How does Holstein cattle in Switzerland react to heat stress?

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Overview

1. Background/Motivation (Introduction)
2. Material and Methods
3. Results
4. Conclusion/Discussion

Background/Motivation I

1. Heat stress / Heat tolerance
   - Climate change
   - Hot topic in R&D (e.g. Carabano et al., 2019, Stranden et al., 2019)
   - Genetic evaluations for heat tolerance has been launched (e.g. Australia (Nguyen et al., 2018))
   - Europe? Switzerland?

2. Analysis of genotype by environments (GxE) interactions are increasing
   - more information/data available for environment descriptors
   - Resilience (Mulder, 2017)

Background/Motivation II

Questions?

1. How does Holstein cattle in Switzerland react to heat stress?

2. Do we have a reranking of sires if we include meteo data in evaluation models (ebv)?

Material I: Test day records

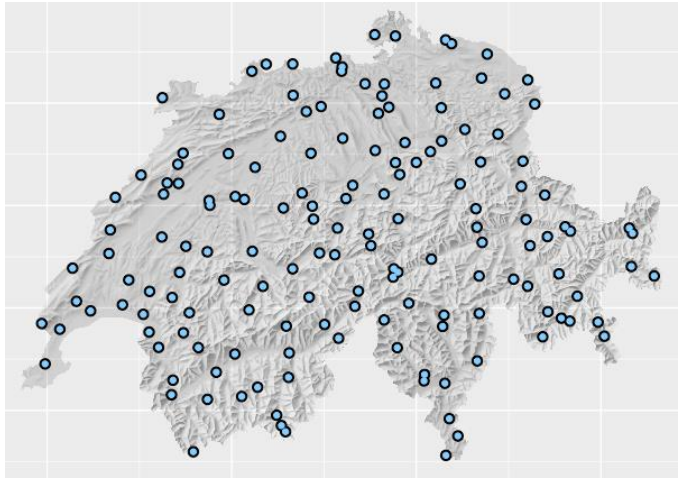
Available test day(TD) records from 2007 - 2016

Breed	n TD records	n Cows	n Herds
Hostein/ Red Holstein	7,340,498	363,472	9,231

Material II: Environment

- 60 official federal weather stations
- Weather data were assigned to each HO herd
- Average of temperature (T) and relative humidity (RH) of 3 days before TD ⇒ TD
- Temperature humidity index (THI) was built (NRC, 1971) :

$$THI = (1.8 * T°C + 32) - (0.55 - 0.0055 * RH\%) * (1.8 * T°C - 26) \quad (1)$$



→ 23 THI classes

Methods I: Random regression test-day model

$$y_{ijkl} = HTD_i + \sum_{n=1}^{q} \alpha_{kn} z_n(s) + \sum_{n=1}^{q} \beta_{jn} z_n(s) + \sum_{n=1}^{q} \gamma_{jn} z_n(s) + \sum_{n=1}^{q} \delta_{jn} z_n(t) + \sum_{n=1}^{q} \varepsilon_{jn} z_n(t) + e_{ijkl} \quad (2)$$

where:

HTD_i	fixed effect of the ith herd-test-day
α_{kn}	the nth fixed regr. coeff. on DIM for the kth age of calving - region - time period - season class
β_{jn}	nth rand. regr. coeff. on DIM for add. gen. effect for cow j
γ_{jn}	nth rand. regr. coeff. on DIM for perm. env. effect for cow j
δ_{jn}	nth rand. regr. coeff. on THI for add. gen. effect for cow j
ε_{jn}	nth rand. regr. coeff. on THI for perm. env. effect for cow j
$z_n(s,t)$	vector of cov. size q descr. shape of lactation/THI curve of fixed and random regressions at s/t DIM/THI
e_{ijkl}	random residual effect
q	number of covariates

Methods II: Random regression test-day model

- Model (2) derived from Bohmanova et al. (2008)
  and from the Swiss model for genetic evaluation for yield traits
- Legendre polynomials of order 3
- Variance/Covariance and ebv estimation: REMLF90 and BLUPF90
  (Misztal et al., 2012)
- Trait of interest: Protein yield (g/day)

