Heat Tolerance: a new index for Italian Holstein”

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Head Research & Development office

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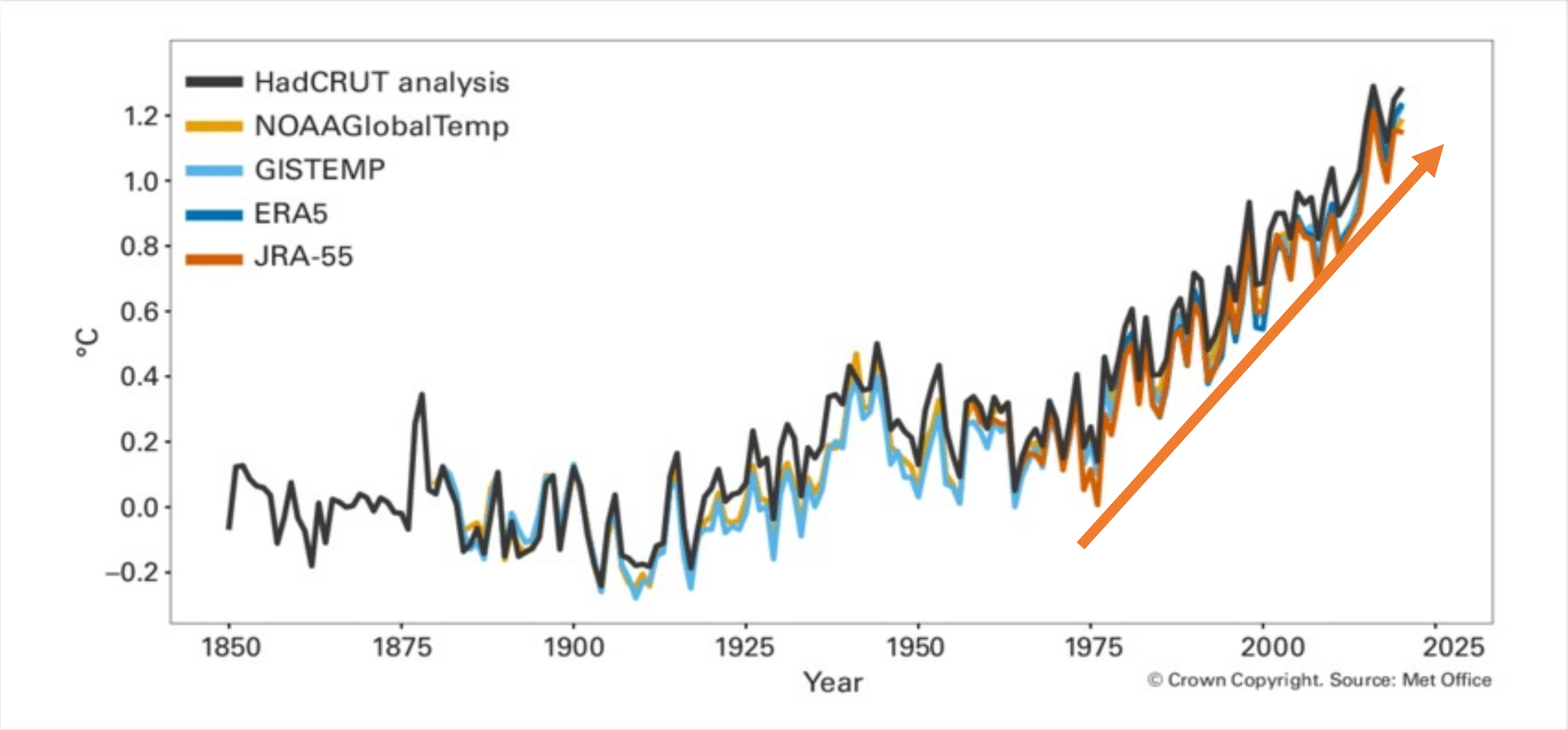
Status



Global mean temperature for **2020 was 1.2 ± 0.1 °C** above the 1850-1900 baseline which places 2020 as one of the three warmest years on record globally.

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GLOBAL WARMING EFFECT

✓ Global warming is having a strong effect

✓ Countries are thinking how to mitigate the effect

✓ Global warming has already a significant economic impact for producers and consumers

✓ **Heat stress** impairs welfare and productive performance of dairy cattle

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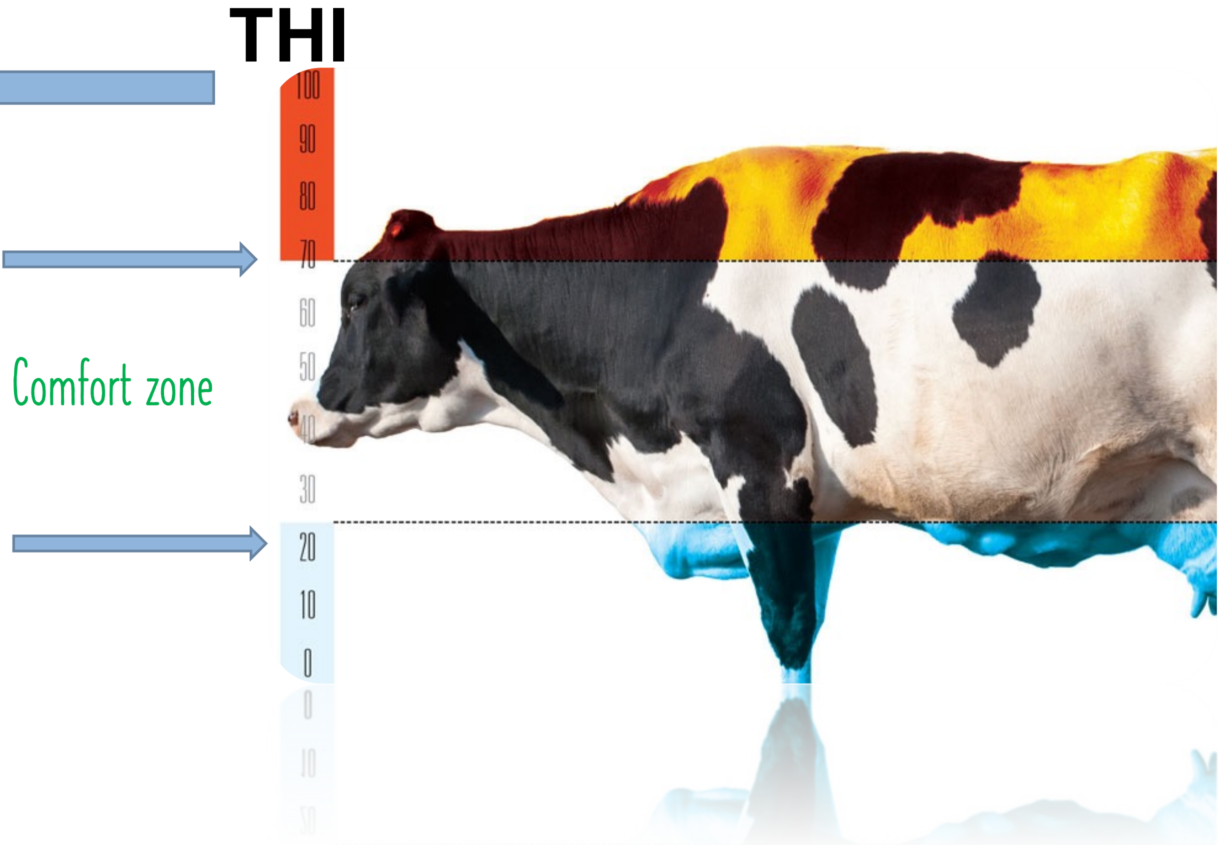
Dairy Cows and Heat Stress

