TOWARDS IMPROVEMENT OF **RUMI**NANT BREEDING
THROUGH **GEN**OMIC AND EPIGENOMIC APPROACHES

Towards new breeding tools in a context of climate change: first results of the RUMIGEN project on new phenotypes for heat tolerance traits

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ICAR Meeting

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RUMIGEN - Objectives

Provide breeding tools :

- Improve efficiency & resilience, in a context of climate change
- Maintain genetic diversity

A large panel of competences:

(i) quantitative genetics

- Heat tolerance traits, genetic diversity

(ii) epigenetics

- How genome and epigenetics do shape the phenotypes?

(iii) new breeding techniques

- Genome integrity using genome editing

With a Human Social Sciences lever, to build breeding tools in line with social expectations (co-construction of new breeding schemes)

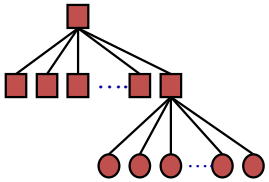
Objective of the study

Measure the impact of heat stress on the performances of dairy cows at the population level

Based on existing large scale national data:

Phenotypes

Pedigrees



Weather (daily records) associated to each herd

1. Study in each country separately, using the same approach (**production, health,** reproduction)
2. Comparison of results

Material

Holstein (FRA, SPA, NLD)

Montbéliarde (FRA)

MRY (NLD)

Performances: Test-Day records on Milk Yield (MY), Fat Yield (FY), Protein Yield (PY), Fat Content (FC), Protein Content (PC) and Somatic Cell Score (SCS)

- Periods from past 5 to 11 years, pending the country (NLD: 2010-2020; SPA: 2010-2021; FRA: 2016-2020)
- ≈ 7 Mo French, 500,000 Dutch and 1 Mo Spanish Holstein cows,
- ≈ 10,000 Dutch MRY and 1.2 Mo French Montbéliarde cows

Daily weather information associated to each farm:

- Provided by national Meteo Agencies
  - France : Grids of 8x8 km
  - Spain : 1,993 weather stations
  - NLD : 34 weather stations

Temperature Humidity Index

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

With T: average daily temperature (°C); RH: average daily humidity

Method

→ **Estimation of the effect of a variation of THI at the population level:**

Each lactation analysed separately

Cow i, TD j, submitted to a given THI

$$y_{ij} = \text{THI} + \sum \text{other fixed effects}_{i,j} + a_i + p_i + e_{ij}$$

