Evaluation of MIR predicted milk components as biomarkers of heat stress in dairy cows using a residual approach

P. Lemal[1] , M-N. Tran[2] , C. Grelet[3] , H. Soyeurt[1] , M. Schroyen[1] , N. Gengler[1]

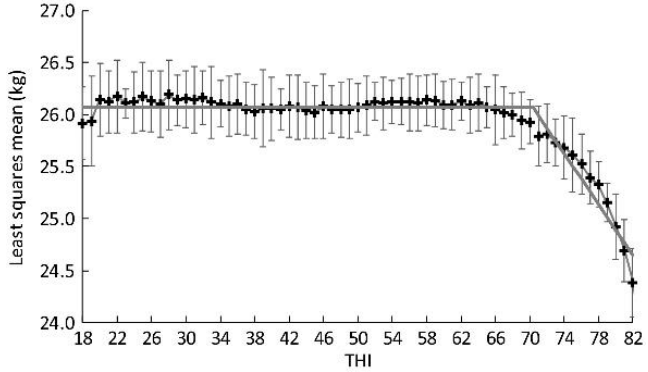
[1]Gembloux Agro-Bio Tech, University of Liège, Gembloux, Belgium.

[2]Elevéo, awé groupe, Ciney, Belgium.

[3]Walloon Agricultural Research Center (CRA-W), Gembloux, Belgium.

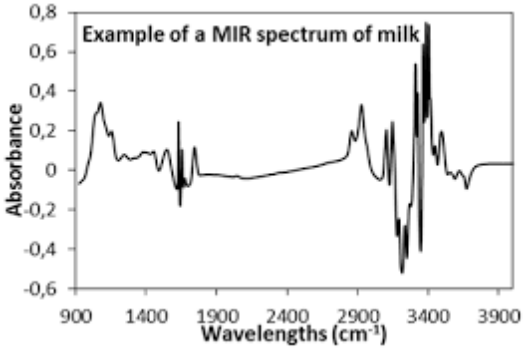
Introduction

- Heat stress → production ↘, health ↘, fertility ↘, welfare ↘ ...
- Large-scale studies → decrease of performances with temperature and humidity index (THI)



- Predictions from MIR spectra also available in routine

  → Potential biomarkers of heat stress



<u>Objective:</u> Determine which MIR predictions could be interesting biomarkers of heat stress

Data

- Milk recording data and THI from weather stations

→ Milk yield, fat %, protein % and somatic cell score (SCS)

→ 12 MIR predictions

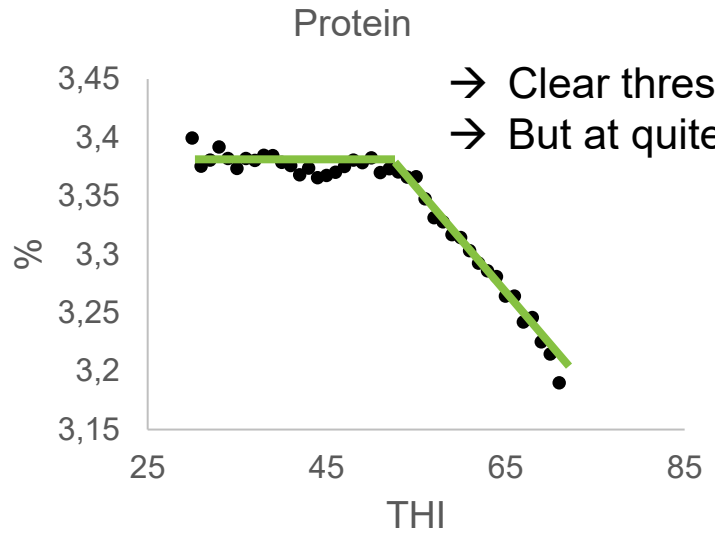
$R^2 \geq 0.55$ and RMSE ≤ 25 %

'General predictions'