Heat stress results from a combination of environmental factors that exceed a cow's comfort zone and ability to keep cool.



A single value **representing** the combined effects of **air temperature** and **humidity** associated with the **level of thermal stress.**

$$THI = \{\mathbf{T}_{Max} - [0.55 \times (1 - RH)] \times (\mathbf{T}_{Max} - 14.4)\}$$ **(Kelly & Bond, 1971)**

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Dairy Cows and Heat Stress

To maintain a constant body temperature, heat gained has to equal heat loss:

Heat loss = Heat Gain

Heat loss = Heat Produced + Enviromental heat

Heat stress occurs when heat gain exceeds heat loss:

Heat loss < **Heat Gain**

Heat loss < Heat Produced + **Enviromental heat**

Robertshaw (1985); Hansen (1994)

Dairy Cows and Heat Stress

↑ water consumption

↓ feed intake (DMI)

↑ somatic cell count

↓ milk yield

Above the comfort zone

↓ fertility

↓ rumen function

↓ immunity

↑ risk of mastitis/disease

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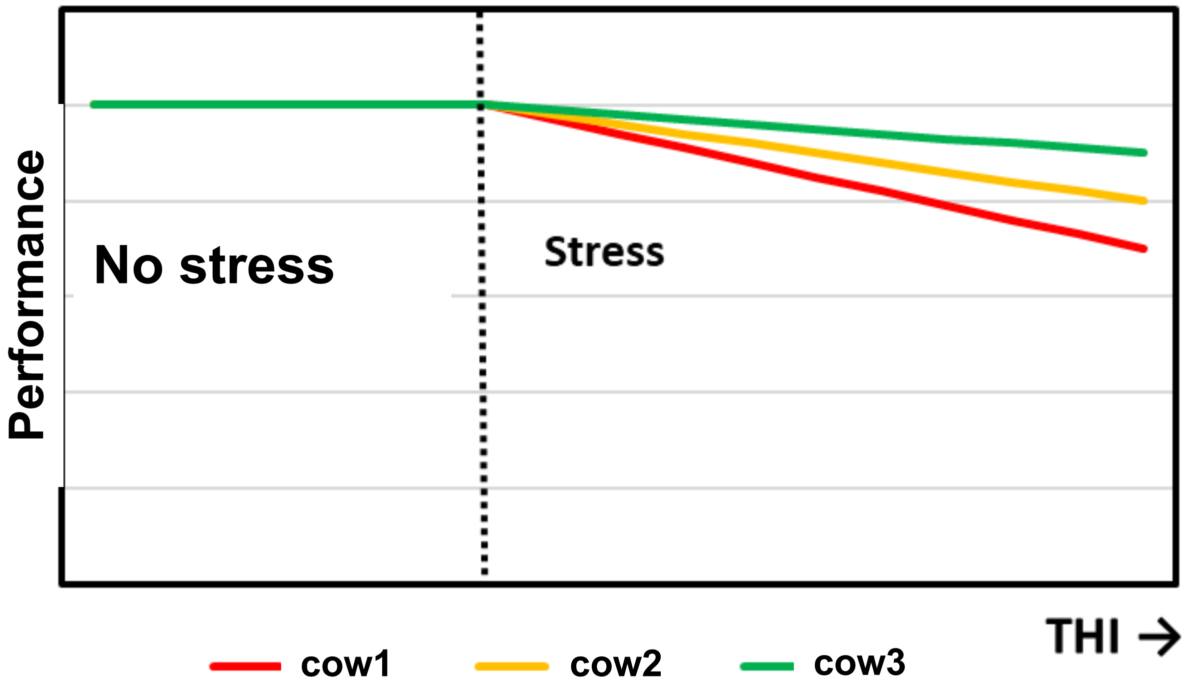
Performance and «heat tolerance» breeding value estimation



2000 J Dairy Sci 83:2126–2130

GENETICS AND BREEDING

Genetic Component of Heat Stress in Dairy Cattle, Development of Heat Index Function

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J. Dairy Sci. 88:1855–1864
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Effect of Heat Stress on Production of Mediterranean Dairy Sheep

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J. Dairy Sci. 86:3736–3744
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Genotype × Environment Interaction for Milk Production of Daughters of Australian Dairy Sires from Test-Day Records

