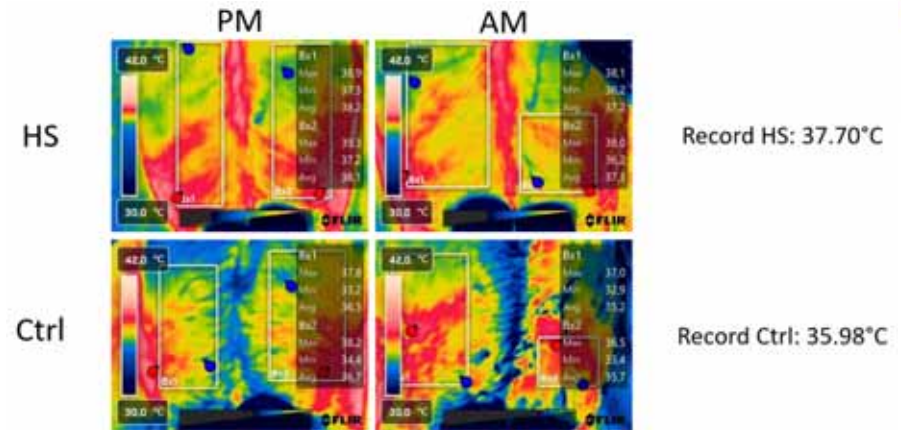
→ Milk yield, spectra (+ associated predictions), body surface temperature
→ 679 records (350 + 329), 399 cows

+ historical milk recording data

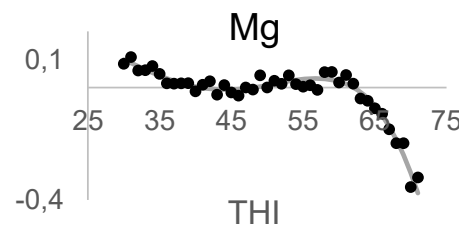
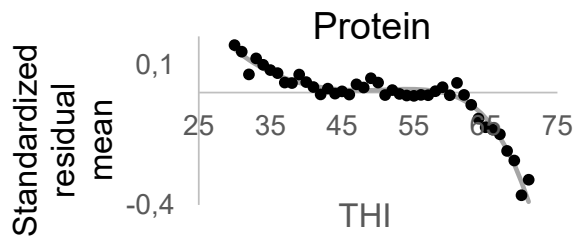
Phenotype definition



- 1) Only body surface temperature
→ Continuous variable



- 2) High body surface temperature + negative protein % and Mg [] residuals
→ Categorical variable



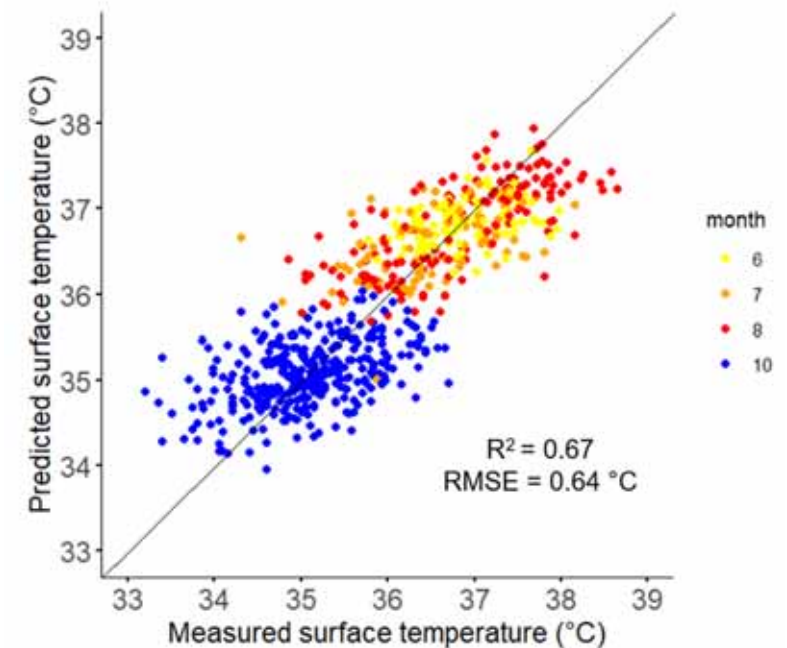
	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Total
r protein %	0.12	-0.27	-0.50	-0.82	-0.28	-0.43
r Mg mg/kg	-0.11	-0.50	-0.54	-0.97	-0.63	-0.61