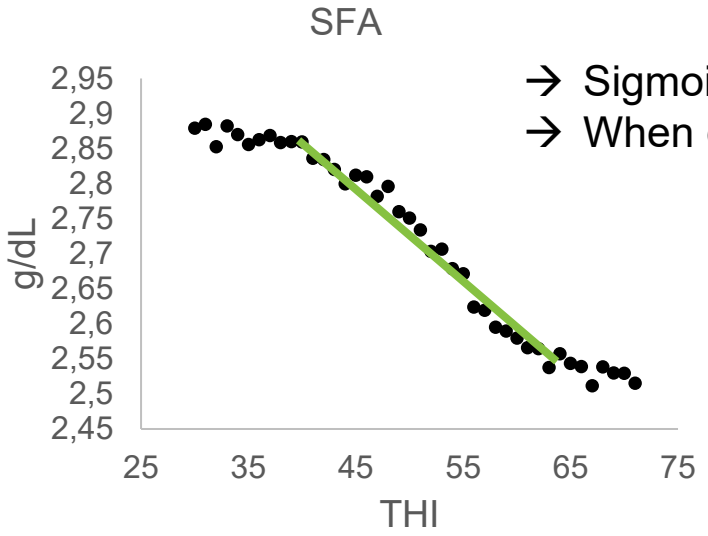
→ Mean of the THI of the day and the 3 previous days

- 97,042 Walloon Holstein cows in lactation 1
- 611,063 records from 2015 to 2022

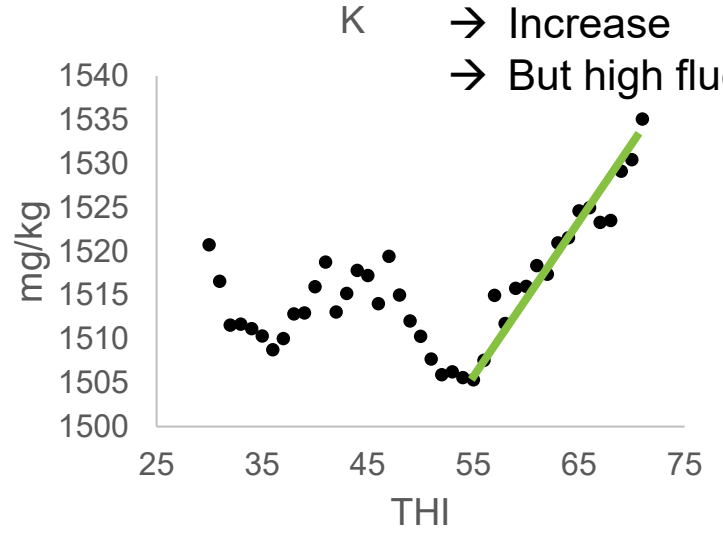
Phenotypic mean evolution with THI



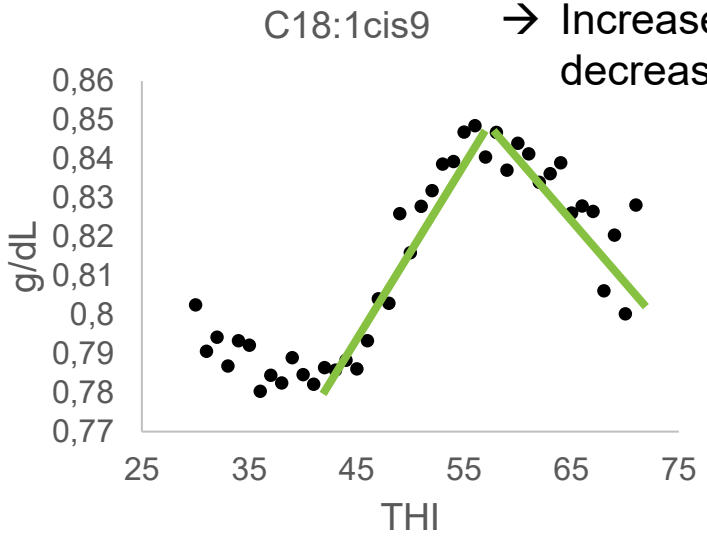
→ Clear threshold
→ But at quite low THI



→ Sigmoid
→ When does HS start ?

