GENETIC EVALUATION OF HEAT TOLERANCE IN ITALIAN HOLSTEIN BREED

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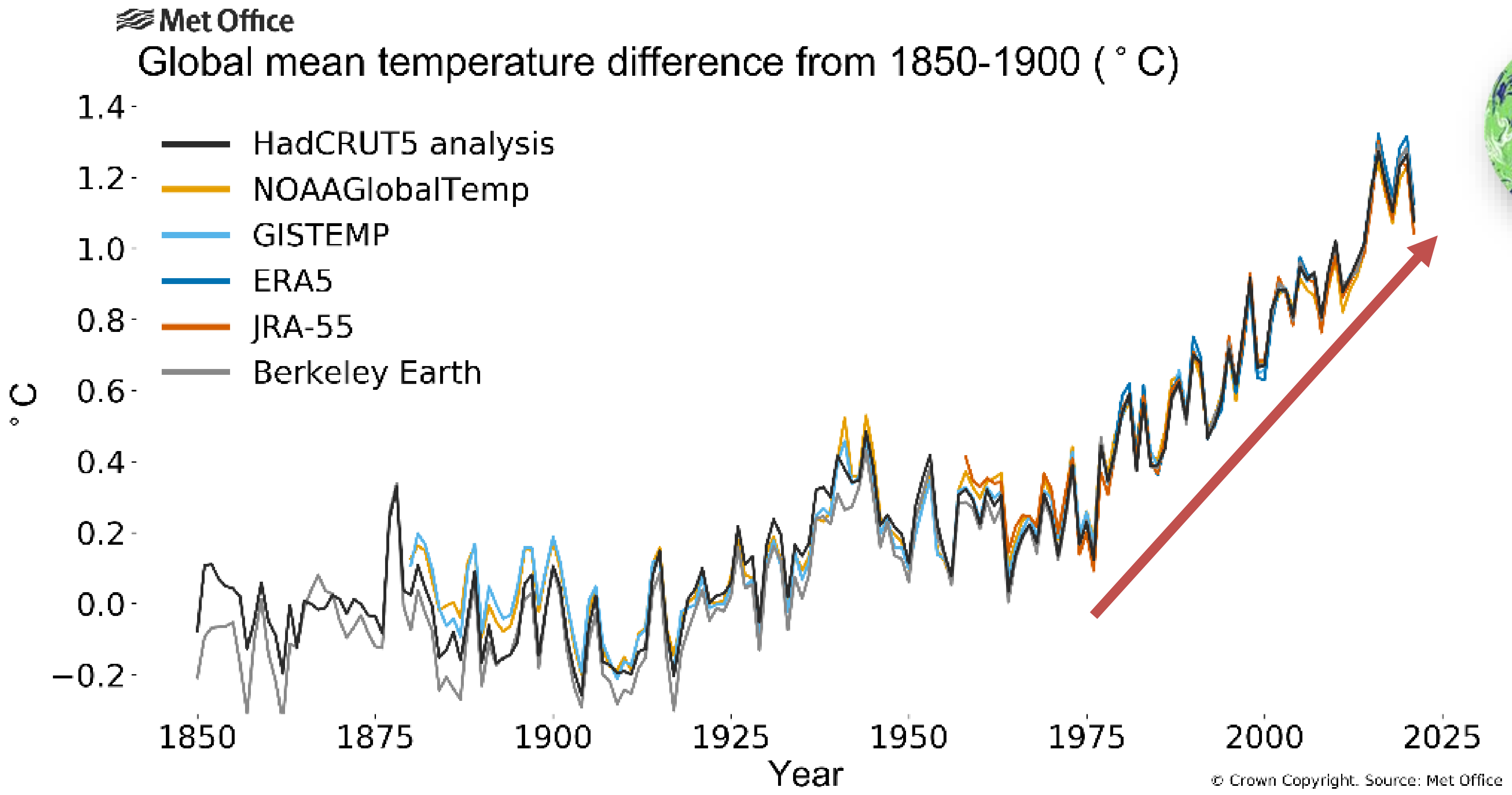
R&D office - **ANAFIBJ**



UN CLIMATE CHANGE CONFERENCE UK 2021
IN PARTNERSHIP WITH ITALY

✓ **+1,09 °C** > 1850 – 1900 (pre-industrial era)

