GENETIC MODELLING OF HEAT STRESS IN ITALIAN HOLSTEIN COWS

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R&D and FA offices - **ANAFIBJ**

ASPA 2021 PADOVA
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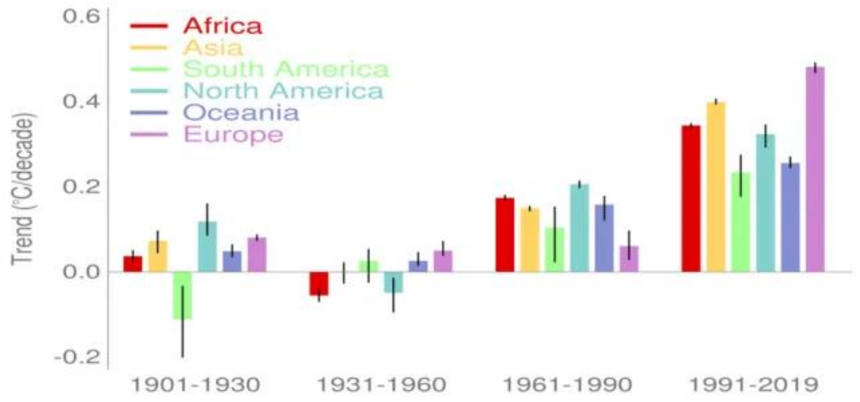
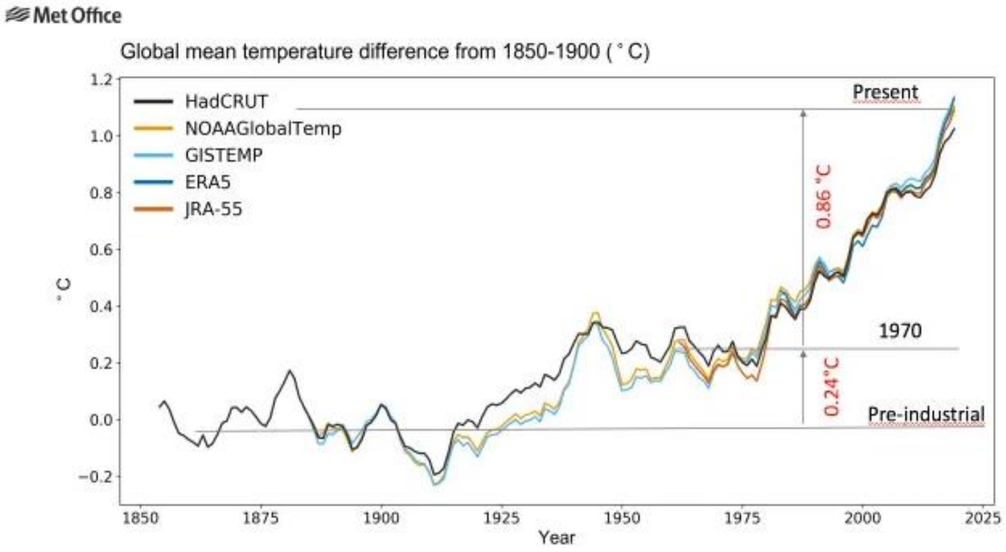
STATE OF THE ART

- **Temperature and rainfall changing**
  - Varies with region & season
  - Floods, droughts, heat waves, high winds
  - Agricultural systems need to be resilient to deal with multiple stressors (including climate change)
  - Global warming is a problem?





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

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.

THI

21 °C

Confort zone

-4 °C

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

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

Heat Tolerance …and Holstein???

- European Mediterranean countries are characterized by exposure to considerable heat between three and six months annually.

- Difficult to quantify the influence of herd management on production performance.

→ *IS IT POSSIBLE TO SELECT FOR HEAT TOLERANCE?*

- $\boldsymbol{Phenotype = Genotype + Environment + Genotype * Environment}$

Heat stress → «Genetic Effect»??

- Is it possible to set up a genetic evaluation using routine National data?

Genetic Component of Heat ...
Development of Heat Ind...
GENETIC...