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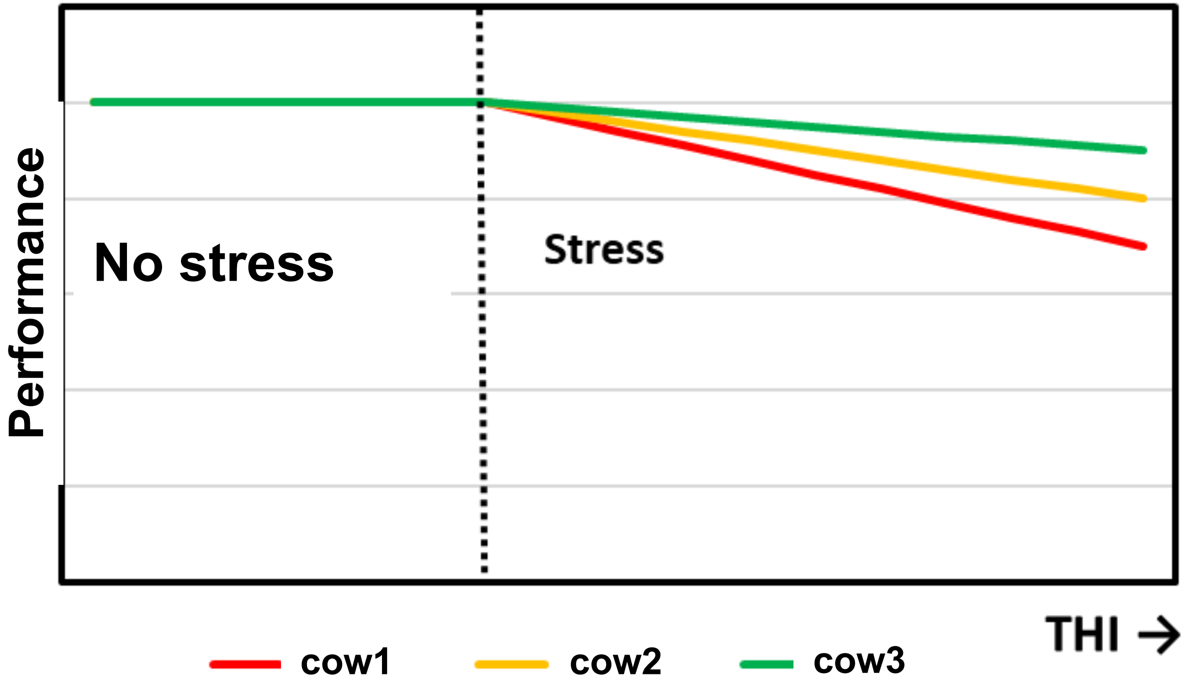
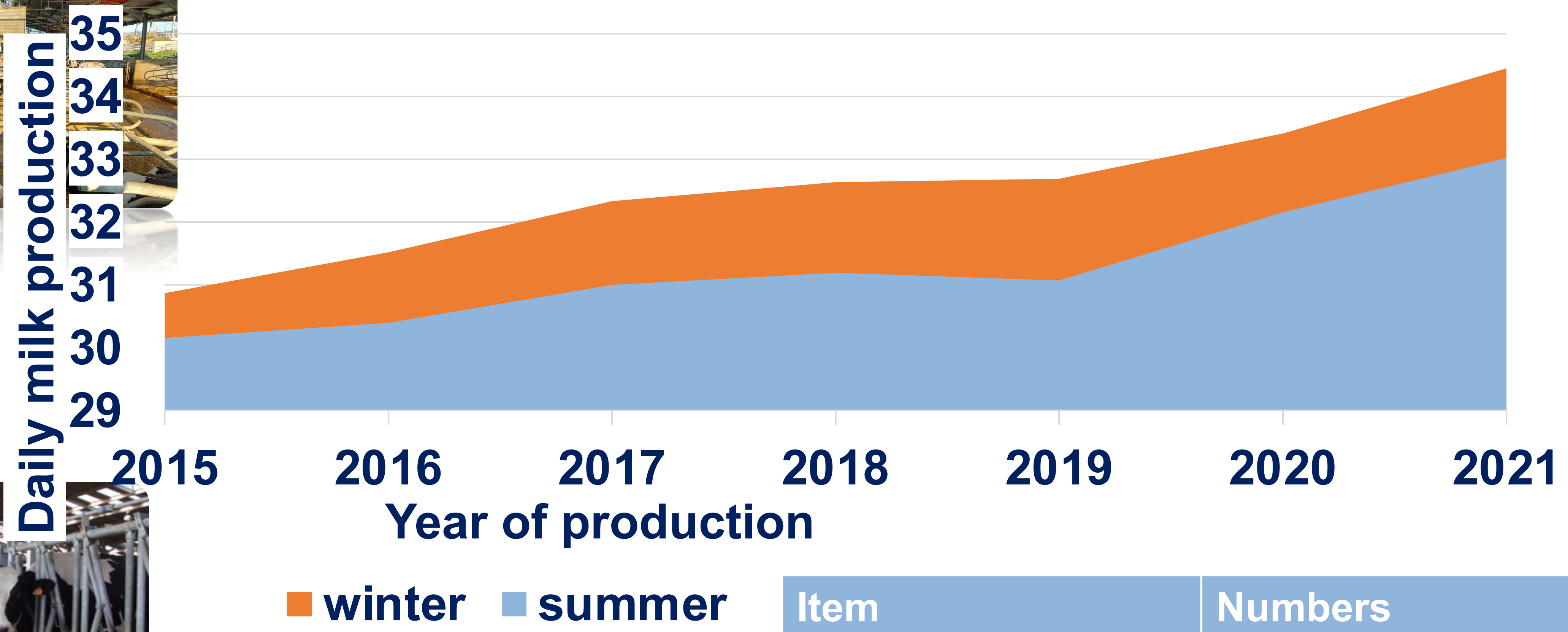
Performance and «heat tolerance» breeding value estimation



There are two available info
- Routine animal data - collection
- THI data – weather stations

→ G=f(THI)

Milk production Summer and Winter



ANAFIBJ source 2022

Approach Flamenbaum, 2016 *– S/W ratio*

Item	Numbers
Daily milk prod. lost	**-1,5 kg/d**
Summer days	180
N° of cows in italy	1,000,000
Production loss	**-270,000 tons**