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

Comfort zone

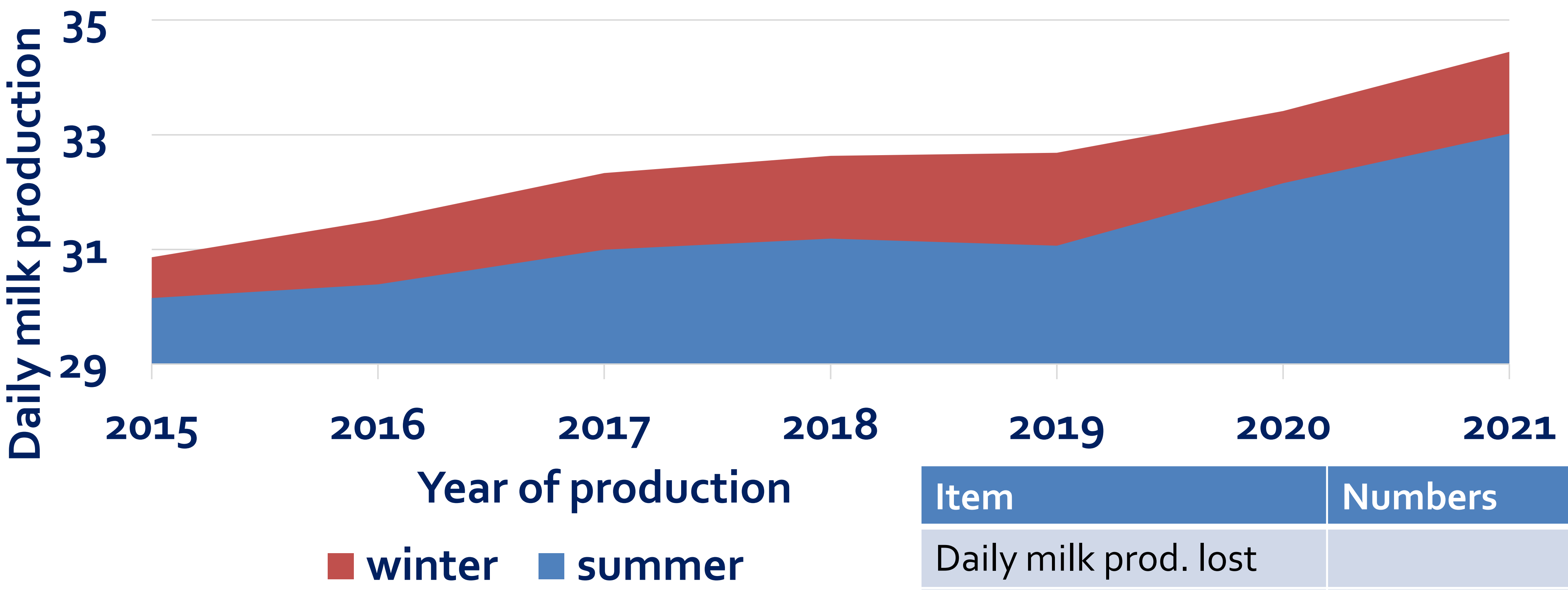
-4 °C

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)