With

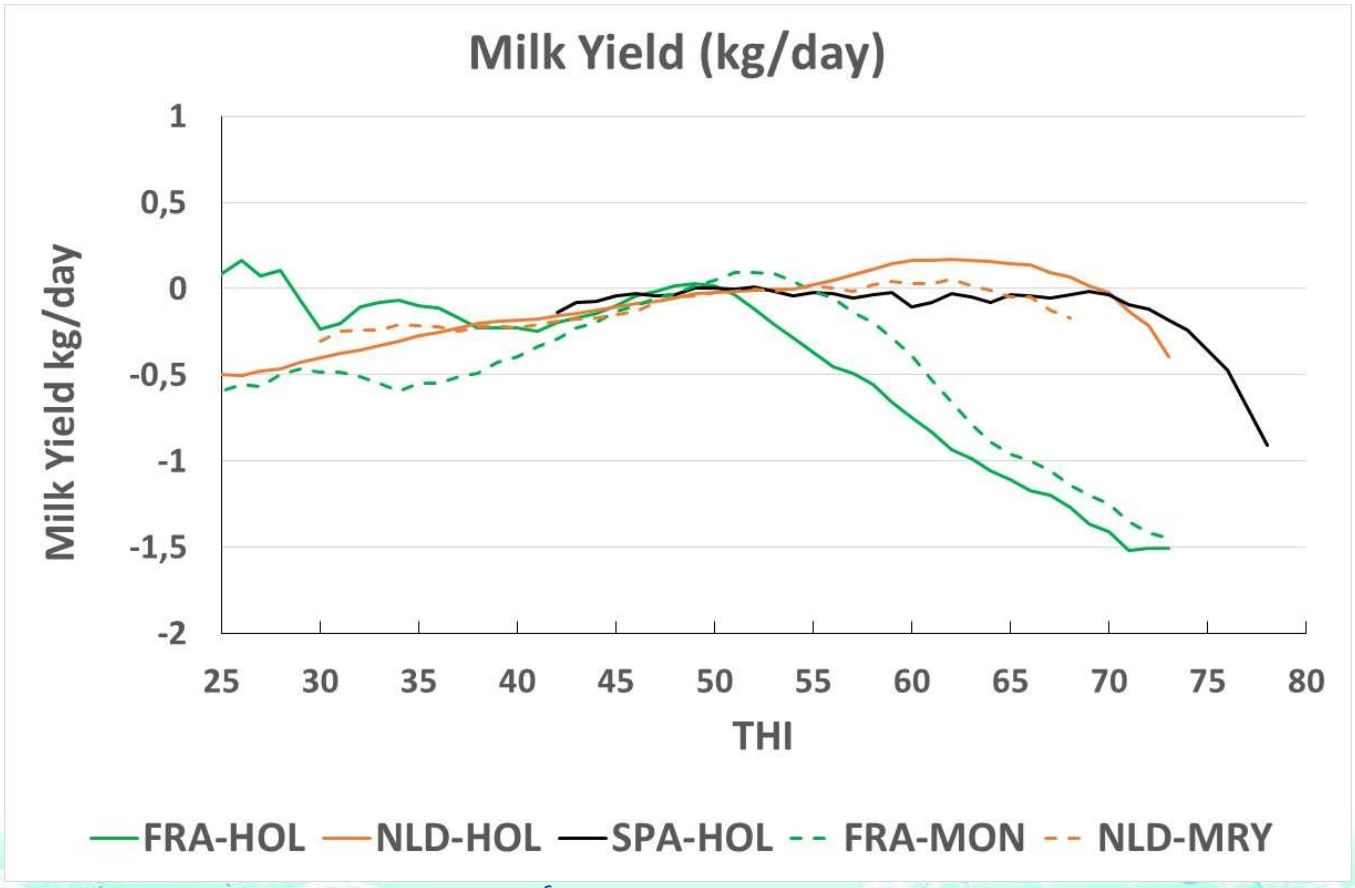
- Y_{ij}: performance of the cow
- Random effects: a_i additive genetic value, p_i : permanent effect, e_{ij}: residual
- THI (fixed): averaged within 3 days before the TD
- Fixed effects (other than THI)
  - FRA: Herd-Year, DIM, gestation stage, month of calving and age at calving;
  - NLD: Herd-Year, DIM, gestation stage, age at calving–year– season
  - SPA: Herd-Year-Season, DIM, age

