How to select a heat tolerant cow?

Ignacy Misztal

University of Georgia

EAAP Regional Mtg, Nicosia, Cyprus, Apr 24-26, 2024

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Η ΕΠΙΣΚΟΠΙΚΗ ΒΑΣΙΛΙΚΗ ΤΟΥ ΚΟΥΡΙΟΥ
THE KOURION EPISCOPAL BASILICA
(16) Επισκοπείο
(17) Βασιλική Βαπτιστηρίου
(19) Νάρθηκας Βασιλικής Βαπτιστηρίου
(20) Αίθριο Βασιλικής Βαπτιστηρίου
Ground Plan

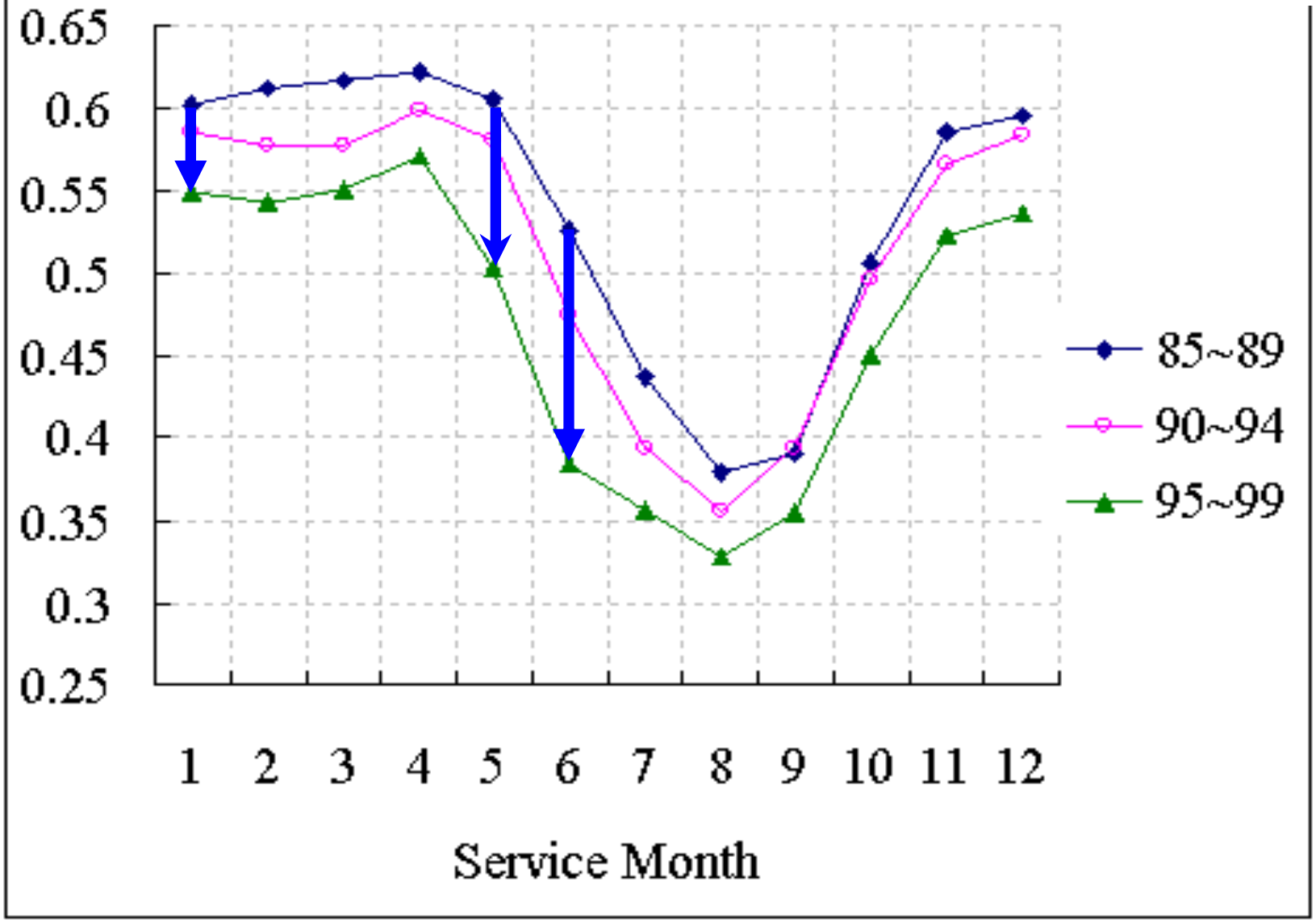
Museum of underwater sculptures

Can we improve heat tolerance in dairy?

- Cows more susceptible to heat stress
  - Poor fertility
  - Mortality
  - Poor survival

- Questions
  - Are animals indirectly selected against heat tolerance?
  - Is genetic selection for heat tolerance possible?

Conception rate of U.S. Holsteins in Southeastern USA



Huang et al., 2006

J. Dairy Sci. 85:1585–1589

Studies on Genetics of Heat Tolerance in Dairy Cattle with Reduced Weather Information via Cluster Analysis

O. Ravagnolo[1] and I. Misztal
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Comparison of lactational responses of dairy cows in Georgia and Israel to heat load and photoperiod

Y. Aharoni[1†], O. Ravagnolo[2] and I. Misztal[2]

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www.elsevier.com/locate/livsci

Utility of on- and off-farm weather records for studies in genetics of heat tolerance

M.S. Freitas [a,b,*], I. Misztal [b], J. Bohmanova [b], J. West [c]

J. Dairy Sci. 94:1592–1596
doi:10.3168/jds.2010-3491

Short communication: Genetic effects of heat stress on days open for Thai Holstein crossbreds

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‡Department of Animal Science, Faculty of Agriculture, Kasetsart University, Thailand 10900
§Bureau of Biotechnology in Livestock Production, Department of Livestock Development, Thailand 10300

Genetic components of heat stress in finishing pigs: Parameter estimation

B. Zumbach, I. Misztal, S. Tsuruta, J. P. Sanchez, M. Azain, W. Herring, J. Holl, T. Long and M. Culbertson

J ANIM SCI 2008, 86:2076-2081.
doi: 10.2527/jas.2007-0282 originally published online May 9, 2008

J. Dairy Sci. 86:3718–3725

Seasonality of Days Open in US Holsteins

S. Oseni, I. Misztal, S. Tsuruta, and R. Rekaya
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J. Dairy Sci. 90:1947–1956
doi:10.3168/jds.2006-513

Temperature-Humidity Indices as Indicators of Milk Production Losses due to Heat Stress

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†Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD 20705

J. Dairy Sci. 92:4689–4696
doi:10.3168/jds.2008-1985

Short communication: Trends for monthly changes in days open in Holsteins

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†Animal Breeding and Genetics Group, Wageningen Institute of Animal Sciences, Wageningen University, 6700 AH Wageningen, the Netherlands
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J. Dairy Sci. 94:2621–2624
doi:10.3168/jds.2010-3893