Milk production Summer and Winter

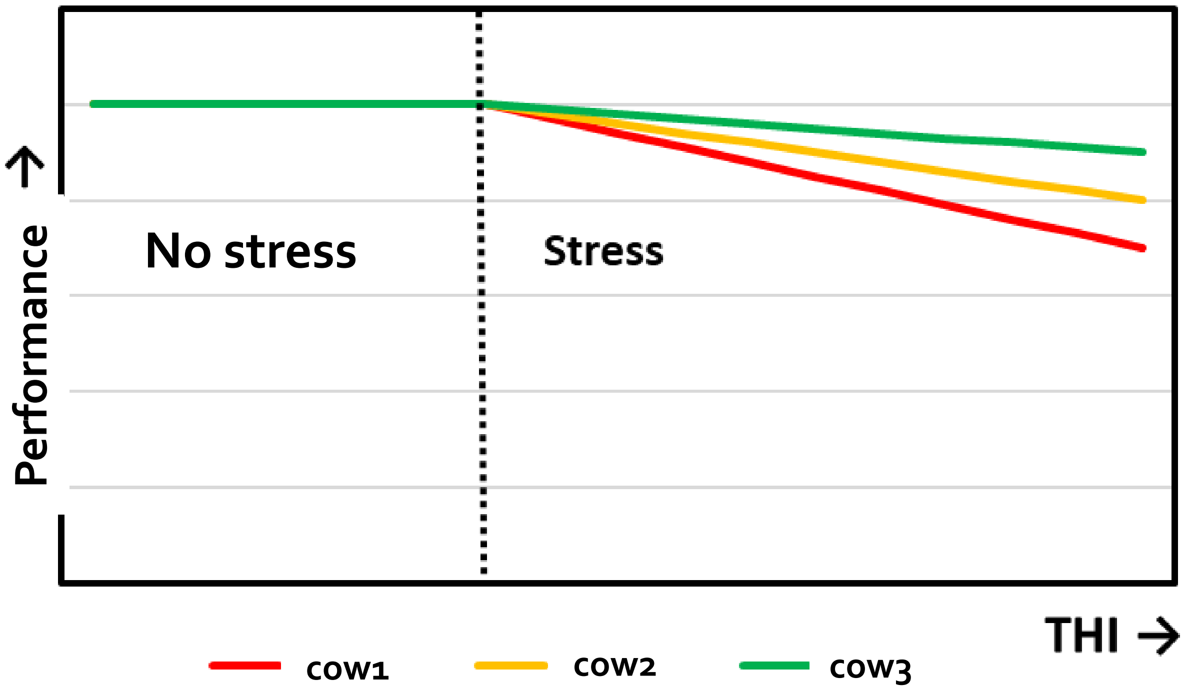


Item	Numbers
Daily milk prod. lost	**-1,5 kg/d**
Summer days	180
N° of cows in italy	1,000,000
Production loss	**-270,000 tons**

ANAFIBJ source 2022

***Approach Flamenbaum, 2016** – S/W ratio*

Performance and «heat tolerance» breeding value estimation



GENETICS AND BREEDING

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

2000 J Dairy Sci 83:2126–2130

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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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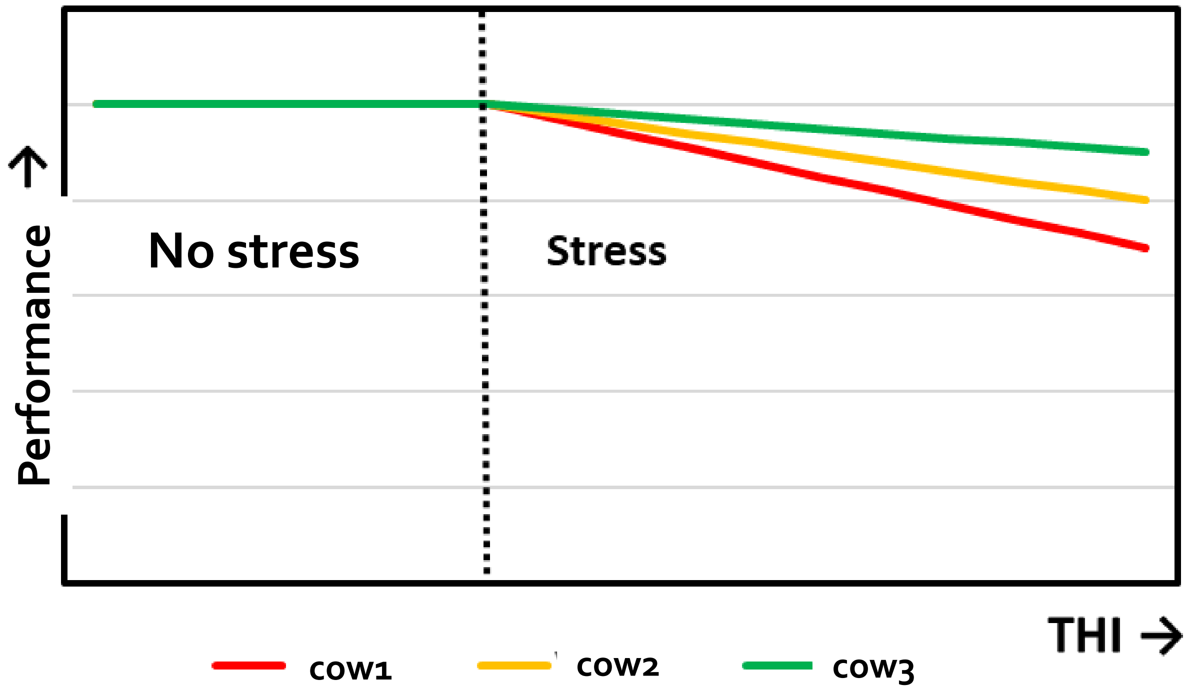
Performance and «heat tolerance» breeding value estimation