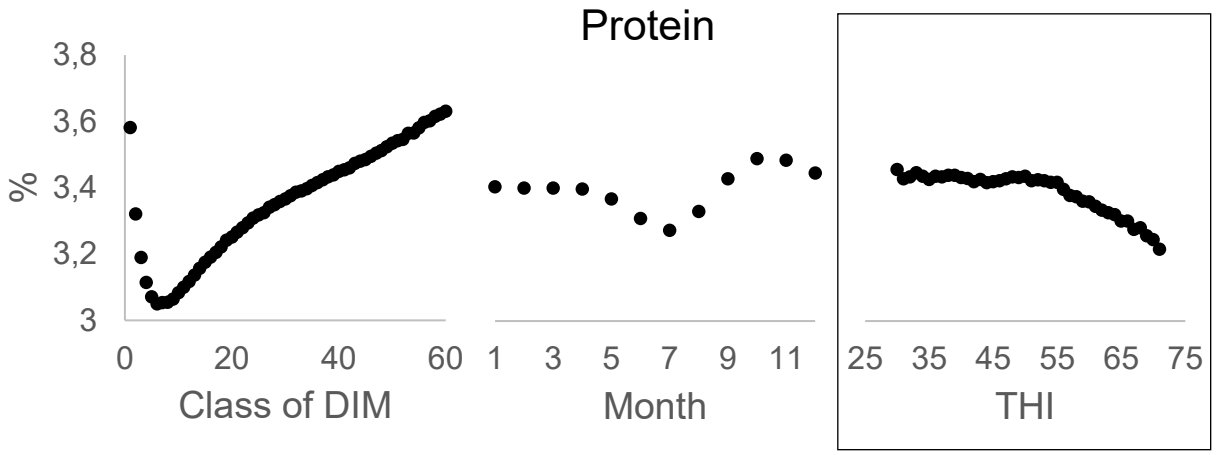


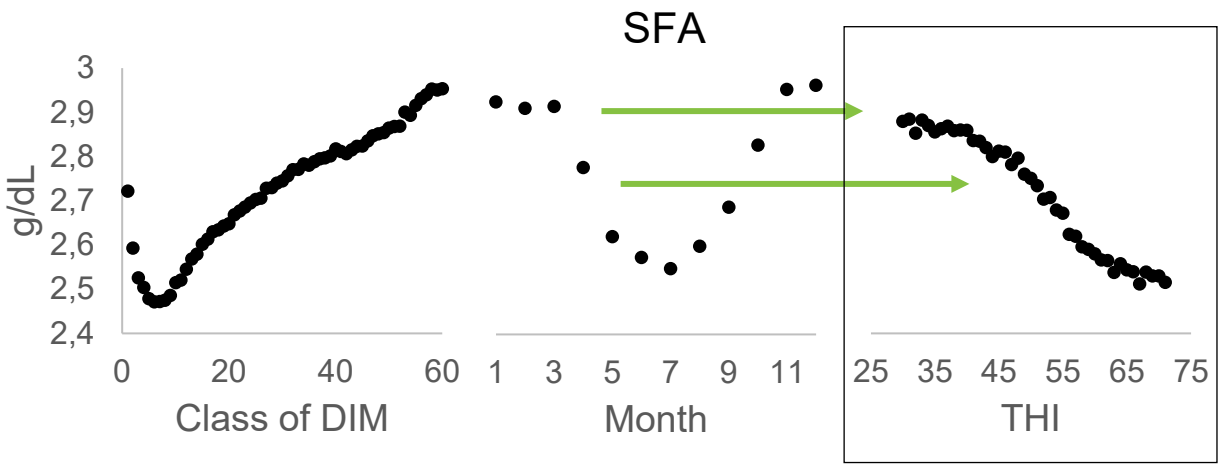
→ Increase
→ But high fluctuation before