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Effect of Heat Stress on Production of Mediterranean Dairy Sheep

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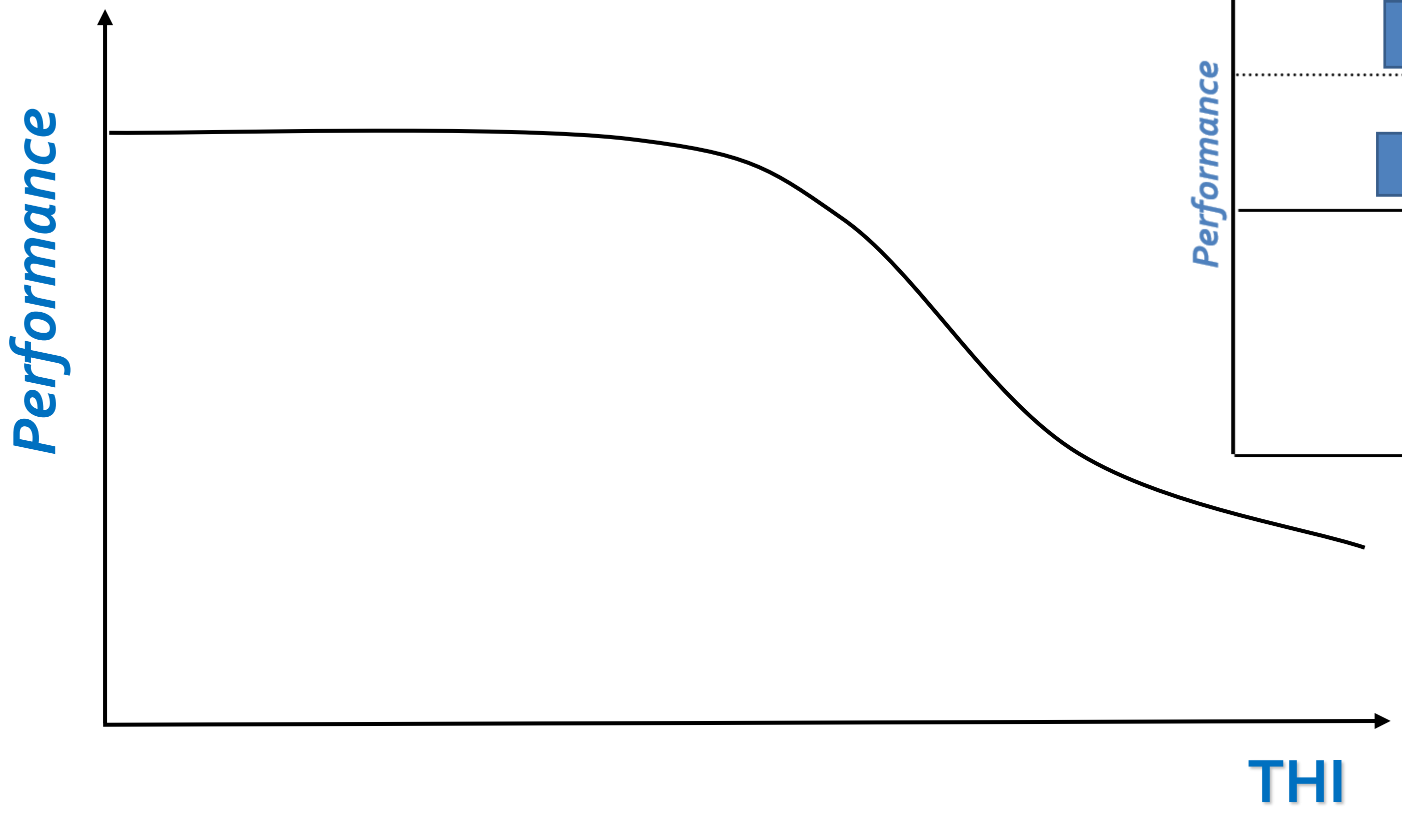
- How big is the «genetic effect»?