Results

Estimated effect of THI on Milk Yield
- Cows in 1st lactation -

Estimated THI effects averaged using a rolling basis of 5 THI units

For each breed-country: $\widehat{THI}(50) = 0$



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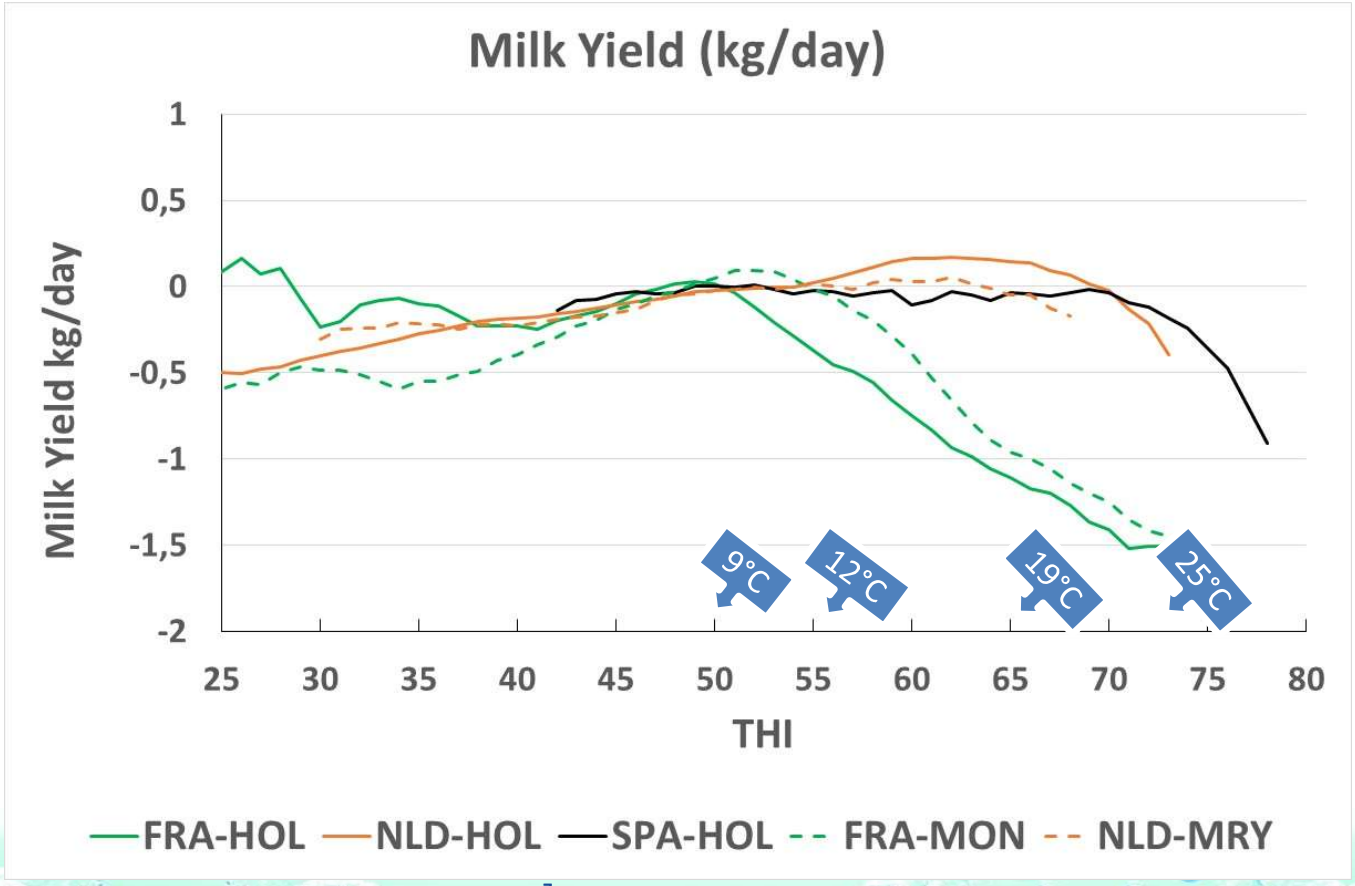
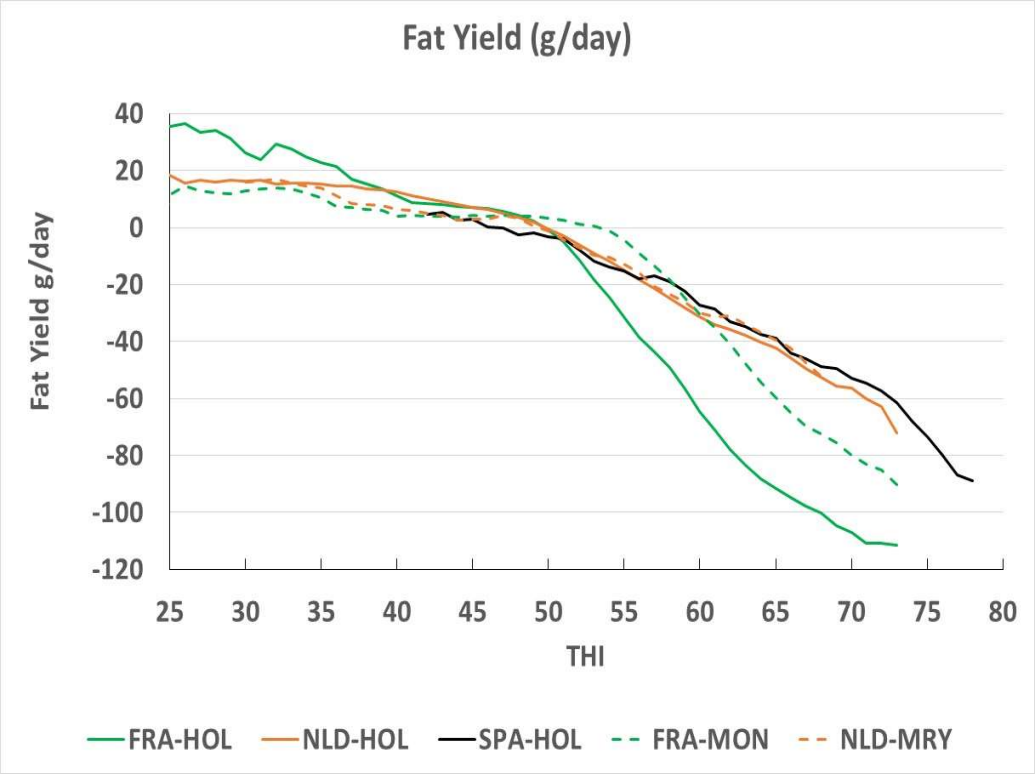
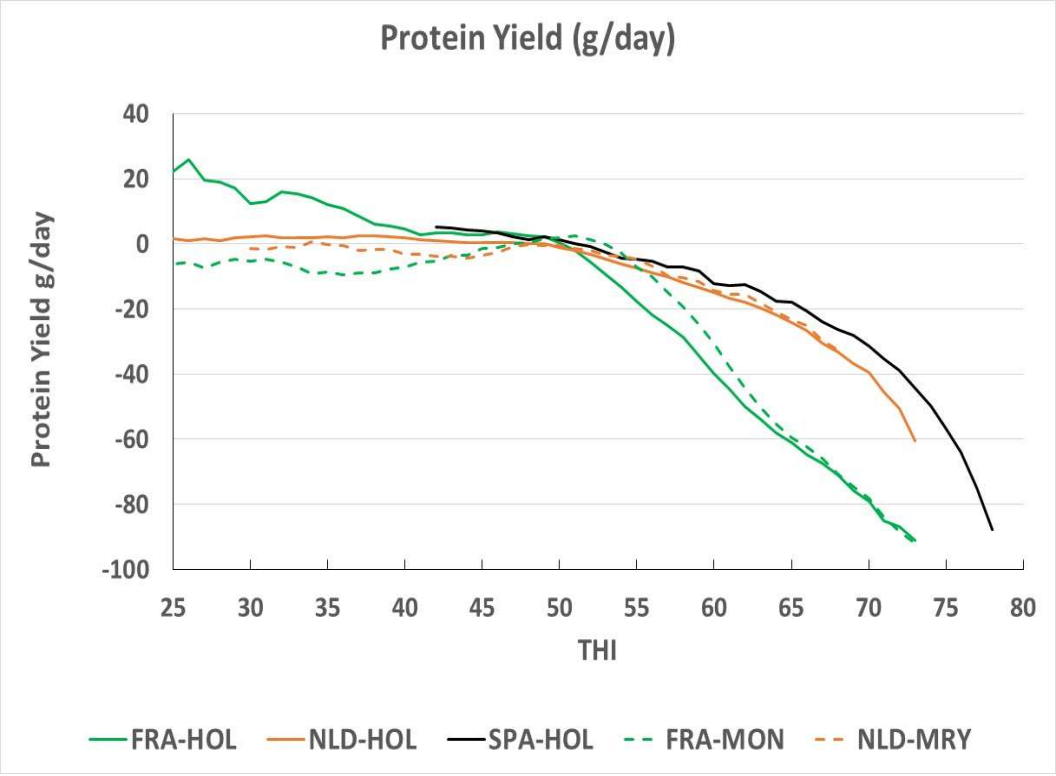