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ANAFIBJ Steps

1. Establish relationship between **performance** and **weather conditions**

2. Determine when thermal stress occurs (**establish the threshold point**)

3. Determine **genetic variability in the Italian Holstein for "Heat Tolerance"**

4. **Genetic parameters estimation**→ Genetic index (selection tool)

5. Comparisons **«top» bulls/cows** and **resistant THI animals**: Differences ??

→ 1st TRAIT IMPLEMENTED DAILY MILK YIELD (EBV official april 2022)

→ Currently in progress milk contents and SCS (preliminary results)

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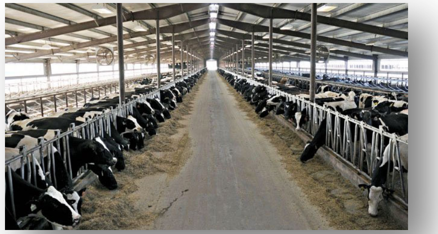
DATA-SET

+



- Data since 1994 (Max T C° & relative humidity)/day → **THI** (Kelly & Bond, 1971)

- **Weather stations (WS-137)→ Latitude/Longitude Coordinates**
- **Herds→ Municipalities → Latitude/Longitude Coordinates**

1. **For each herd → average 2,3 WS with average distance 13,5 km**
2. To each test-days added THI data
3. 7-day average THI was used for each test-day

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Heat threshold analysis: Repeatability model

$$Y = HYS + YC + DIM * age * parity + THI + a + pe + error$$

- Y= phenotype (milk,- fat, protein, SCS)

Fixed effects

- HYS = herd-year season of test-days (4 seasons)
- YC= year of calving
- DIM = days in milk
- Age = age at calving
- Parity (3 lactations)
- THI

Random effects

- a= additive genetic component
- pe = permanent enviroment effect
- error

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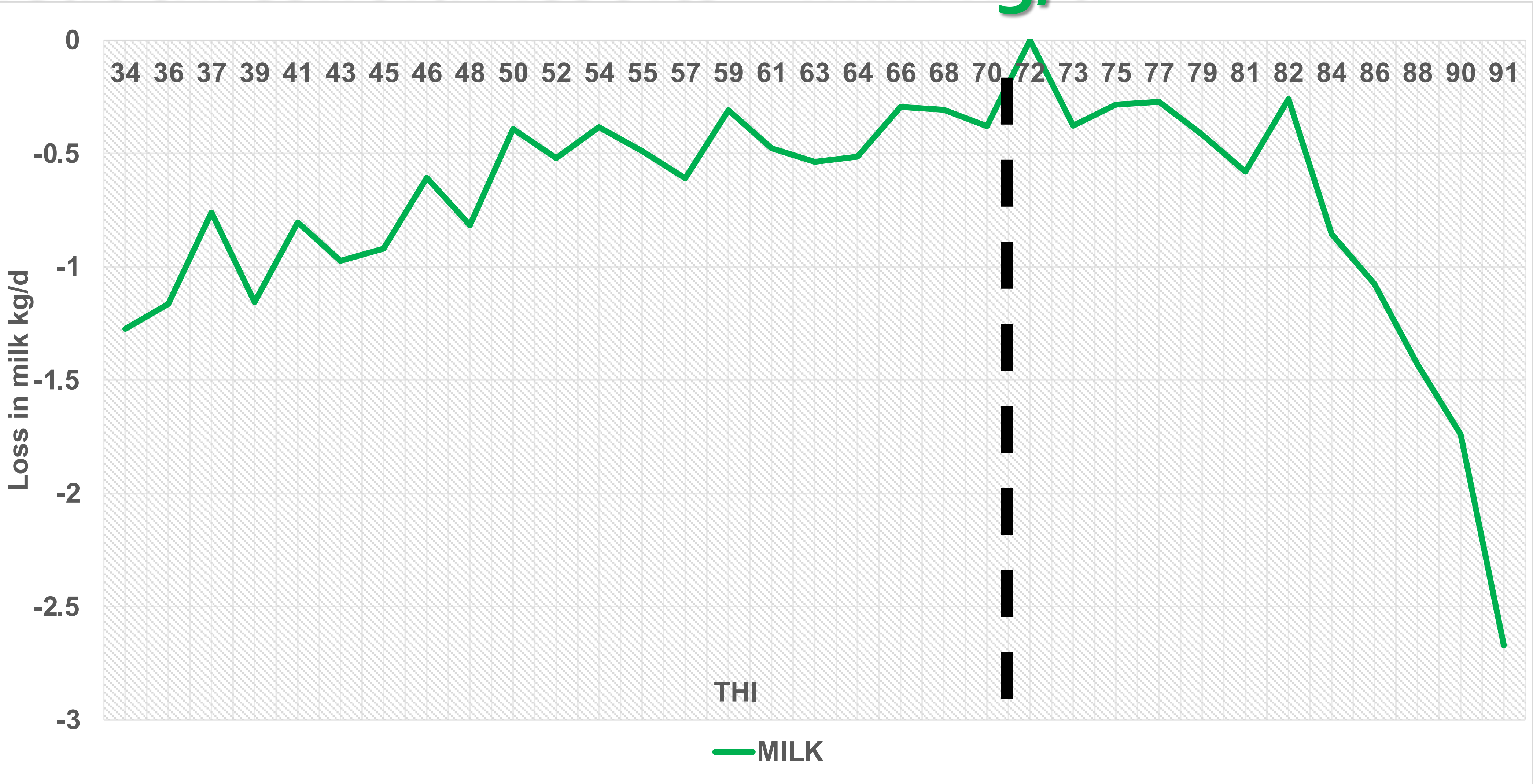
Heat threshold Results – Milk kg/d