Multiple trait genomic evaluation of conception rate in Holsteins

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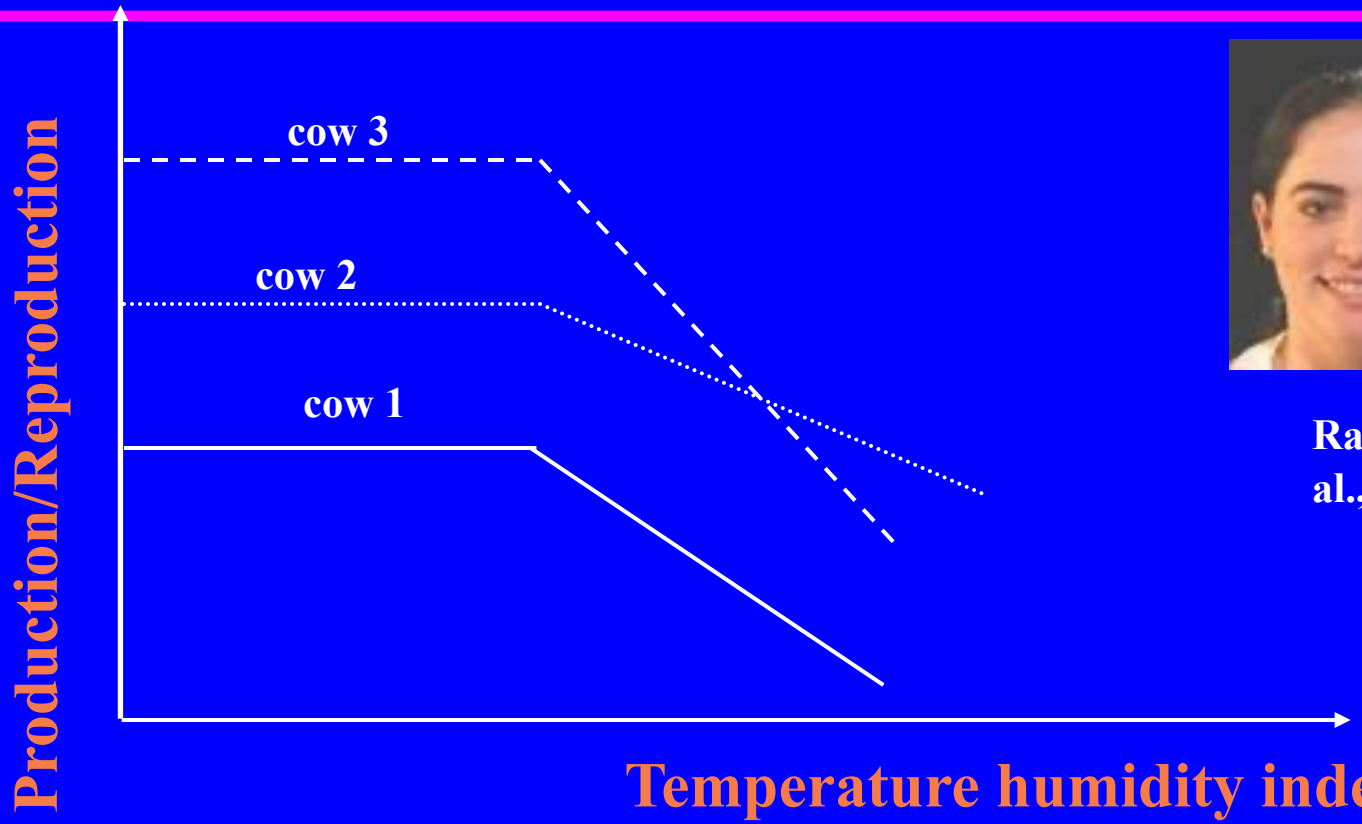
RESEARCH ARTICLE
Open Access

Validation of single-step genomic predictions using the linear regression method for milk yield and heat tolerance in a Thai-Holstein population

Piriyaporn Sungkhapreecha, Ignacy Misztal, Jorge Hidalgo, Daniela Lourenco, Sayan Buaban, Vilsuntita Chanketsakul, and Wutthigrai Boonkum