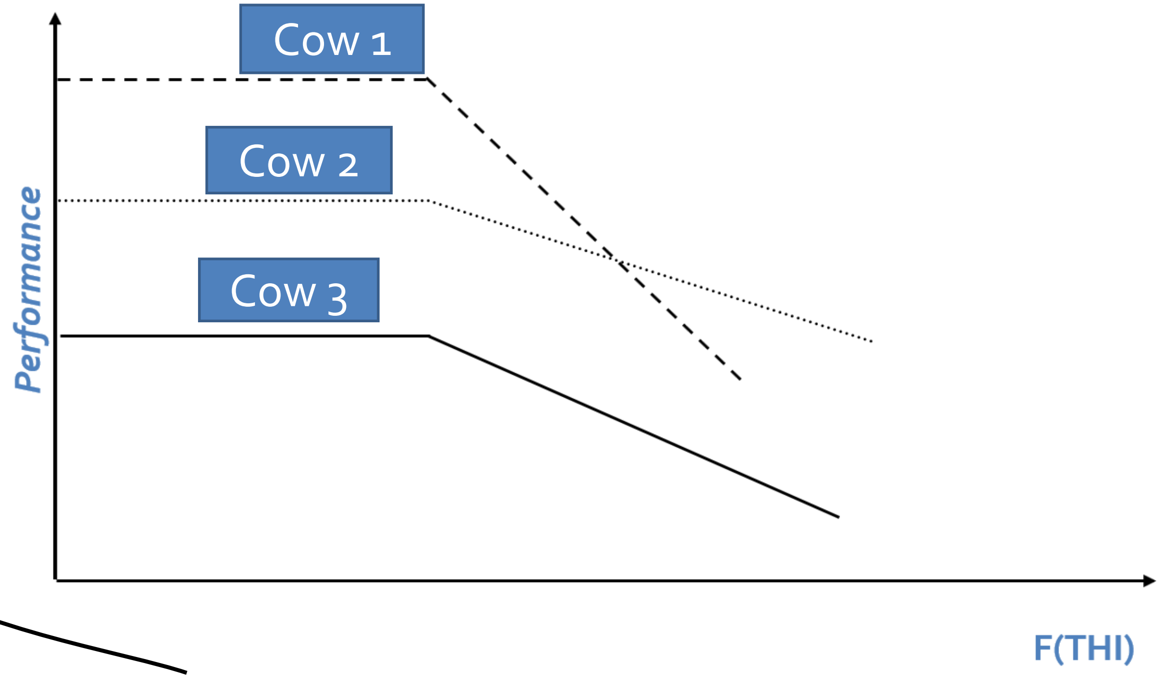
- How can we investigate Genotype*Environment effect?

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

→ G=f(THI)

Performance and «heat stress» breeding value





ANAFIBJ AIM

- Establish relationship between **performance** and **weather conditions**;
- Determine when thermal stress occurs (**Establish the threshold point**)
- Determine if there is a **genetic variability in the Italian Friesian for resistance to heat**
- Estimate **genetic parameters** → Genetic index (selection tool)
- Comparison of **«top» bulls/cows** and **resistant THI animals**: Differences ??

DATA-SET

+

- 1994-2021 Max T/day C° + relative hum/day

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

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

1. **For each herd → average 2,3 WS + average distance 25 km**
2. To each TD added THI data
3. Calculation of THI average of the days prior to TD for WS in the vicinity of the farm (-2d; -4d; -5d; **-7d**;-10d;-14d)

Model Concepts

y = "Fixed effects" + a + f*v+ p + f*q + e

y = *Performance*

a = classic additive animal effect

f = heat index function **f(THI)**

$$f(THI) = \begin{cases} 0 & \text{if } THI \leq THI_{threshold} \\ THI - THI_{threshold} & \text{if } THI > THI_{threshold} \end{cases},$$