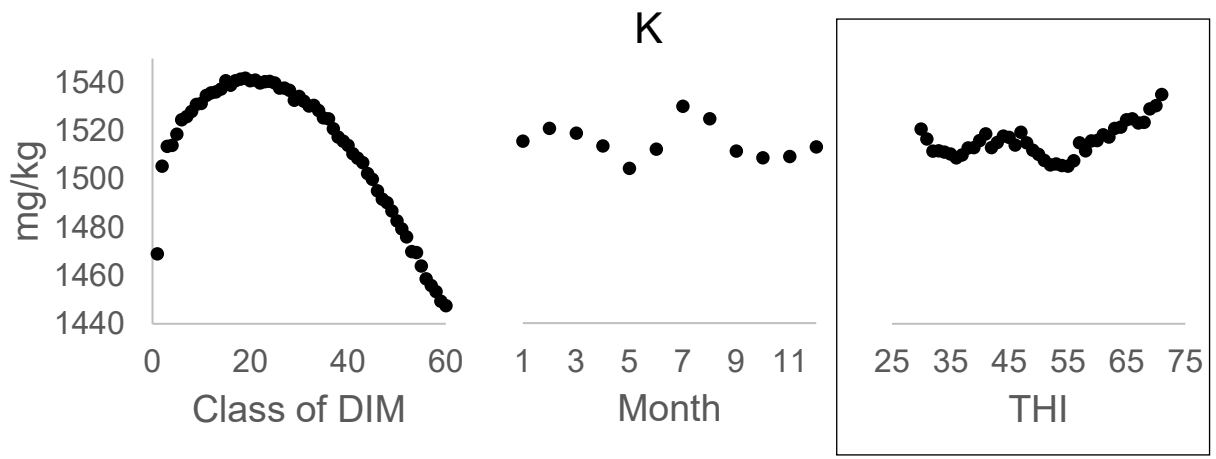


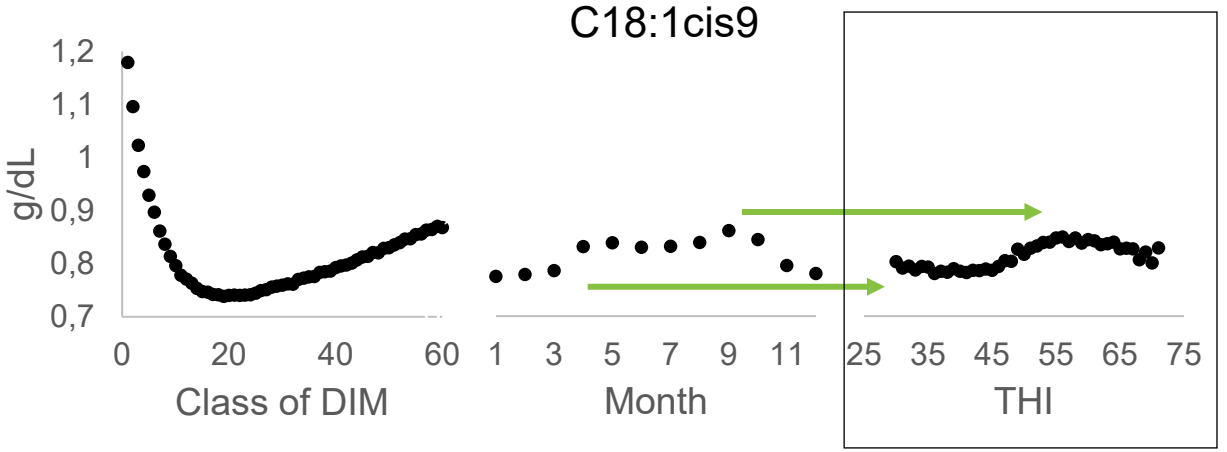
→ Increase followed by a decrease

Other effects → HS blurring









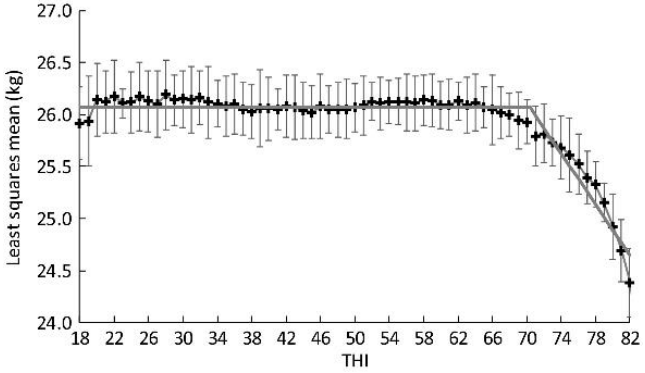
- Traits highly affected by lactation stage (DIM) and feed (month of recording)