Assumption for heat stress model

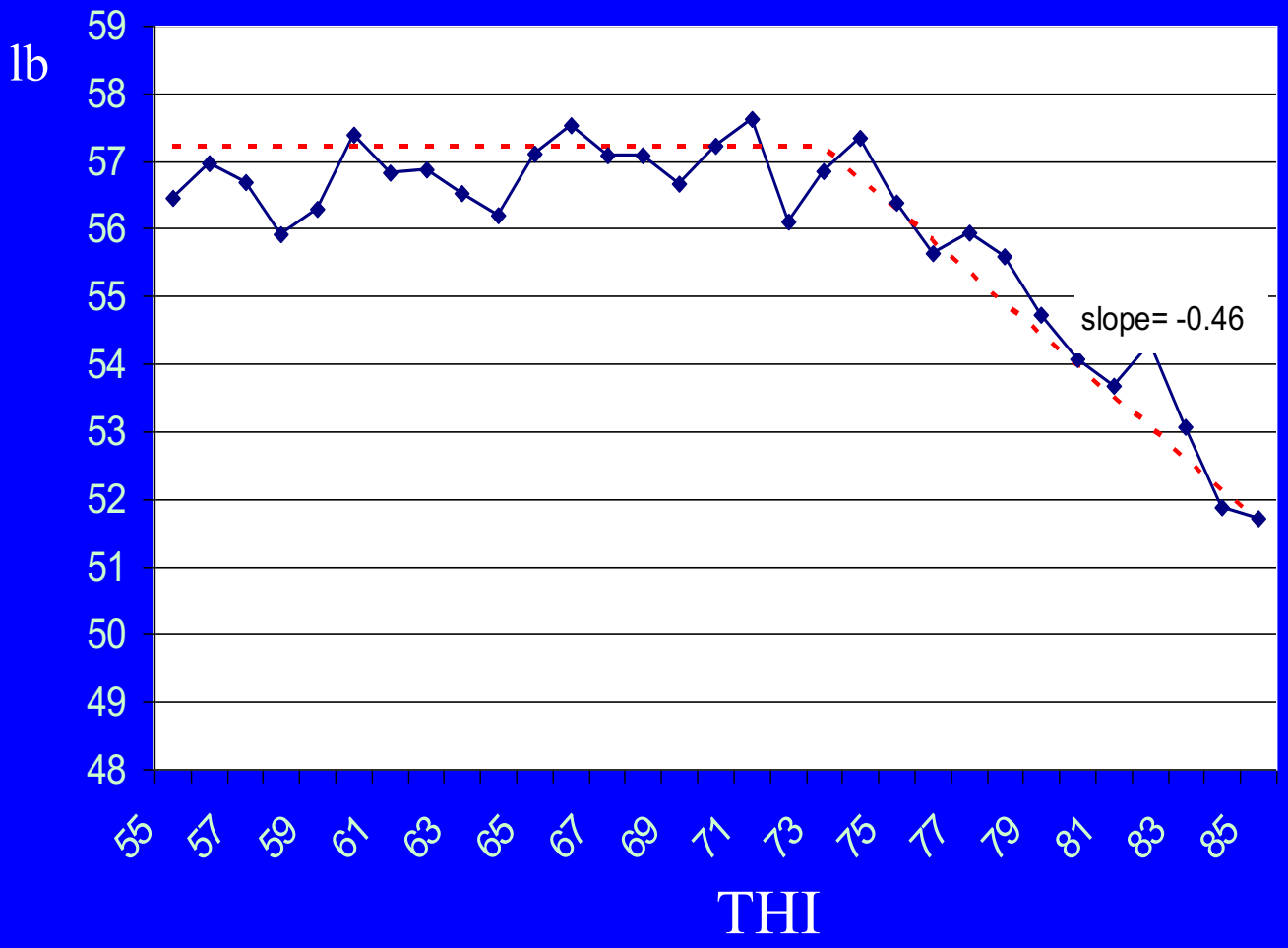


Ravagnolo et al., 2001

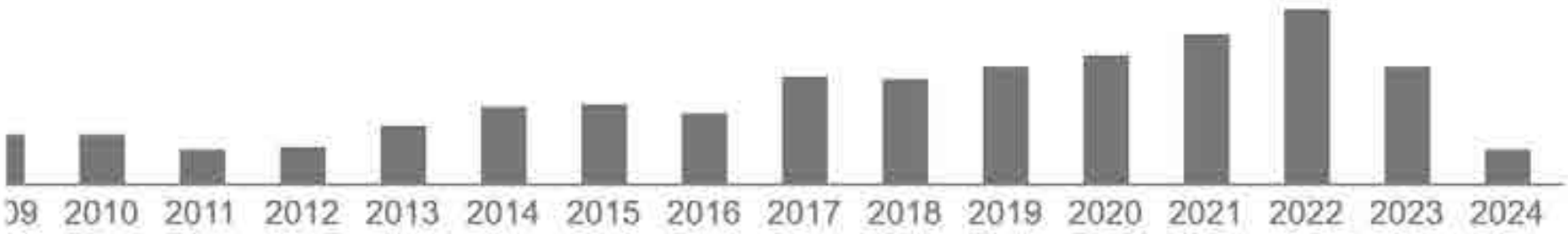
Breeding value: $BV = a + f(THI)*v$

a – regular breeding value v – heat-tolerance breeding value
f(THI) – function of temperature humidity index

Effect of THI on daily milk production

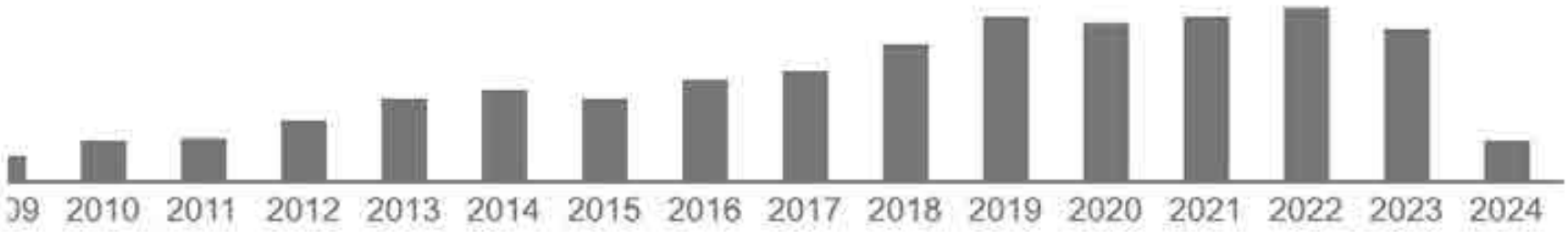


Cited by 707



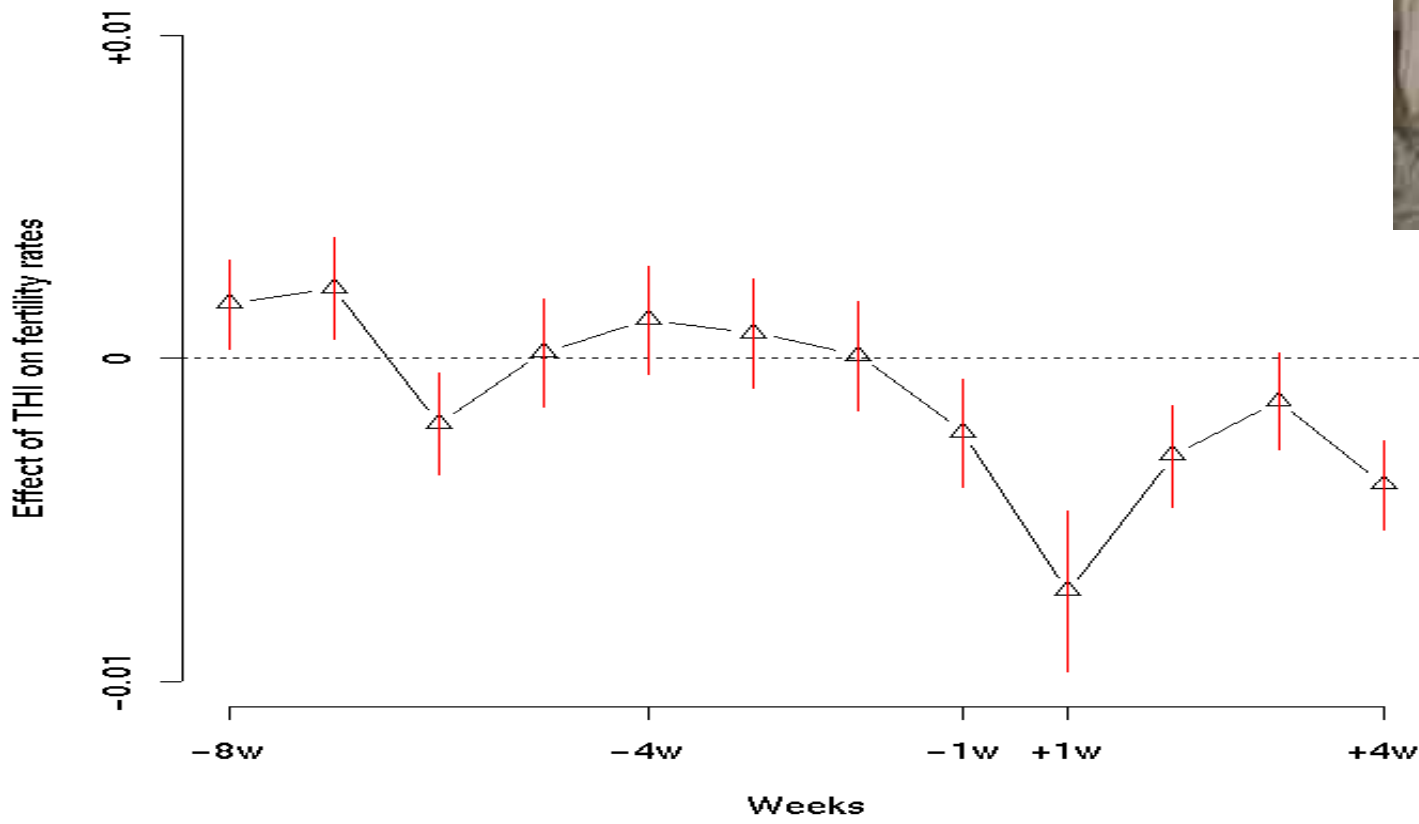
Genetic component of heat stress in dairy cattle, development of heat index function
O Ravagnolo, I Misztal, G Hoogenboom - Journal of dairy science, 2000