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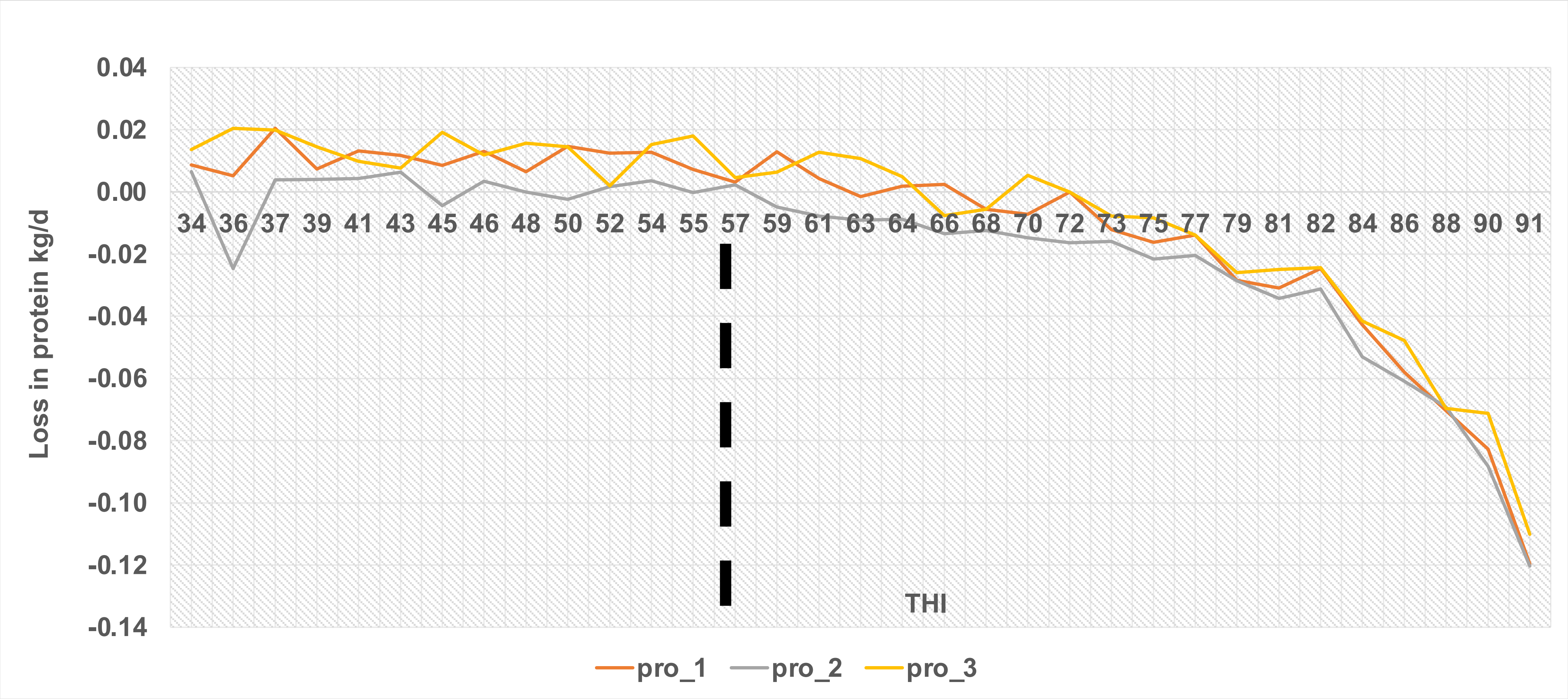
Heat threshold Results – PROTEIN kg/d



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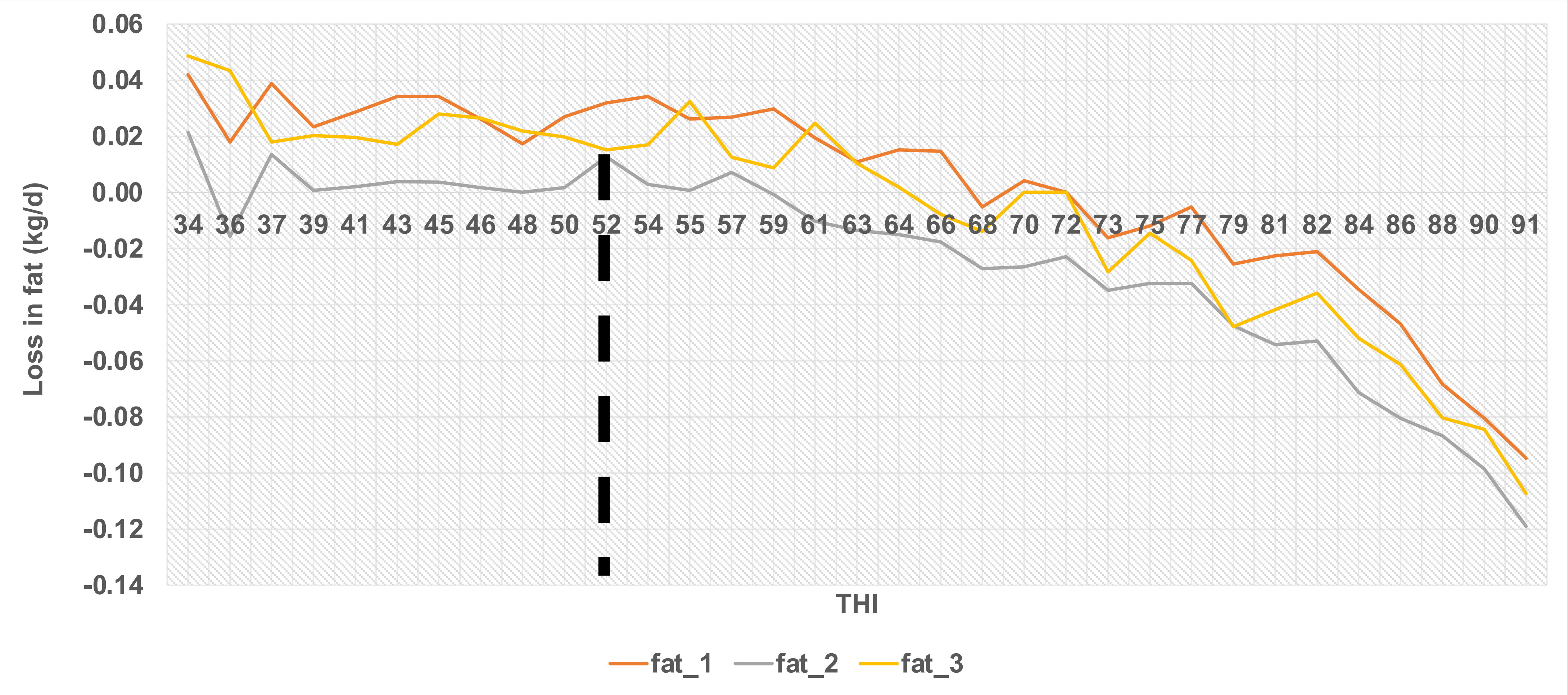
Heat threshold Results – FAT kg/d