Phenotype 1

- First derivative of standardized MIR spectra
- 212 wavenumbers
- Variable pre-selection (Correlation ≥ 0.3)

PLS

- 679 records
- R^2 cross-validation : 0.67
- RMSE cross-validation : 0.64 °C



Phenotype 2



RF

- RRM to estimate residuals on historical data
- 350 records during heat waves

- 88 classified affected by heat stress (X1)
(Temperature > mean + 3SD and negative residuals)
- 28 classified non-affected by heat stress (X0)
(Temperature < mean + 2SD and positive residuals)
+ 60 from other periods without heat stress
- 234 classified intermediate (X0.5)
→ 88 randomly selected

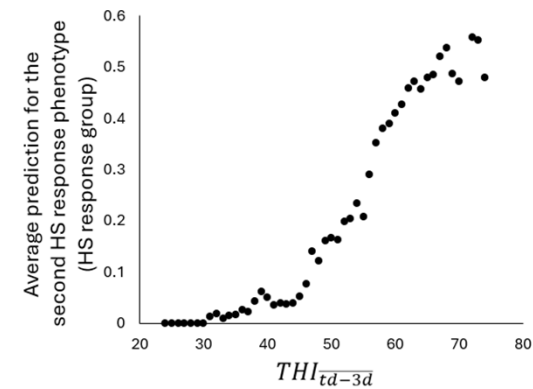
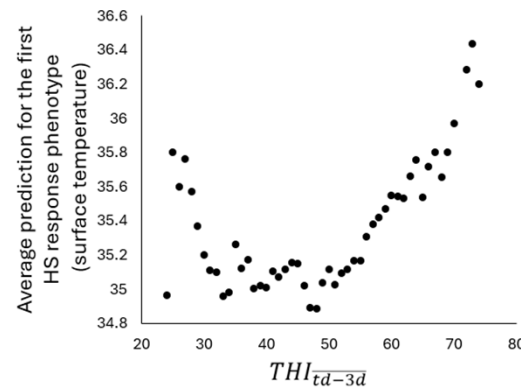
		Reference		
		X0	X0.5	X1
Prediction	X0	56	6	1
	X0.5	21	46	28
	X1	11	36	59
Sensitivity		64%	52%	67%
Specificity		96%	72%	73%
Global accuracy		61%		



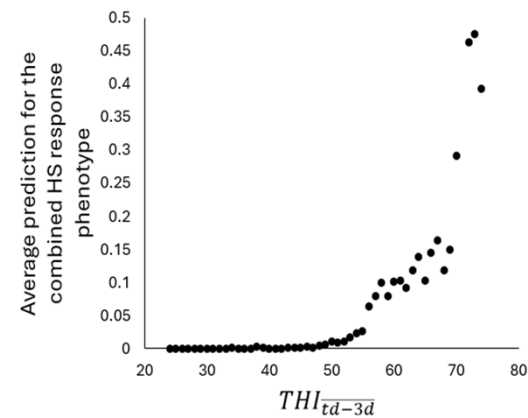
External validation (phenotypic)