Cited by 954



Temperature-humidity indices as indicators of milk production losses due to heat stress
J Bohmanova, I Misztal, JB Cole - Journal of dairy science, 2007

Effect of THI around the time of insemination on conception rate



Ramos, 2007

Differences between most 100 and least 100 heat tolerant sires

Milk	-1100kg
Fat%	+0.2%
Pro%	+0.1%
Dairy Form	-1.4
Udder	+0.7
Longevity	+0.90
Fertility	+1.6
Index	+36

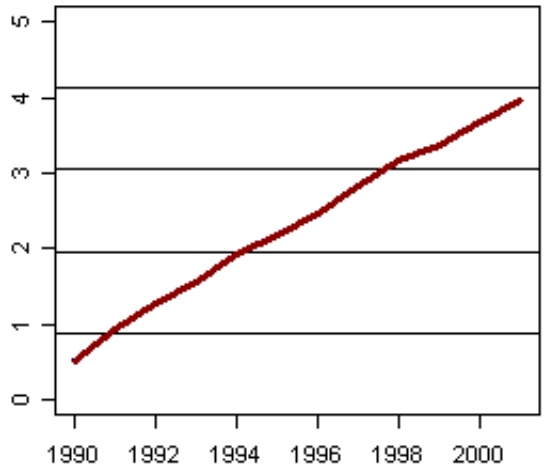
Bohmanova et al. (2005 and 2006)

National evaluation of U.S. Holsteins (Aguilar et al, 2010)

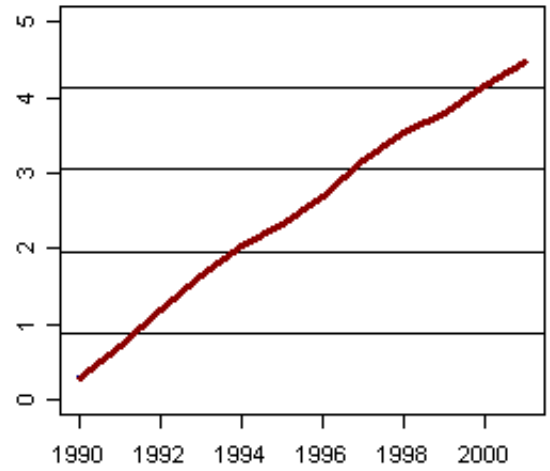
- 90 million test days of 9 million Holsteins
- 3 trait test day model
- 3 parities
- Heat stress effect