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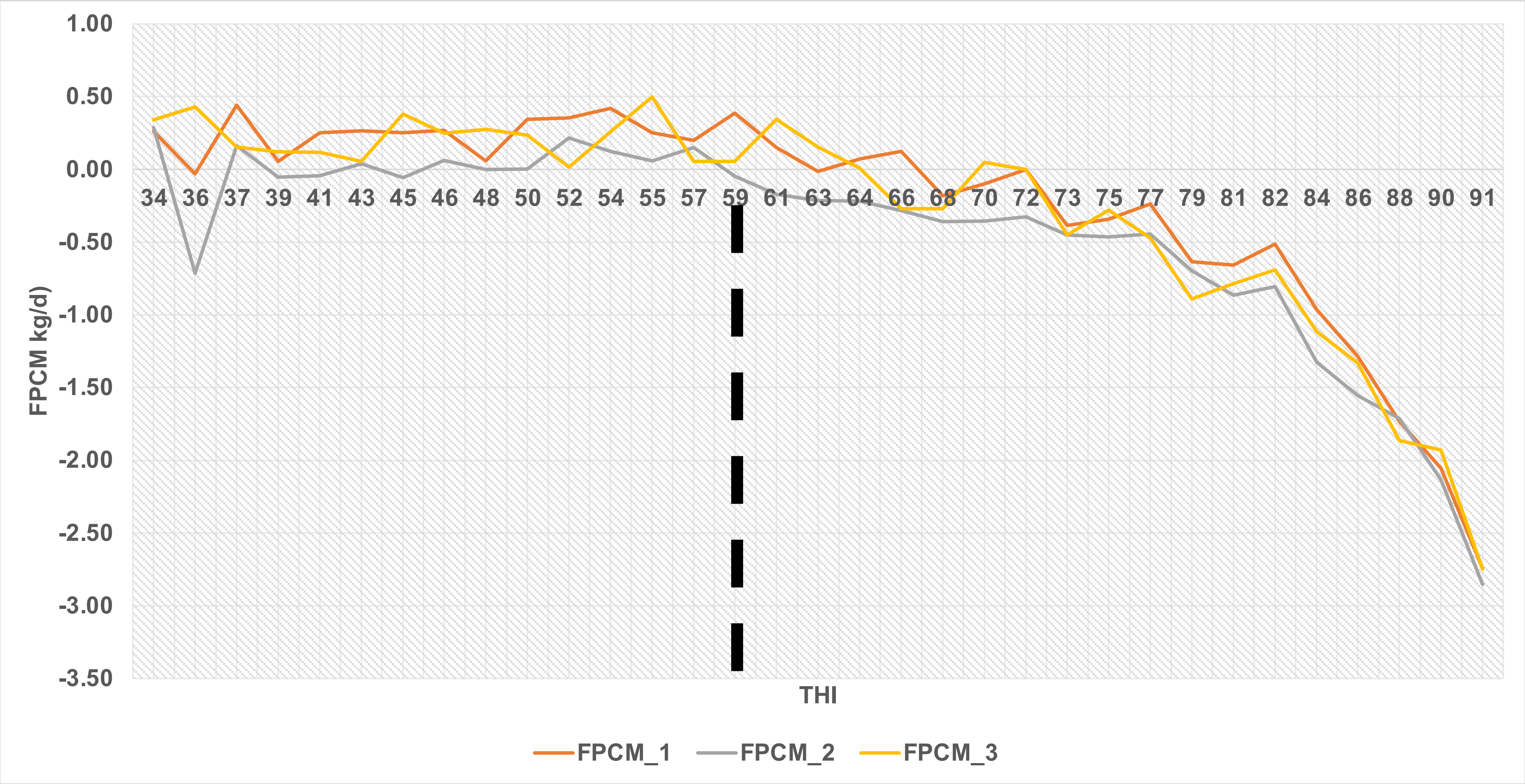
EHRC General Assembly and Conference will be held in Ireland 26th – 29th April 2023