Results

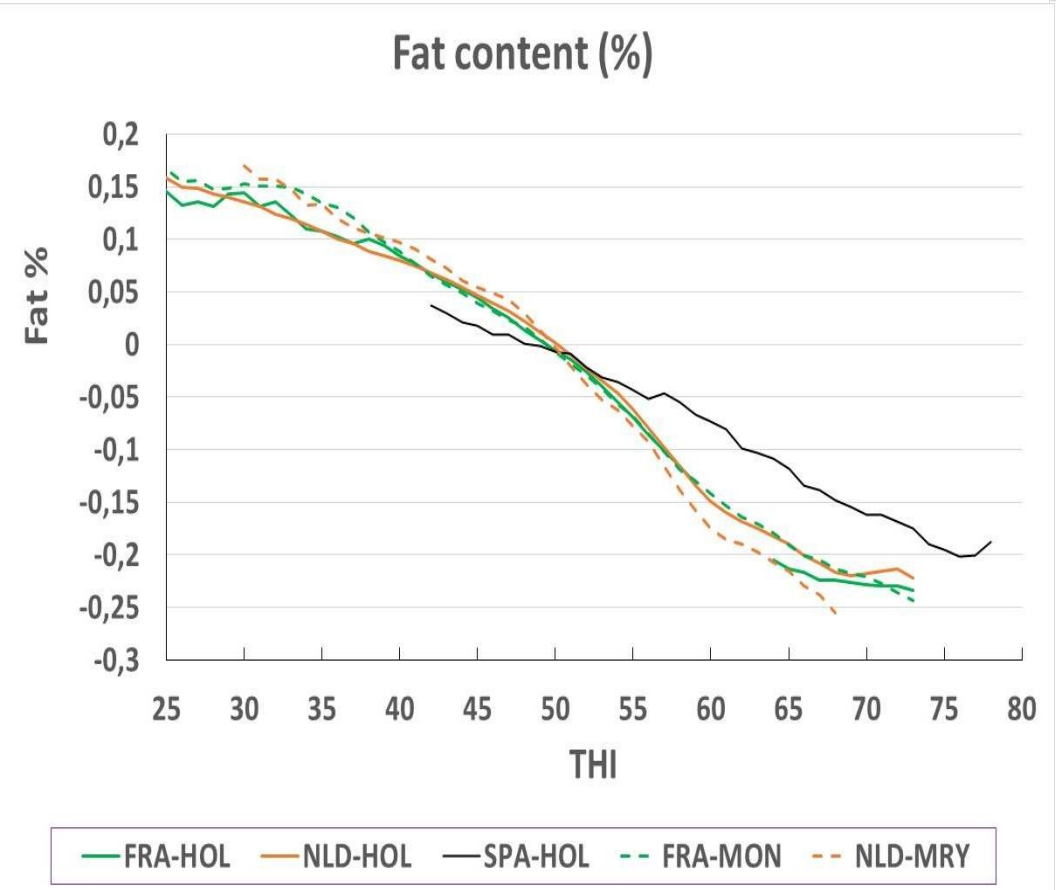
Estimated effect of THI on Fat and Protein Yields
- Cows in 1st lactation -