Genetic trends of daily milk yield for 3 parities – regular effect

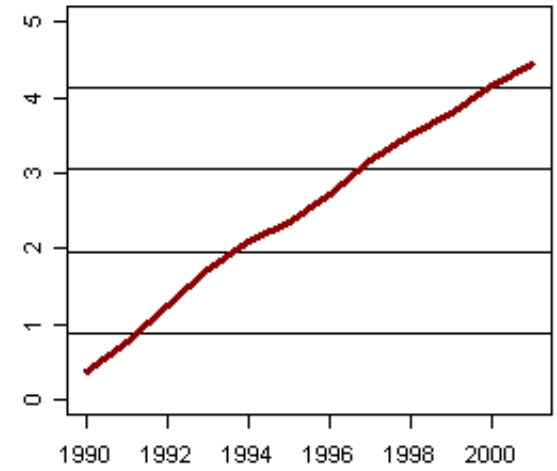
First



Second

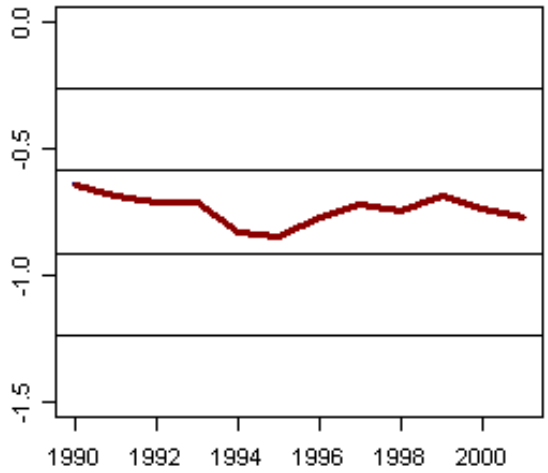


Third

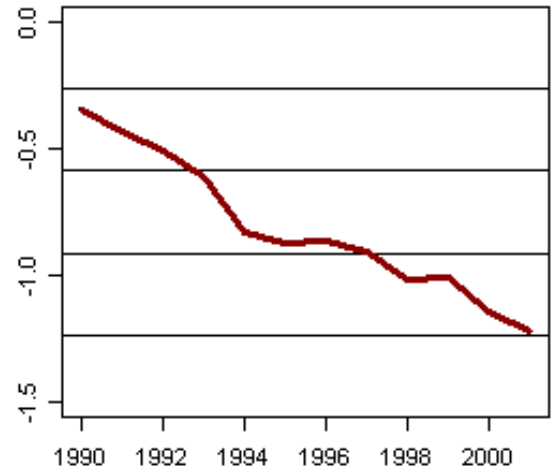


Genetic trends for heat stress effect at 5.5º C over the threshold

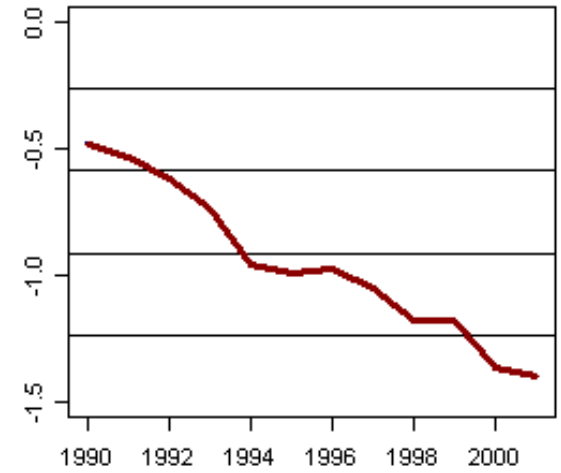
First



Second



Third



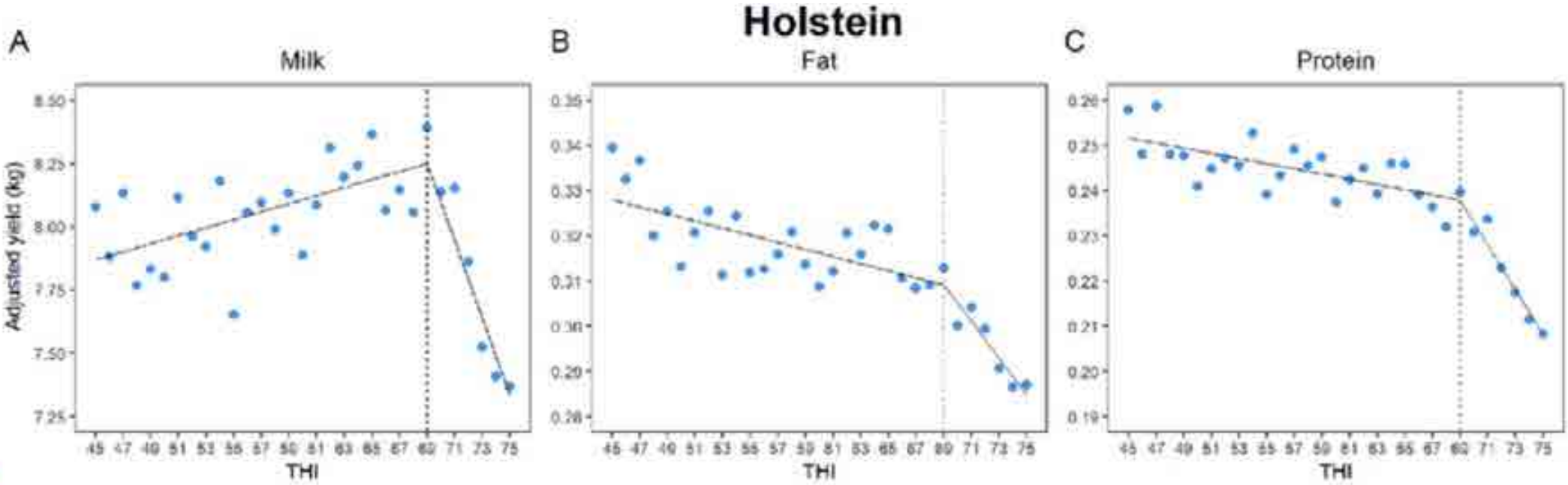
All methodology and programs ready - why no implementation?

- Poor milk and fertility → better sprinklers and fans
- Still poor fertility and poor heat detection → timed AI
- Low survival and not enough replacements → sexed semen

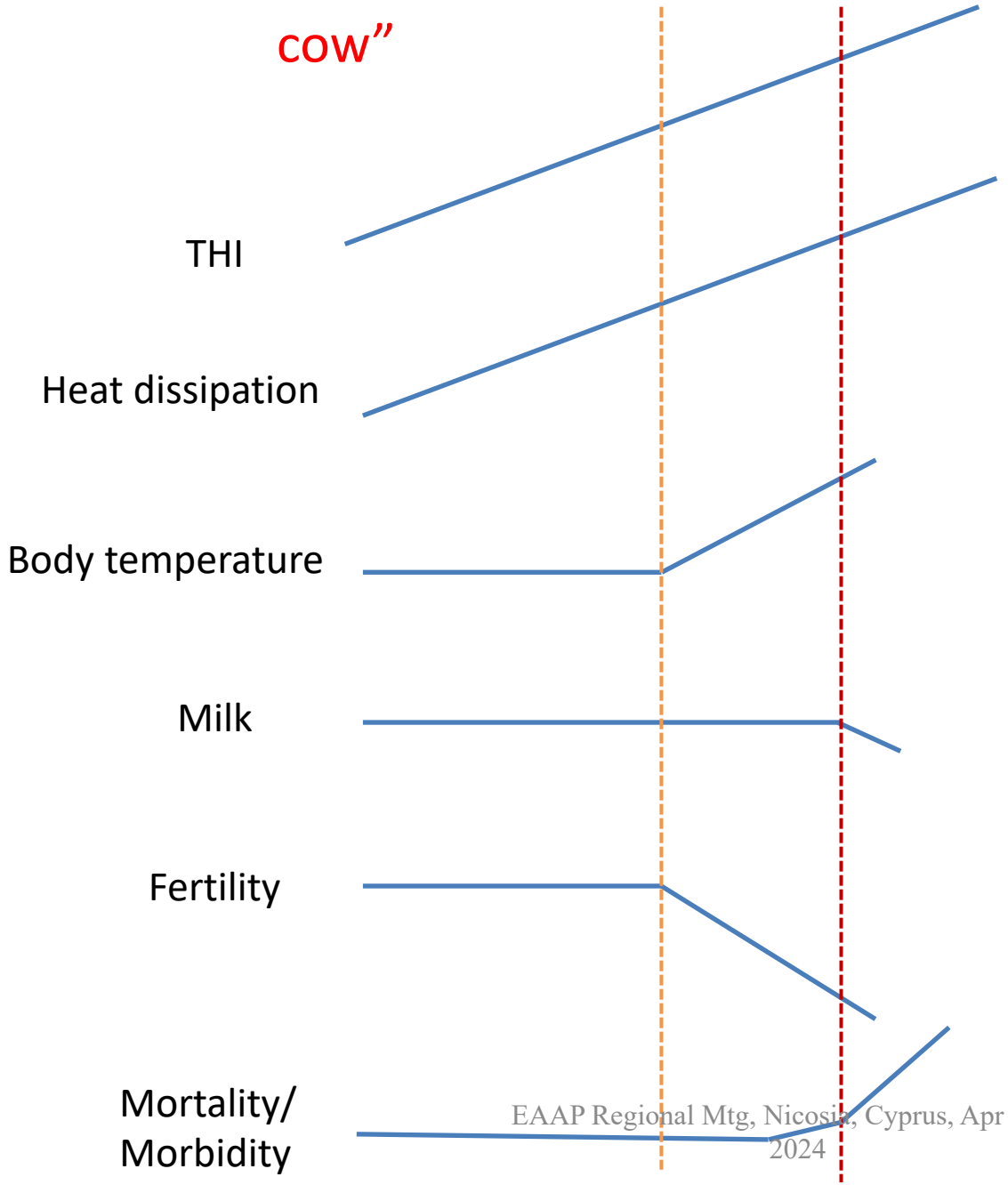
- Do farmers want heat tolerant cows? (Matin-Collado et al., 2023)

Later developments

- Heat stress moving north
  - In Canada, threshold of heat stress 57 for protein (Campos et al., 2022)
- With genomics, high reliability even for cows
- Genetic evaluation for heat stress in Australia (Nguyen et al., 2017)
- New interest by AI companies, e.g., Select Sires (Taylor et al., 2022)


Holstein
A
Milk
Adjusted yield (kg)
8.50
8.25
8.00
7.75
7.50
7.25
45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75
THI
B
Fat
0.35
0.34
0.33
0.32
0.31
0.30
0.29
0.28
45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75
THI
C
Protein
0.26
0.25
0.24
0.23
0.22
0.21
0.20
0.19
45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75
THI