Model (mean)

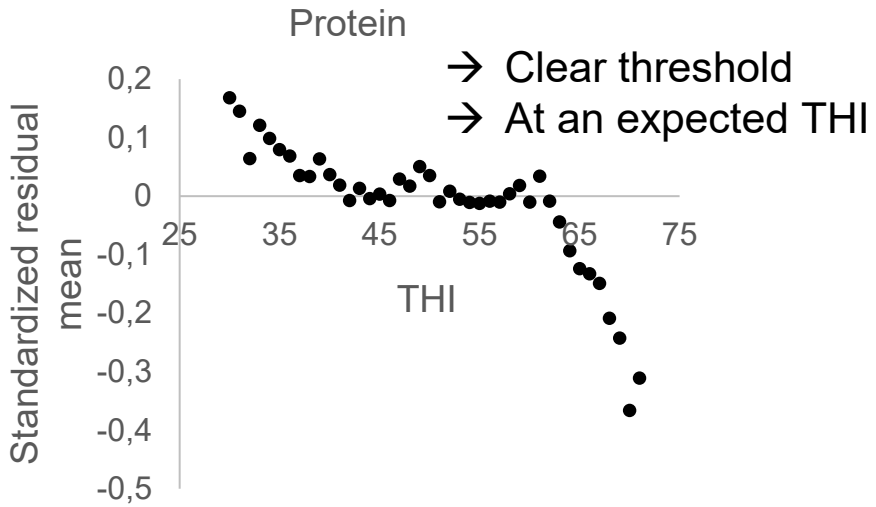
Model: $y = Xb + Q(Wh + Z_1a + Z_2p) + e$

→ Fixed effects: ~~herd-test day (HTD)~~
classes of age at calving, classes of DIM, season of calving

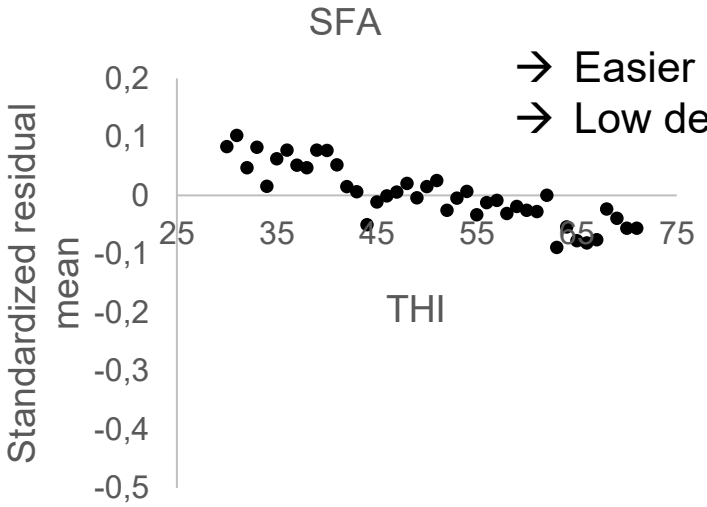
→ Random effects: lactation curves for HY of calving, additive genetic and permanent environment