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

→ G=f(THI)

ANAFIBJ AIM

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**

DATA-SET

- 1994-2021 (Max T C° & relative humidity)/day

→ Derived **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. THI averaged days prior to TD for WS in the vicinity of the farm (-2d; -4d; -5d;**-7d**;-10d;-14d)

Methods

- Tested single and multiple trait model

- **Fixed effects** : HYS + YC + DIMC* age at calving class + THI + error

- **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 (9 levels); THI (5-33)**

- **Genetic Parameter estimation**: GIBBS2F90 (Misztal et al. 2002) + EBV estimation Mix99 software (Lidauer et a., 2019)

Five data-sample of 150 herds ~30,000 cows each and 5 generations back pedigree

Model Concepts

Ravagnolo et al. 2000 Theory

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

y = *Performance*

a = classic additive animal effect

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

v = *heat- tolerance*-additive effect

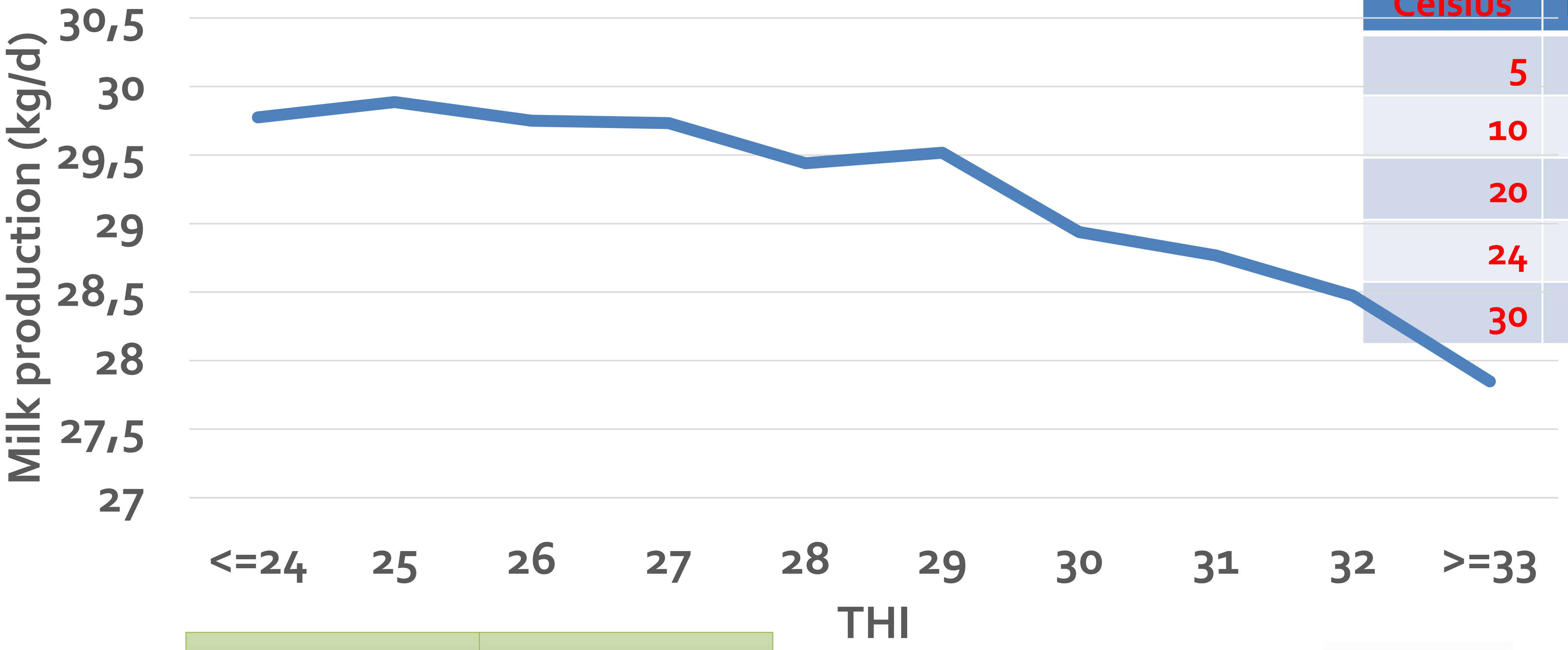
p = permanent environmental effect