v = *heat- tolerance*-additive effect

p = permanent environmental effect

q = *heat-tolerance*-environmental effect

- *a* e *v* = same n° levels
- *p* e *q* = same n° levels

Methods

1. Five data-sample of 150 herds with an average of 30,000 cows each + 5 generations back pedigree

2. Each lactation considered as a trait (Multiple –trait) -

Aguilar et al. 2009

J. Dairy Sci. 92:5702–5711
doi:10.3168/jds.2008-1928

Genetic components of heat stress for dairy cattle with multiple lactations

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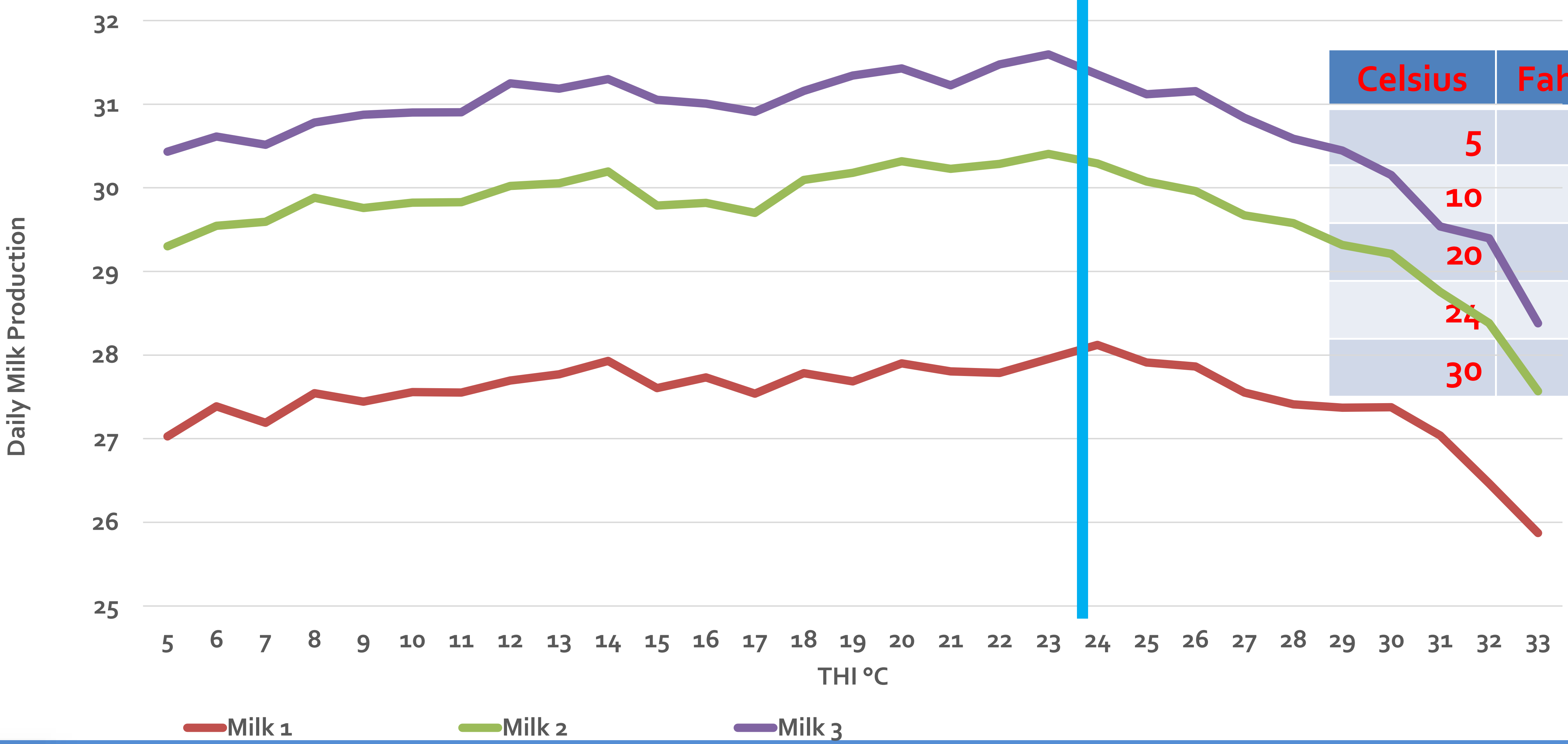
3. Fixed effects : HYS + YC + DIMC* age at calving class + THI + error (Milk1, Milk2, Milk3)
   - *Test-days years: 2004 -2020*
     - *HYS= herd – year – season of TD (4 seasons); YC = Year – season of calving (4 calving season: winter, spring, summer, fall) (64 levels) ; Stage of lactation classes : 5- 305 DIM (31 levels); Age calving classes : 1) First parity 22-30 months 2) Second parity 34 -46 months 3) Third parity 48 - 60 months (9 levels); THI*