► Milk recording of Walloon Holstein cows from 2020 to 2022

→ 1,038,149 records



→ Combination



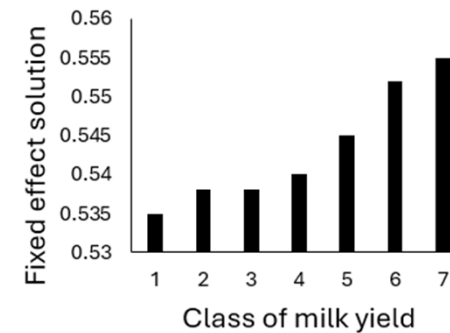
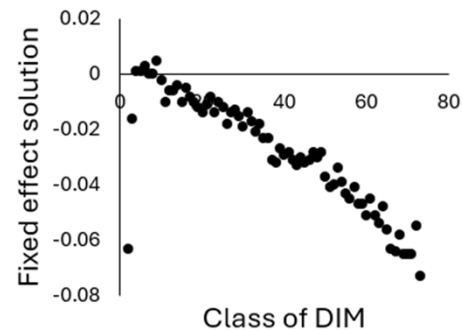
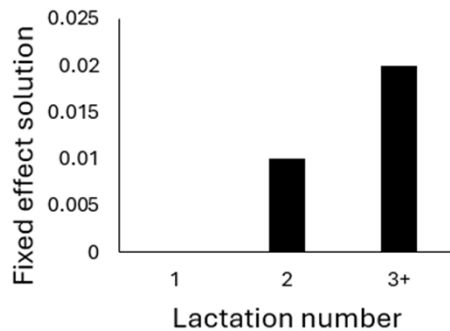


External validation (phenotypic)

► Mixed model :

$$y_{jklmn} = HTD_j + lact_k + DIM_l + milk_m + a_n + pe_n + e_{jklmn}$$

→ Fixed effect solutions





External validation (genomic)

- ▶ THI-independent method :

$$y_{jklm} = HTD_j + lact_k + DIM_l + a_m + pe_m + e_{jklm}$$

→ Only HTD with average of at least 0.1

→ Fully THI-independent

Heritability: 0.10

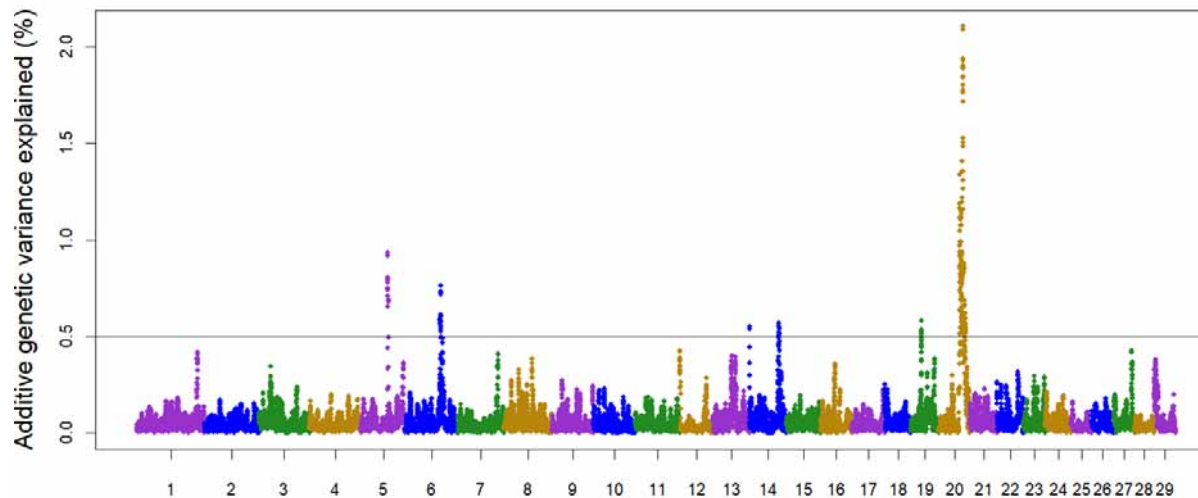
Genetic correlations:

	Milk	Fat	Protein	SCS	Longevity	Fertility
HS	0.15	0.04	-0.14	0.16	-0.33	-0.39



External validation (genomic)

- ▶ 7,170 genotypes animals and 28,442 SNPs
- ▶ GWAS
 - Windows of 20 SNPs
 - Candidate genes related to heat stress
 - Regions in common with GWAS related to energy balance





Conclusion

- ▶ MIR-predicted heat stress response:
 - Large-scale detection of heat-stressed cows
 - THI-independent genetic evaluation for heat tolerance
- ▶ Heat stress may be closely linked to energy balance



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Thank you for your attention