Methods II: Random regression test-day model

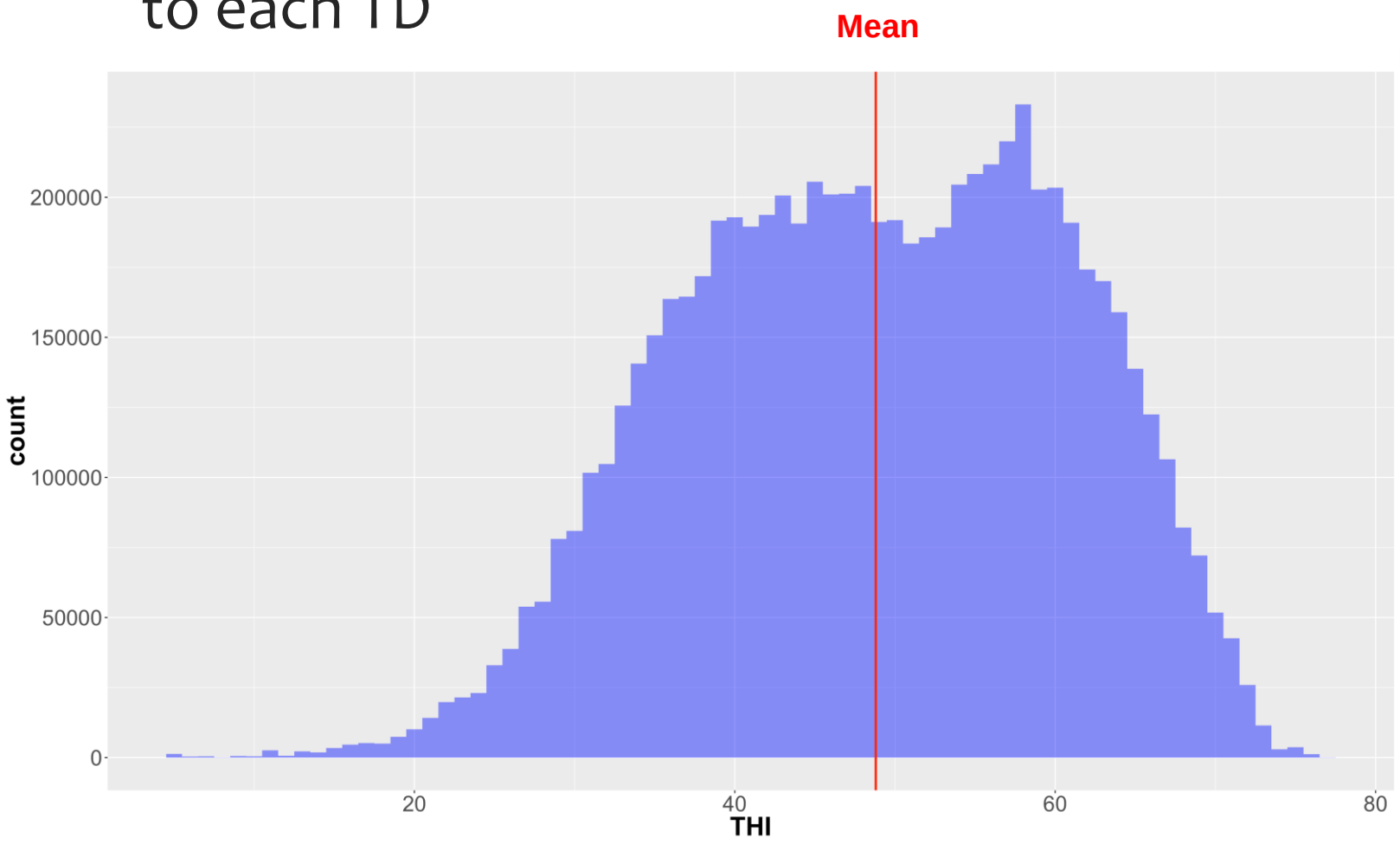
Running the evaluations (VCE & EBV) with and without weather informations as covariates:

- Model 1 (M1): Including weather information (THI) and days in milk (DIM)
- Model 2 (M2): Including only days in milk (DIM)