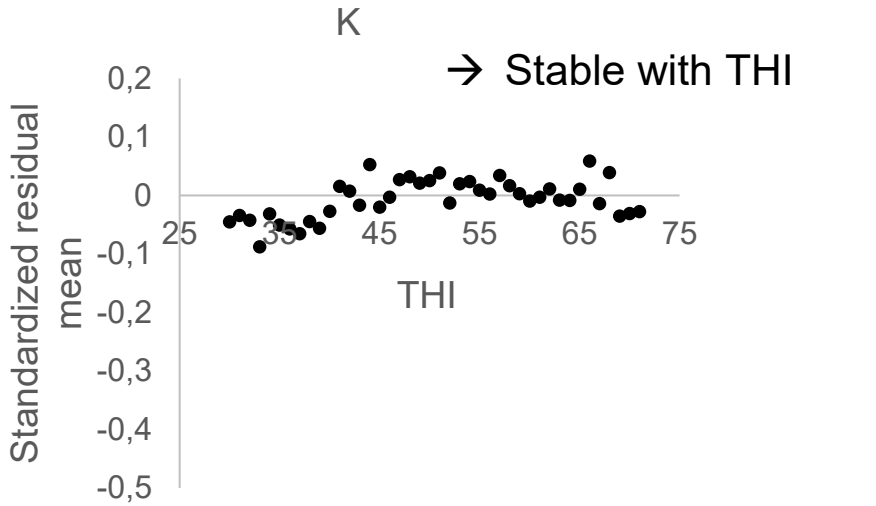
Residual mean evolution with THI



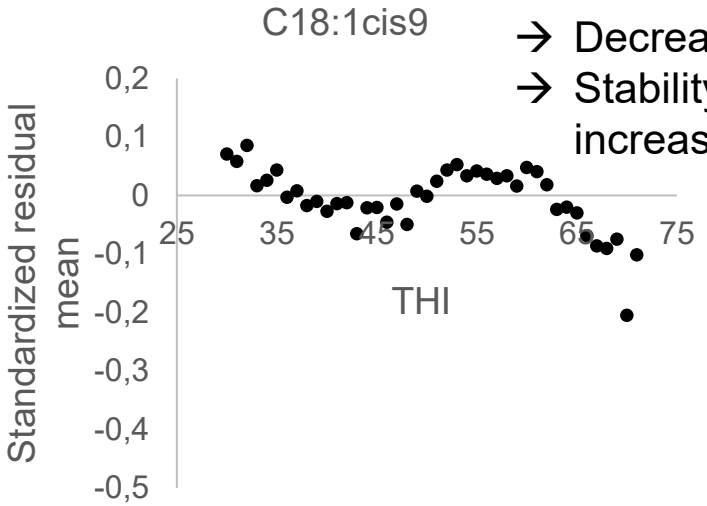
→ Clear threshold
→ At an expected THI



→ Easier threshold
→ Low decrease

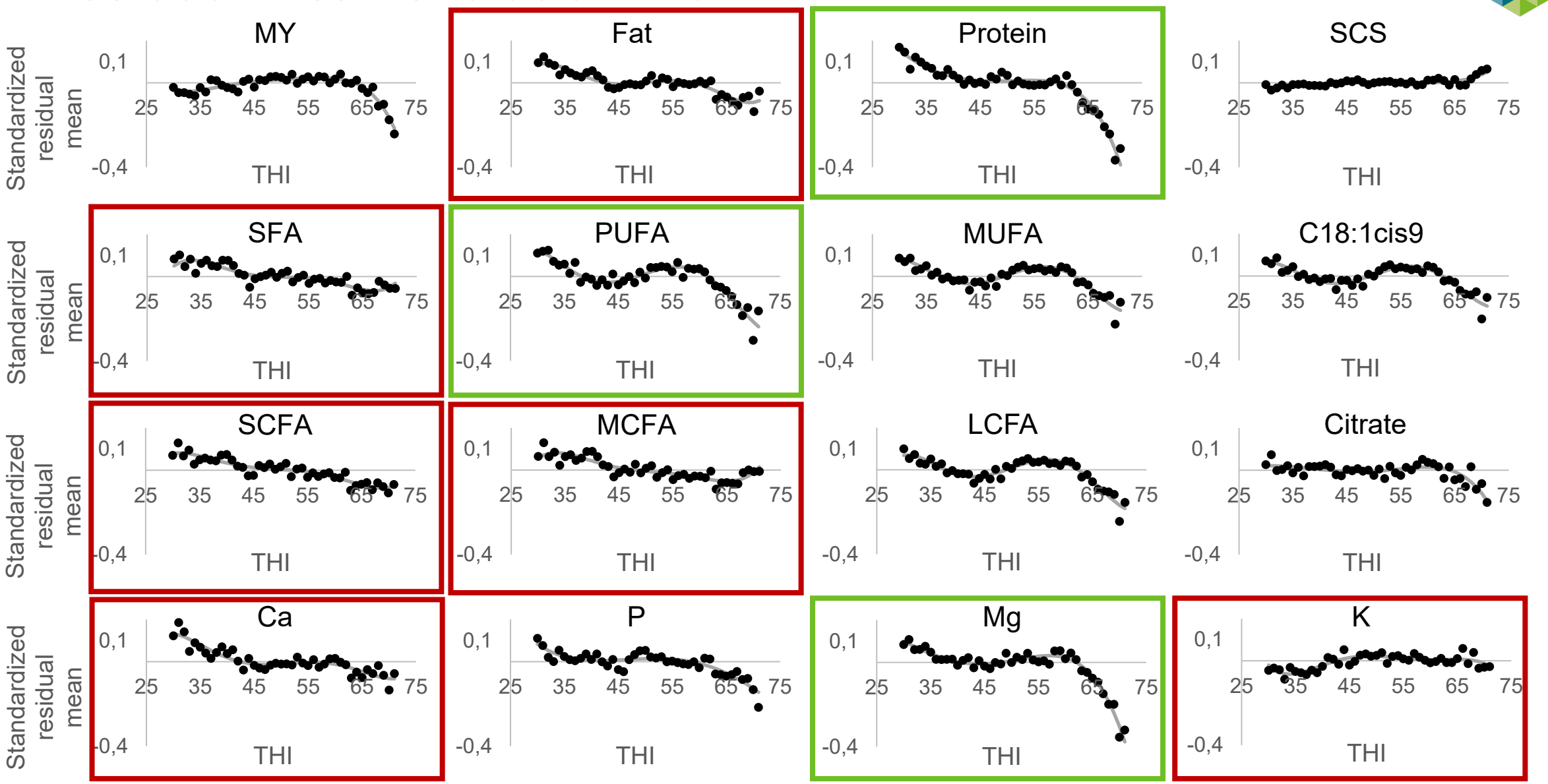


→ Stable with THI



→ Decrease with THI
→ Stability before the decrease, first increase almost totally removed

Residual mean evolution with THI



Biomarkers

Criterion	Description	Assumptions
Strength of association	Strong associations are more likely to have causal components than weaker associations.	Associations can be measured
Consistency	Observing similar evaluation results across evaluation methods, over time, and across countries from meta-analyses increases the likelihood of causal relationships.	Results have been measure consistently over time and space
Specificity	Observing an association specific to outcomes of interest among specific groups increases the argument for causal effect.	Malaria interventions are highly likely to reduce all-cause under-five mortality, particularly among vulnerable groups
Temporality	Changes in program must precede changes in disease or coverage outcomes.	Scale-up of interventions has been measured
Gradient	Changes in disease or coverage outcomes increase the same amount for increases to program exposure or intensity.	Coverage has been measured in different geographic areas
Plausibility	Biological plausibility links exposure to intervention with health outcome.	Malaria contributes to all-cause child mortality
Coherence	Causal inference is possible only if the literature or substantive knowledge supports this conclusion	There are documented studies showing that malaria interventions affect mortality
Experiment	Causation is a valid conclusion if researchers have seen observed associations in prior experimental studies.	There are documented studies showing that malaria interventions affect mortality
Analogy	For similar programs operating, similar results can be expected to bolster the causal inference concluded.	Program context has been similar in the past