Heat threshold Results – Combination milk/fat/protein Kg/d



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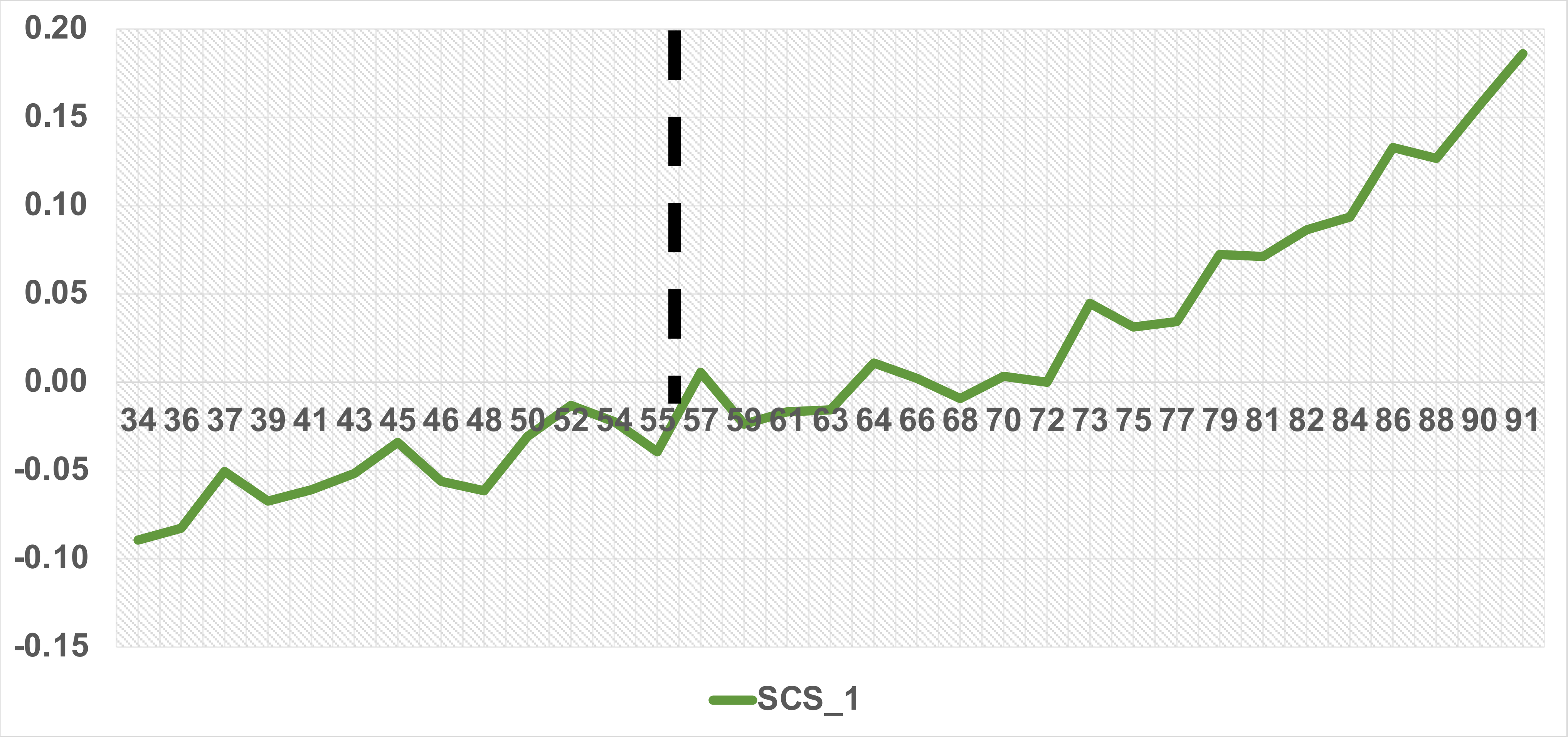
Heat threshold Results – SCS (Ali&Shook, 1980)



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Heat threshold analysis: Repeatability model

$$Y = HYS + YC + DIM * age * parity + a + (f * v) + pe + (f * q) + error$$

- Y= phenotype (milk,- fat, protein, SCS)

Fixed effects

- HYS = herd-year season of test-days (4 seasons)
- YC= year of calving
- DIM = days in milk
- Age = age at calving
- Parity (3 lactations)

Random effects

- a= additive genetic component ← General animal genetic merit
- f *v = heat tolerance additive effect ← Heat tolerance genetic merit
- pe = permanent enviroment effect
- q *v = permanent enviroment tolerance effect
- error

Ravagnolo et al. 2000 Theory

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Genotype*Enviroment interaction (GXE)

- Random effects were regressed on a fuction of THI

$$f(THI) = \begin{cases} 0, & \text{THI} \leq \text{THI}_{\text{threshold}} \ (\text{no heat stress}) \\ \text{THI} - \text{THI}_{\text{threshold}}, & \text{THI} > \text{THI}_{\text{threshold}} \ (\text{heat stress}) \end{cases}$$

Trait	Threshold level
Milk (kg/d)	70
Protein (Kg/d)	59
Fat (Kg/d)	52
Somatic Cell Score	55

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Correlations

- Relationship between general genetic merit and heat tolerance genetic merit of production

TRAIT	Genetic correlation	Hereditability
Milk	-0,48	14%
Protein	-0,57	15%
Fat	-0,53	12%

Negative correlationsindicate opposing relationship, but they are moderate

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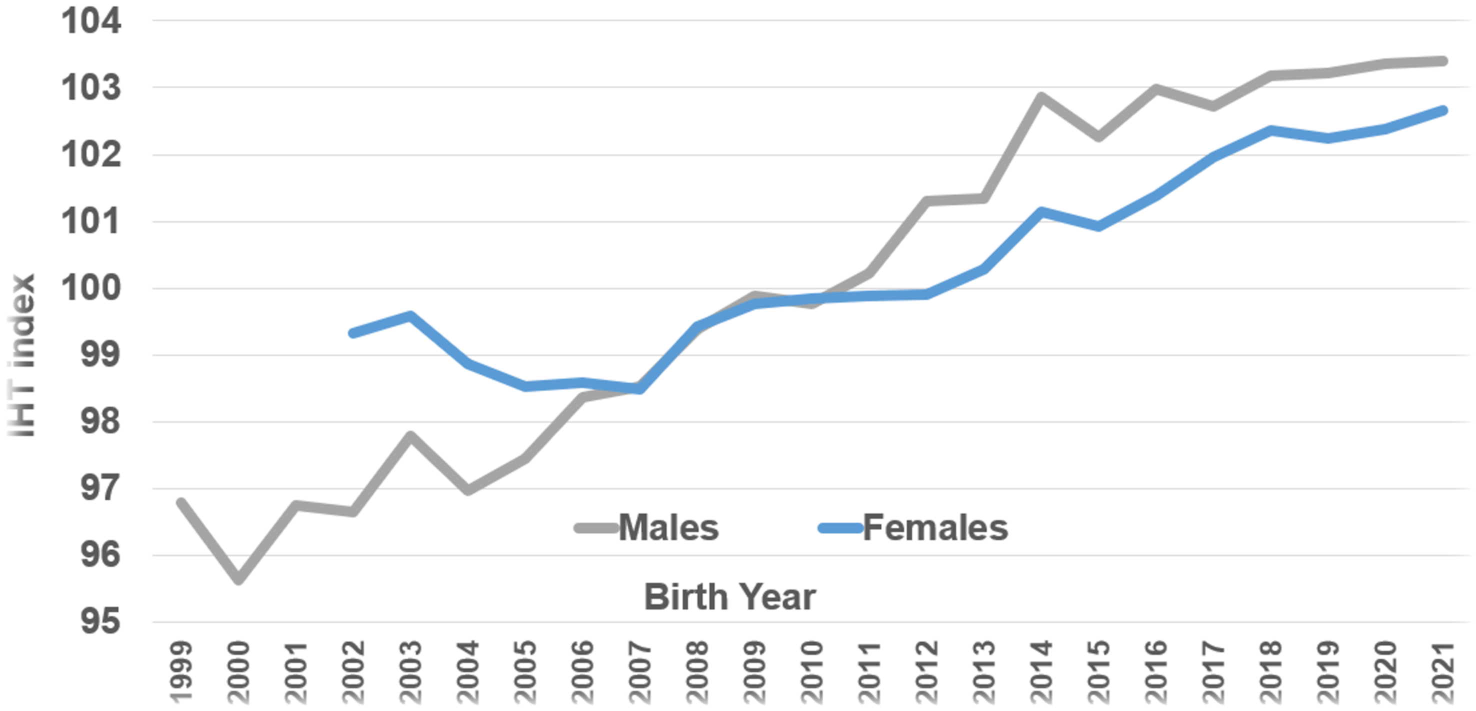
APRIL 2022 – New Heat tolerant index