q = *heat-tolerance*-environmental effect

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

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

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

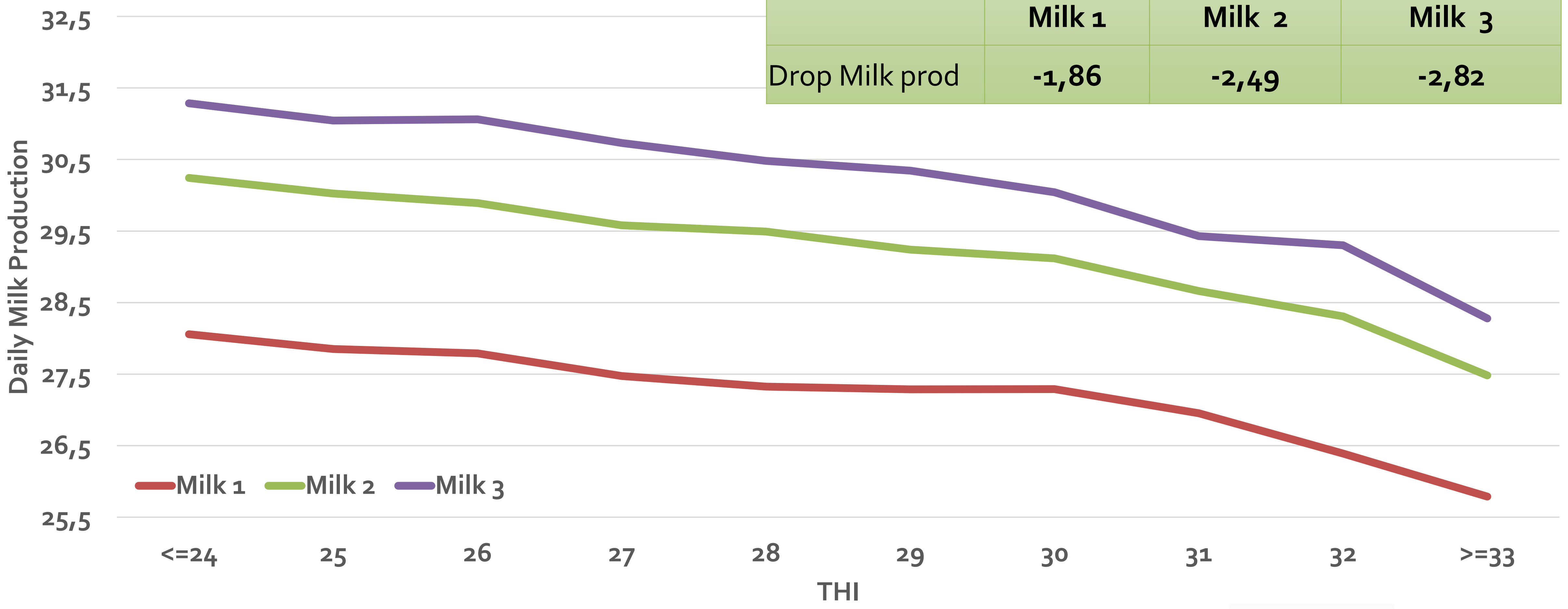


Celsius	Fahrenheit
5	41
10	50
20	68
24	75,2
30	86

	Milk (kg/d)
Milk loss kg/d	-1,93

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

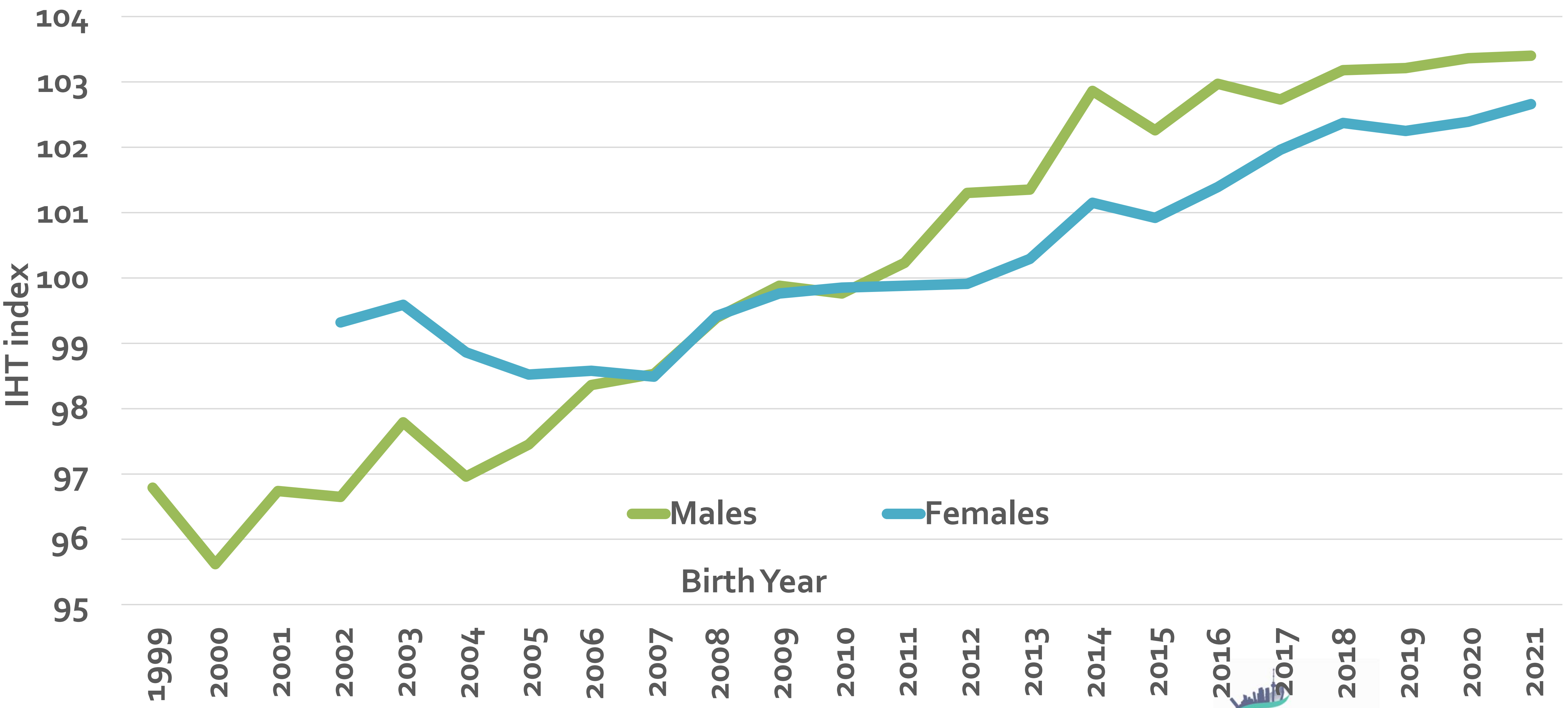


Genetic Parameter & EBV

Single trait	Genetic Parameters
Genetic Correlation ANIMAL;THI (Genotype*Env)	-0,45
h^2	0,16