Profile of a “heat-tolerant cow”

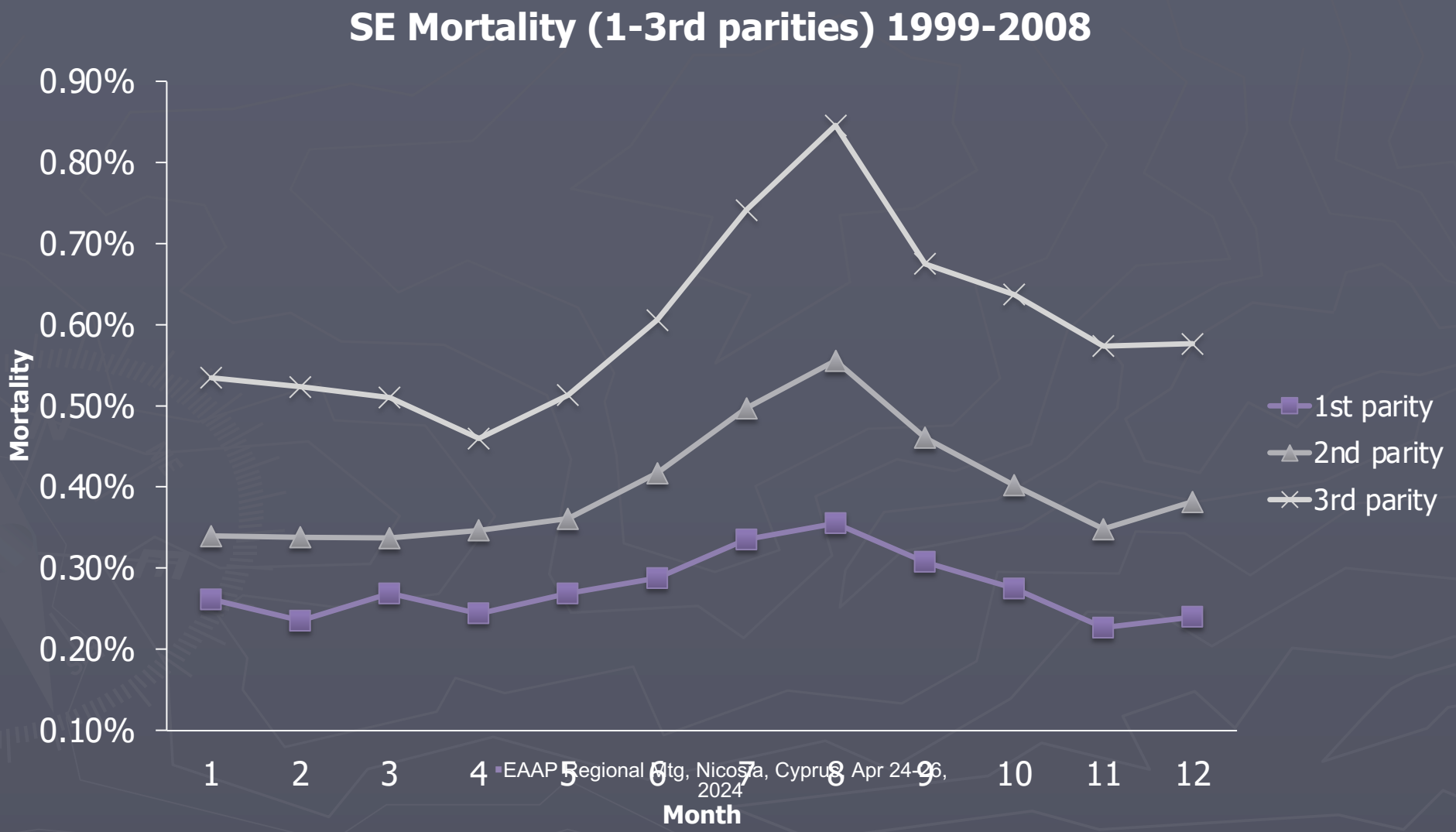


- “Heat tolerant” cow – workaholic
- Milks as long as possible despite dangers
- Thresholds depend environment

Partially based on Dikmen et al. (2012)

Mortality in SouthEast

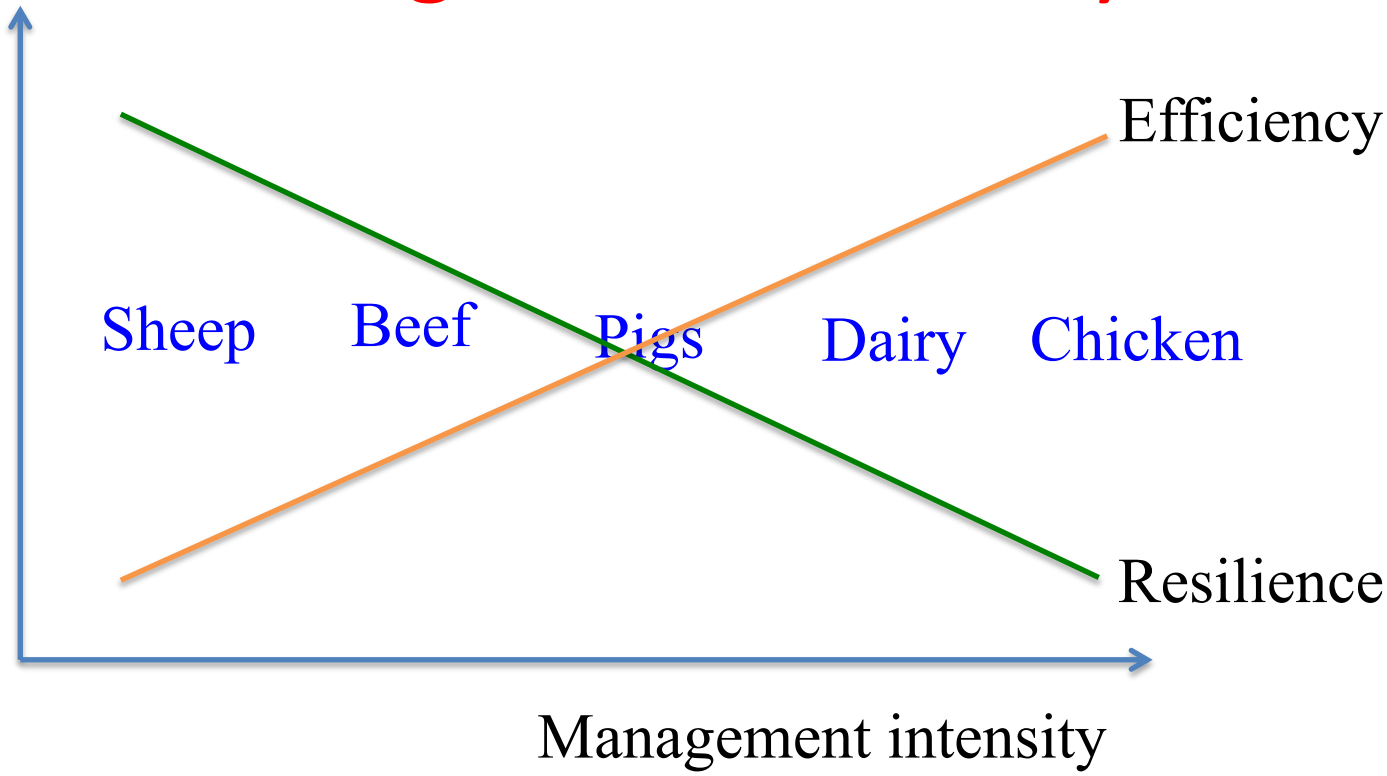
Tokuhisa et al. (2011)