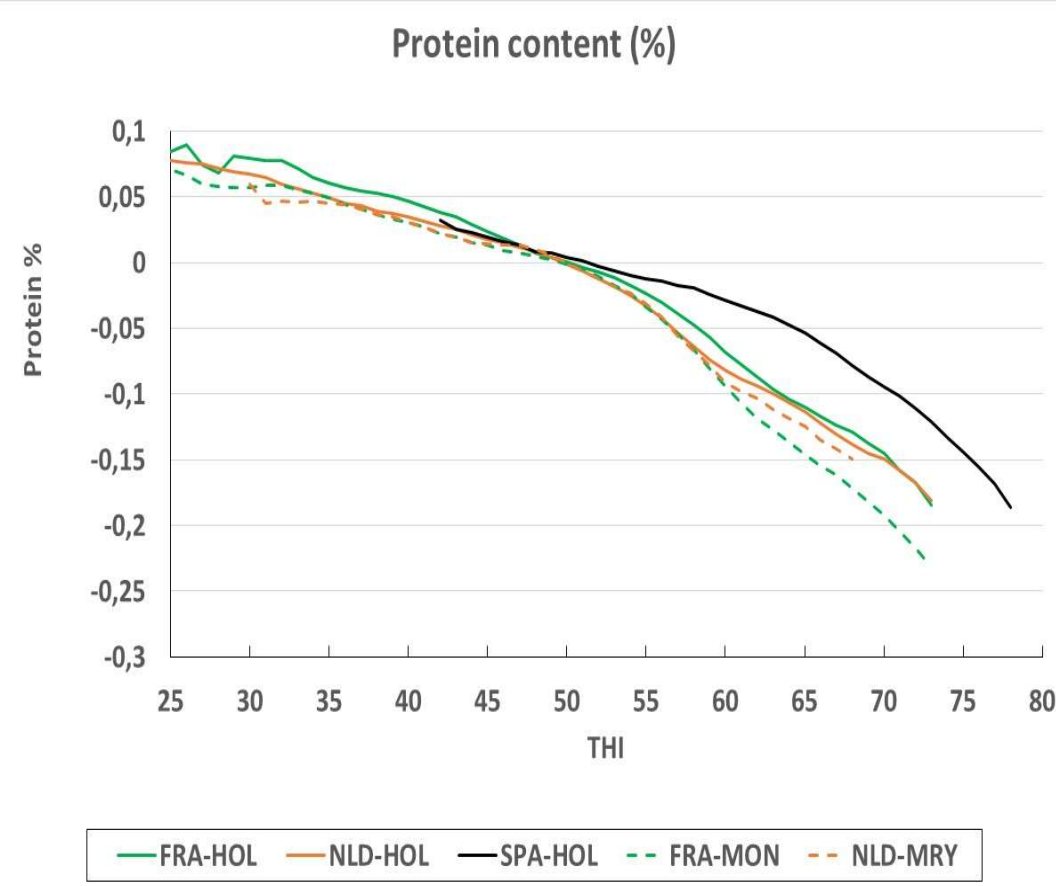




Results

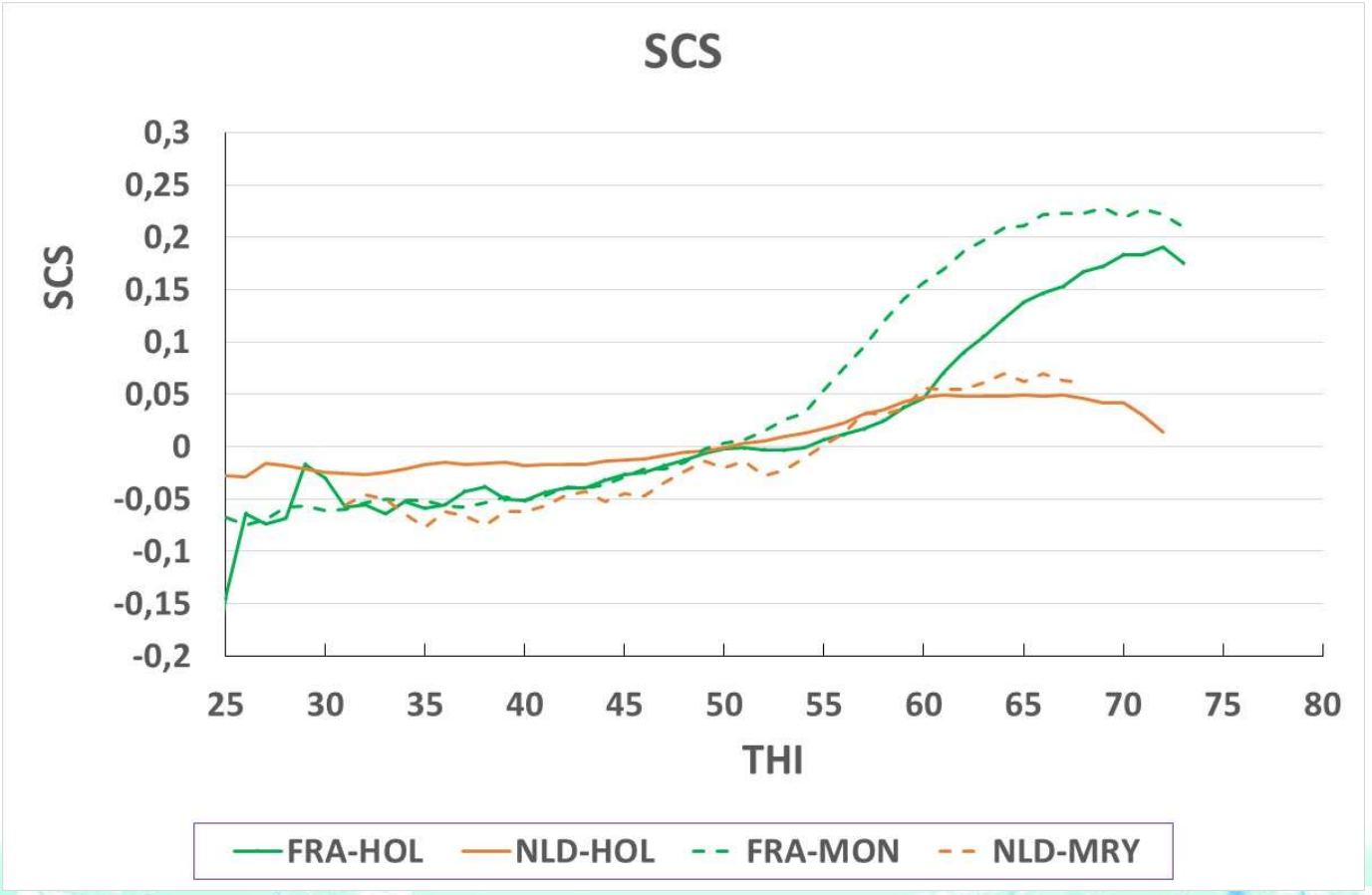
Estimated effect of THI on Fat and Protein Contents
- Cows in 1st lactation -





Results

Estimated effect of THI on SCS
- Cows in 1st lactation -



Discussion

- **A negative impact of increasing THI on performances**
  - **Stronger on production than on SCS**
    - Eg.: MON, FRA, L1: THI 50->70 :
      - PY: -84 g/day <-> 11% of daily average production <-> 0.7 σ_p
      - SCS: +0.22 <-> SCC x 1.3 <-> 0.2 σ_p
  - **The pattern of the curves depended on the trait**
- **More differences between countries than between breeds**
  - FRA (yields): HS thresholds lower than expected / literature and / SPA and NLD
  - **Farming conditions ?**
    - Dutch cows: 2/3 farms of this study equiped with robots (large farms)
    - Spanish cows: not exposed to outdoor conditions, barns better equiped to mitigate heat stress
    - French cows: more pasture (outdoor -> more exposure to HS, feeding)
  - **Spain: acclimatation?**
  - **…**

Conclusion

- Heat Stress indicators can be defined, combining performances & weather data

- A negative impact of heat stress, stronger on production than on SCS
  - The pattern of the curves depended on the trait
  - → Heat tolerance is a complex trait

- Consistant patterns between breeds & countries

- HS thresholds: more differences between countries than between breeds
  - Farming systems
  - Acclimatation
  - …
  - … to be confirmed!

- Next step:
  - Reproduction traits
  - Genetic determinism of heat tolerance traits

Aknowledgement

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RUMIGEN PARTNERS

Thank you for your attention

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