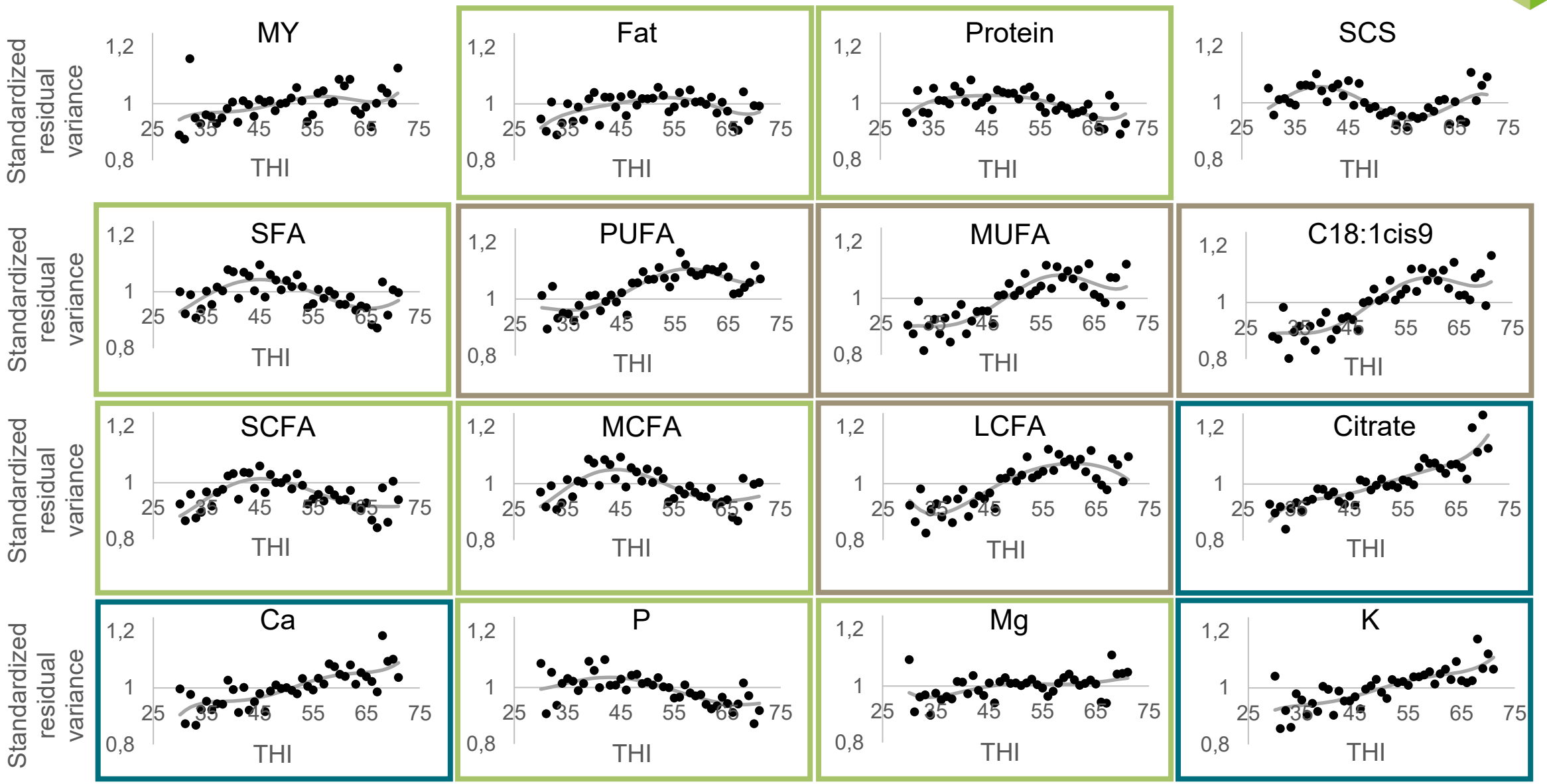
Model (variance)

Model: $y = Xb + Q(Wh + Z_1a + Z_2p) + e$

→ Fixed effects: ~~THI~~, herd-test day (HTD)
classes of age at calving, minor and major classes of DIM

→ Random effects: lactation curves for HY of calving,
additive genetic and permanent environment

Residual variance evolution with THI



Discussion

- Most promising potential biomarkers

→ Protein percentage: Strength and consistency + coherence with literature

→ Magnesium concentration: Strength and consistency

- However, variability could be of interest

→ MUFA, C18:1cis9 and citrate concentrations

- Variability only when THI high

→ Citrate concentration

Conclusion

- Residual approach for biomarkers identification

→ Mitigate interaction of other effects

- Means but also variances can be informative

- Choice of markers can vary depending on the objective


Thank you for your attention