Selection as optimization

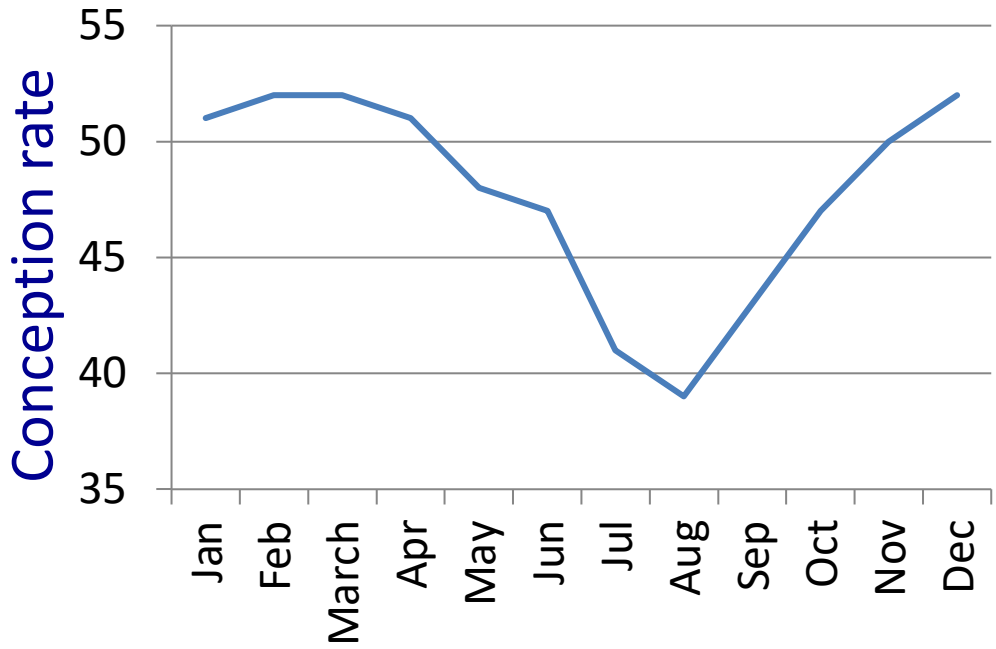
- Gains for selected and higher h^2 traits
- Correlated losses for unselected or low h^2 traits
- Effect of losses reduced/eliminated by management
- New management changes traits over time

Resilience (heat tolerance)/efficiency and management intensity



Is heat stress important in less intensive environments? - Iranian Holsteins

Small effect for milk



Mokhtar et al, 2012

Question

- Select for high producing or resilient cows?

- High producing cows
  - Tries to keep production under challenging conditions
  - Risk of mortality/morbidity
  - Need high level of management

- Resilient cow
  - Limits production under challenging conditions
  - Resumes production after end of challenge

- Impact of duration of heat stress

Heat tolerance of beef cows

- Research by Don Spiers in beef cattle (Missouri)
  - 3 days in heat chamber without water
  - Cows stopped eating
  - Recovery after a few days

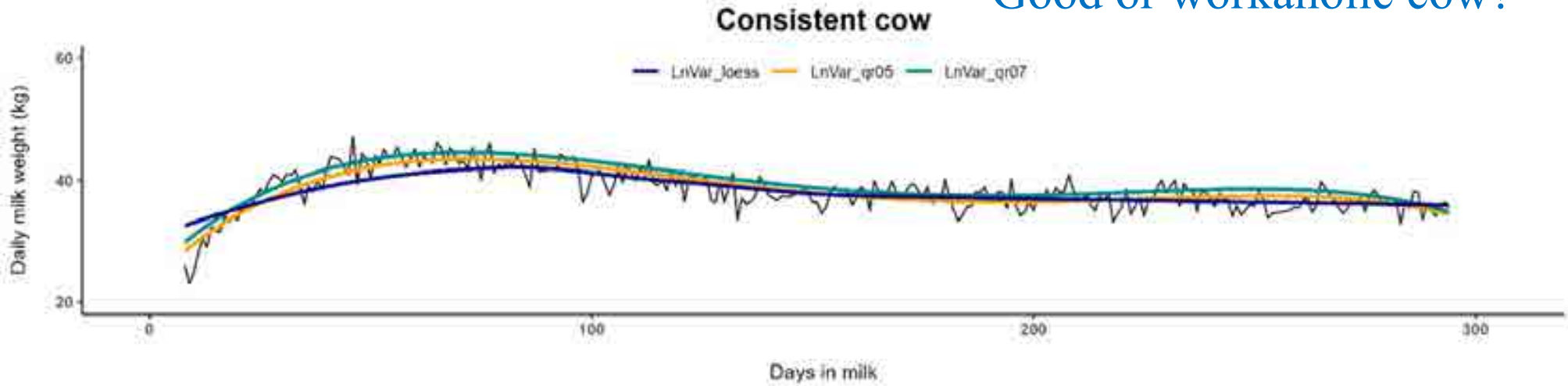
How to select resilient animals

- Ability to recover production after stress (Wang et al., 2022)

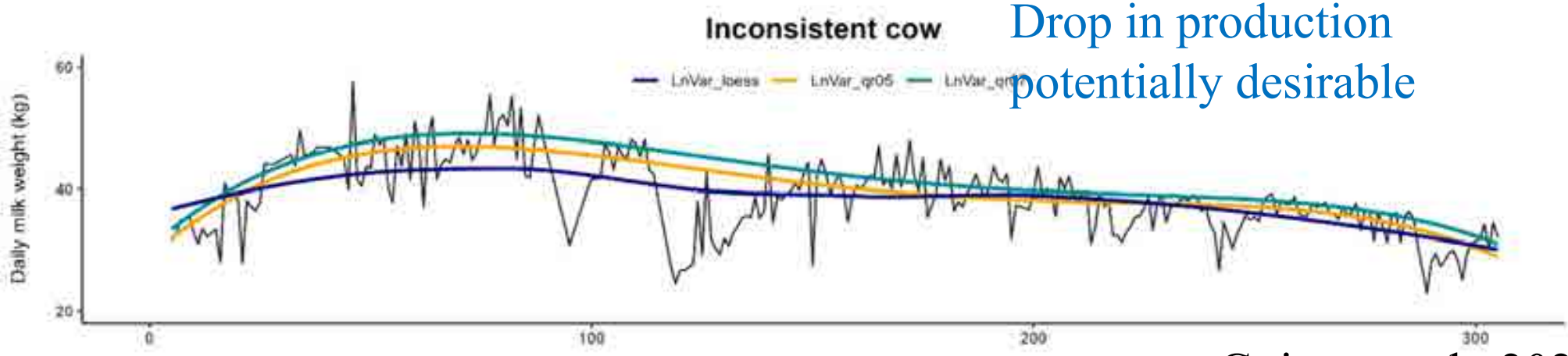
- Larger production variations with heat stress events - canalization theory in reverse (Bodin et al., 2002, WCGALP)

Deviation from averages

Good or workaholic cow?