- IHT breeding value for Milk (kg/d)
- Developed with 100 ±5 DS



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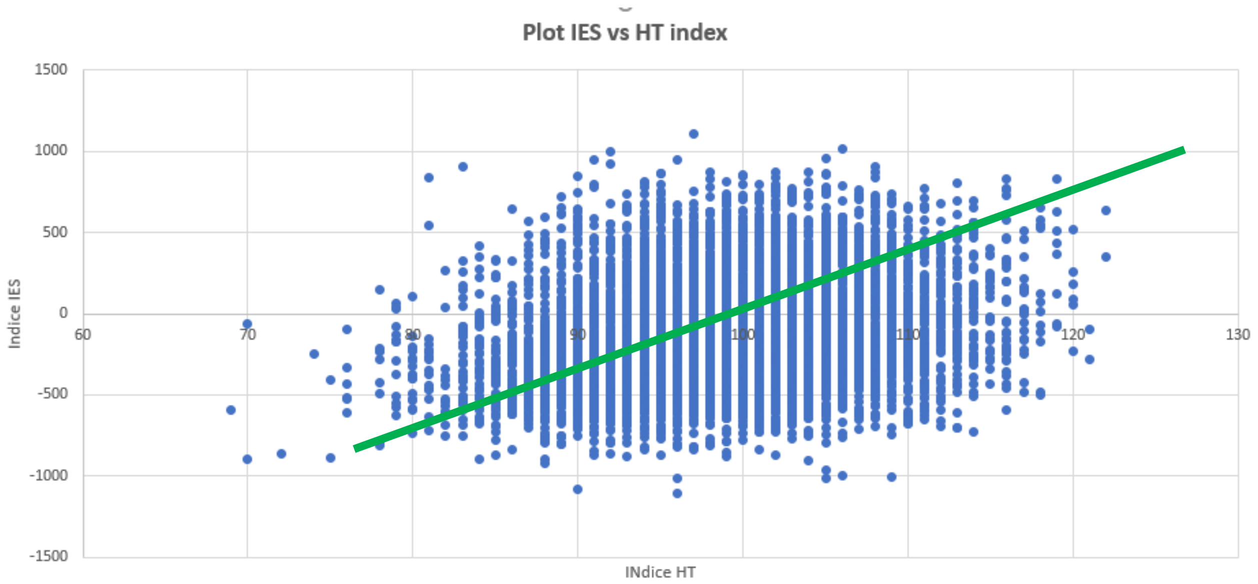
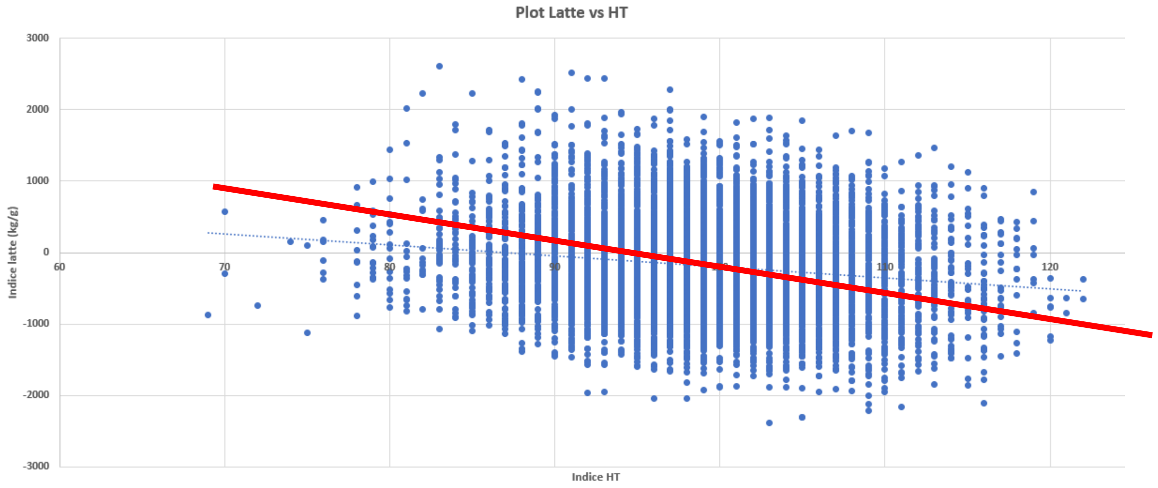
gEBVs correlations

gEBVs	Positive/Negative
gPFT	+
gIES	+
gICS-PR	+
gMilk	-
gMST	+
gSCS	+
gIAF	+





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Bull comparisons TOP/LOW -- SUMMER/WINTER

BULLS ≥ 1000 DAUGTHERS

	Bulls group	Differences within group Summer -Winter	Differences between groups
TOP	EBVs HT ≥ 105	-2,7 kg/d	~ -1kg/d
LOW	EBVs HT≤ 95	-3,6 kg/d	

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Conclusions and Work in Progress

- ✓Confirmed the antagonistic relationship between animal and environment
- ✓IHT published for the first time April 2022
- ✓We started "Milk Heat Tolerance" Genomic Breeding Value
- ✓More traits are going to be included ...work in progress (December 2023)

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Thanks!

Ufficio Servizi FA

Ufficio LG

Ufficio R&D

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Thanks!

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