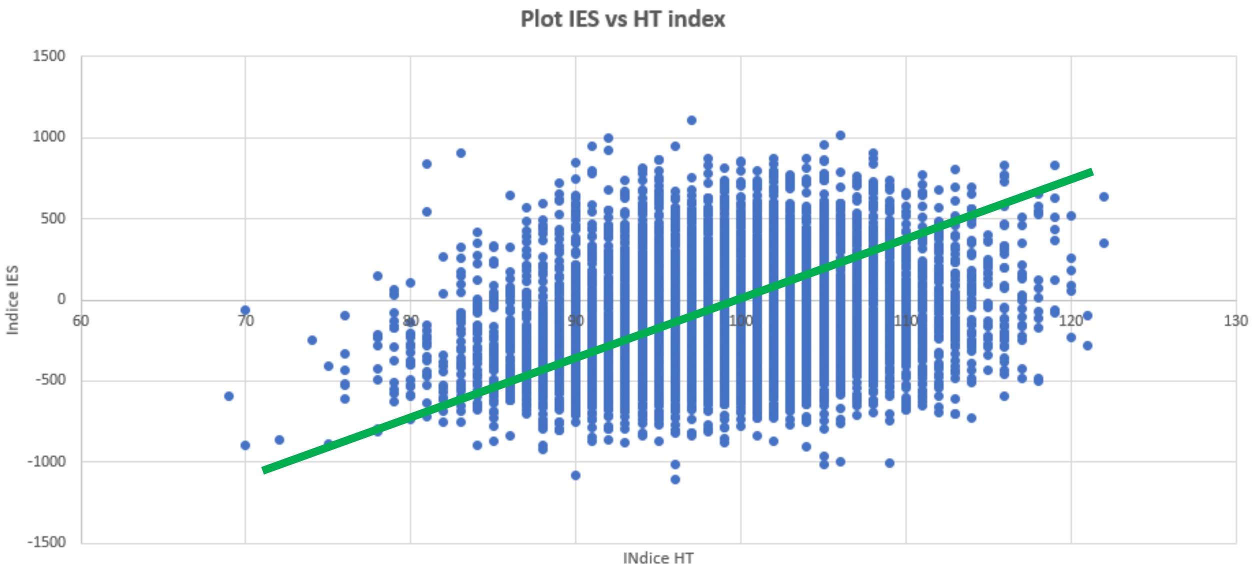
IHT breeding value developed with 100 ±5 DS

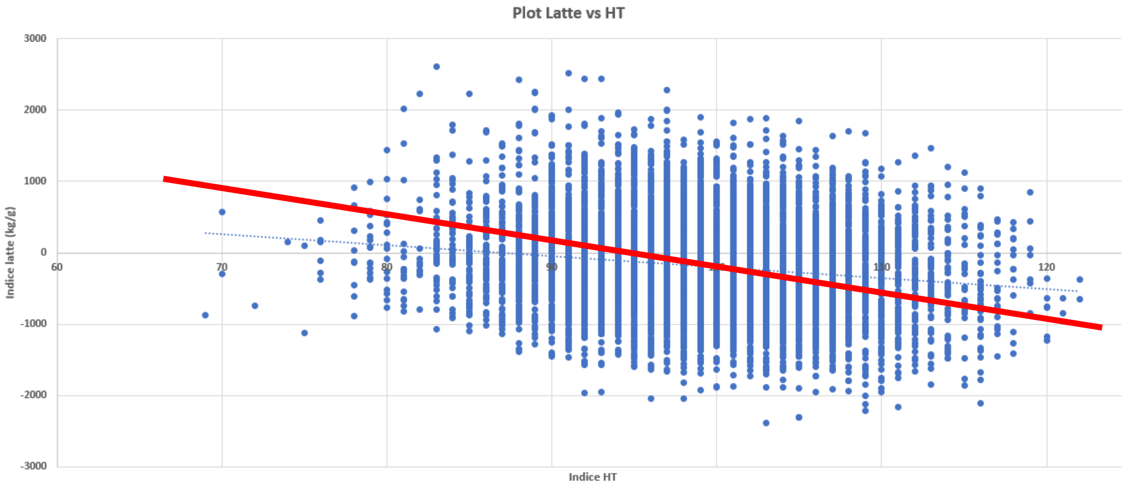
IHT trend for year of birth (males and females)



EBVs correlations

EBVs	Positive/Negative
PFT	+
IES	+
ICS-PR	+
Milk	-
MST	+
SCS	+
IAF	+





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	

Conclusions and Work in Progress

- ✓Confirmed the antagonistic relationship between animal and environment

- ✓IHT published for the first time April 2022

- ✓We are starting with “Milk Heat Tolerance" Breeding Value

- ✓More traits are going to be included …work in progress

THANK YOU!

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