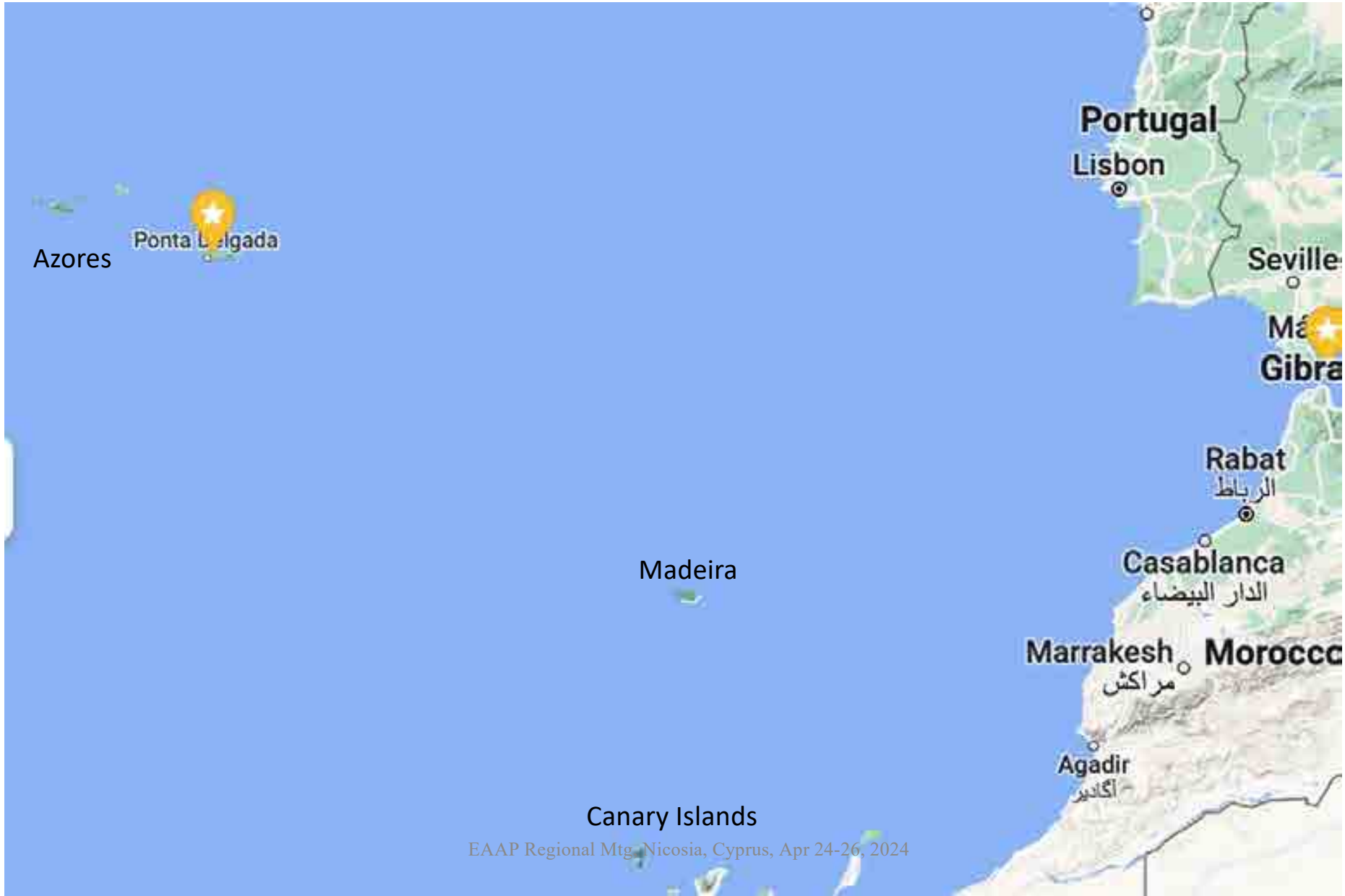


Drop in production potentially desirable



Guinan et al., 2024

Is there heaven for dairy cows?

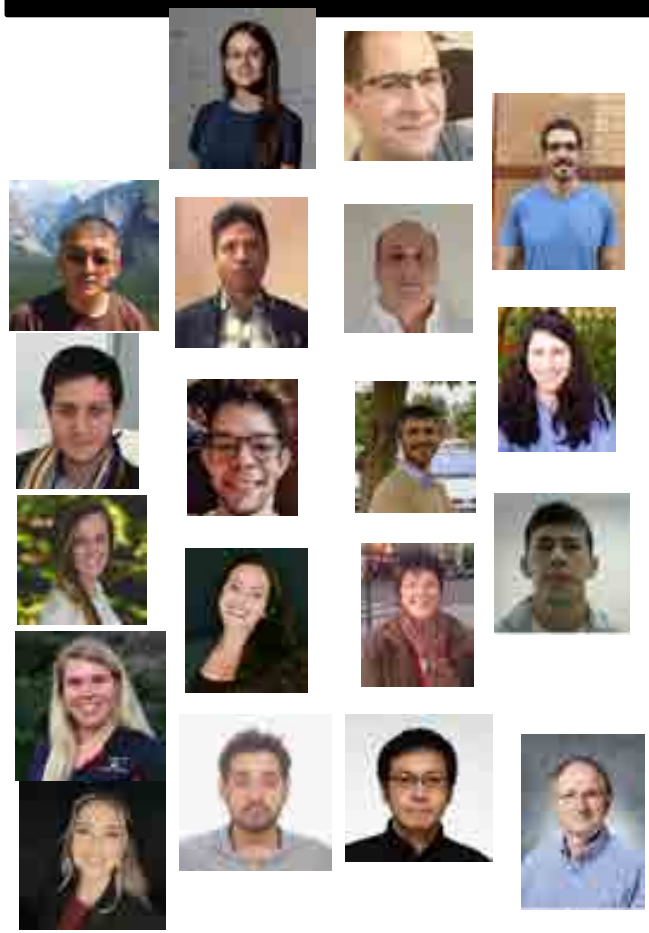



Sete Cidades
Ribeira Grande
Nordeste
Ilha de São Miguel
Furnas
Povoacao
Ponta Delgada
Vila Franca do Campo

Conclusions

- Heat tolerance and production antagonistic
- Current selection against heat tolerance
- Modern cow bred for sophisticated management
- Dilemma: high producing or resilient cow?

UGA AB&G team



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