4. *Genetic Parameter estimation: GIBBS2F90 (Misztal et al. 2002)*

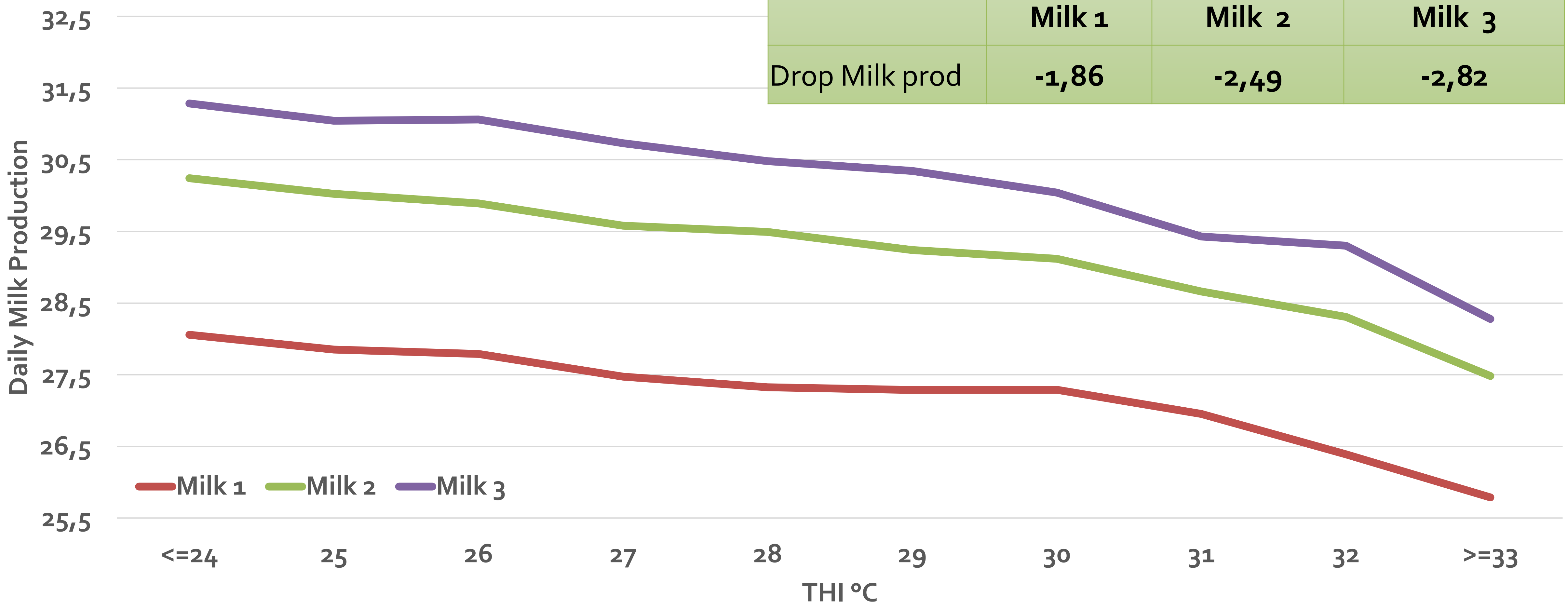
Least Square Means – Milk kg/d (average -7d before TD)



Celsius	Fahrenheit
5	41
10	50
20	68
24	75,2
30	86

Least Square Means – Milk kg/d (average -7d before TD)

	Milk 1	Milk 2	Milk 3
Drop Milk prod	-1,86	-2,49	-2,82



Genetic Parameter

Milk (kg/d)	Milk 1	Milk 2	Milk 3
General genetic correlation Milk 1 ;Milk n		0,88	0,84
General genetic correlation Milk 2;Milk 3			0,96
General genetic correlation THI Milk 1; Milk n		0,77	0,56
General genetic correlation THI Milk 2; Milk n			0,62
Genetic Correlation ANIMAL;THI (Genotype*Env)	-0,47	-0,48	-0,36
Ereditability(h^2)	0,18	0,13	0,11

Conclusions and Work in Progress

- ✓Confirmed the antagonistic relationship between animal and environment
- ✓Second parity are those who have the greatest effect
- ✓The use of a multiple - trait is important
- ✓"Ready" index estimation process
- ✓The definition of the weights for the index is in progress
- ✓We are starting with "milk heat stress" Breeding Value

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THANK YOU!

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