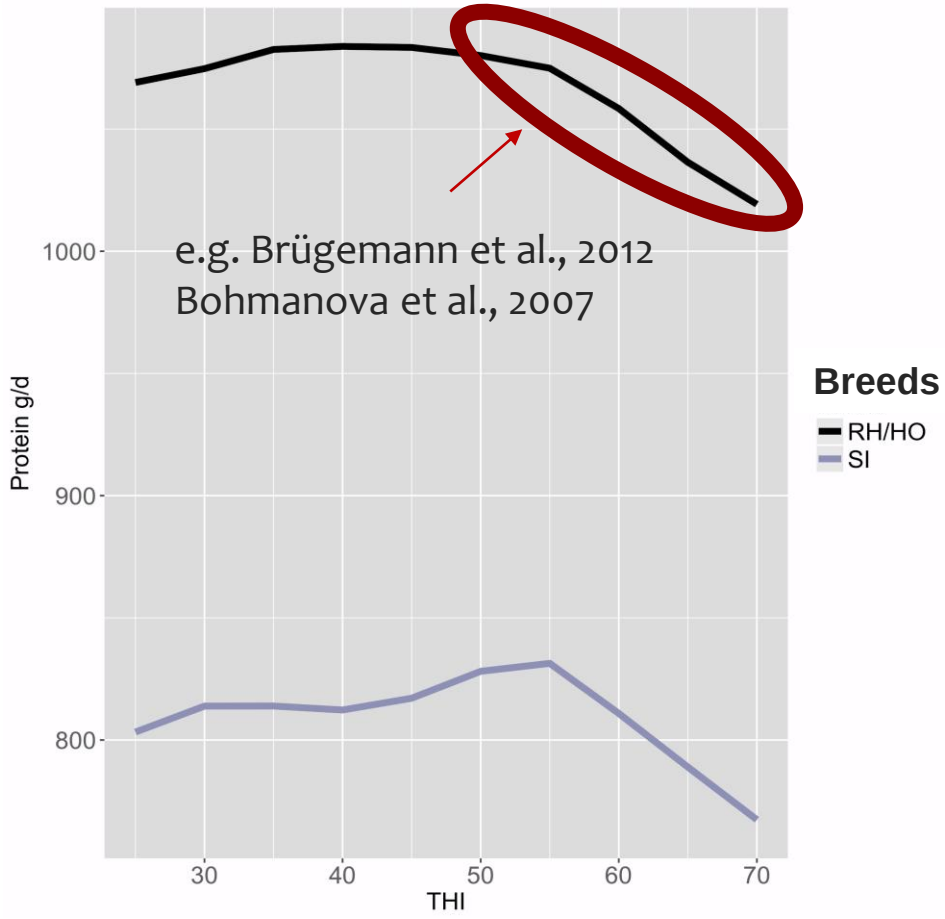
→ **comparison of the two models (M1 & M2)**

Results I: Environment & phenotype

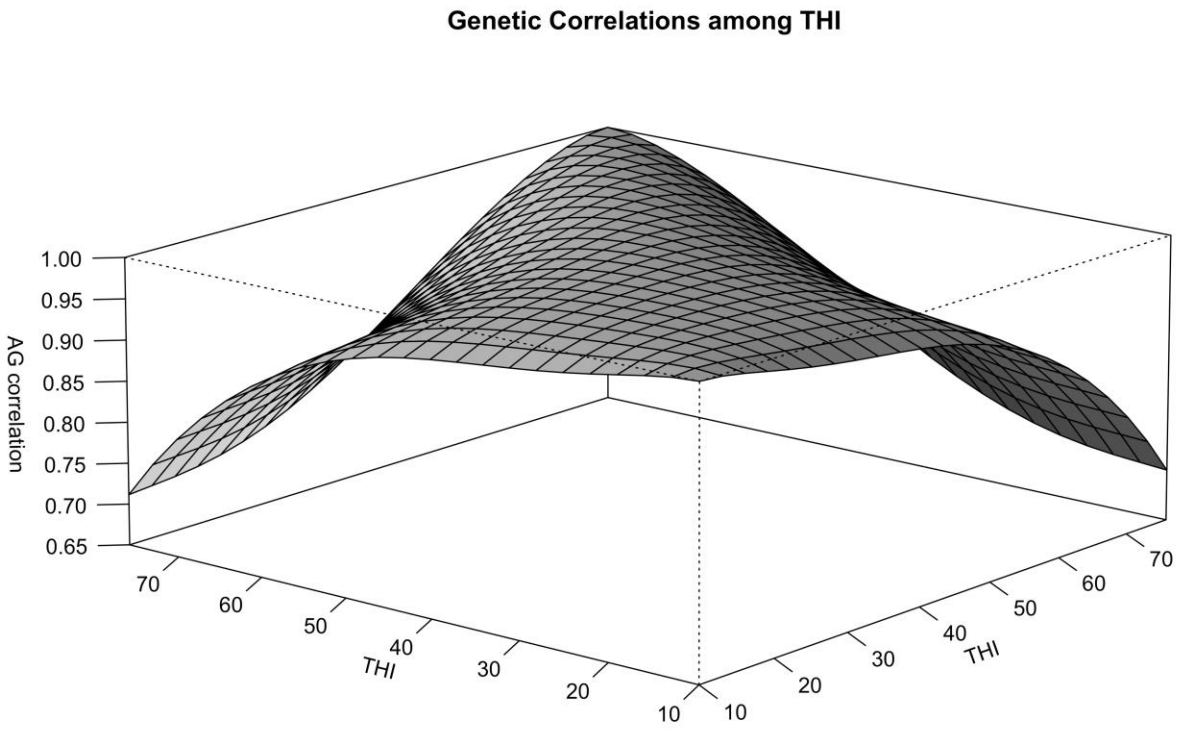
Distribution of the daily THI assigned to each TD

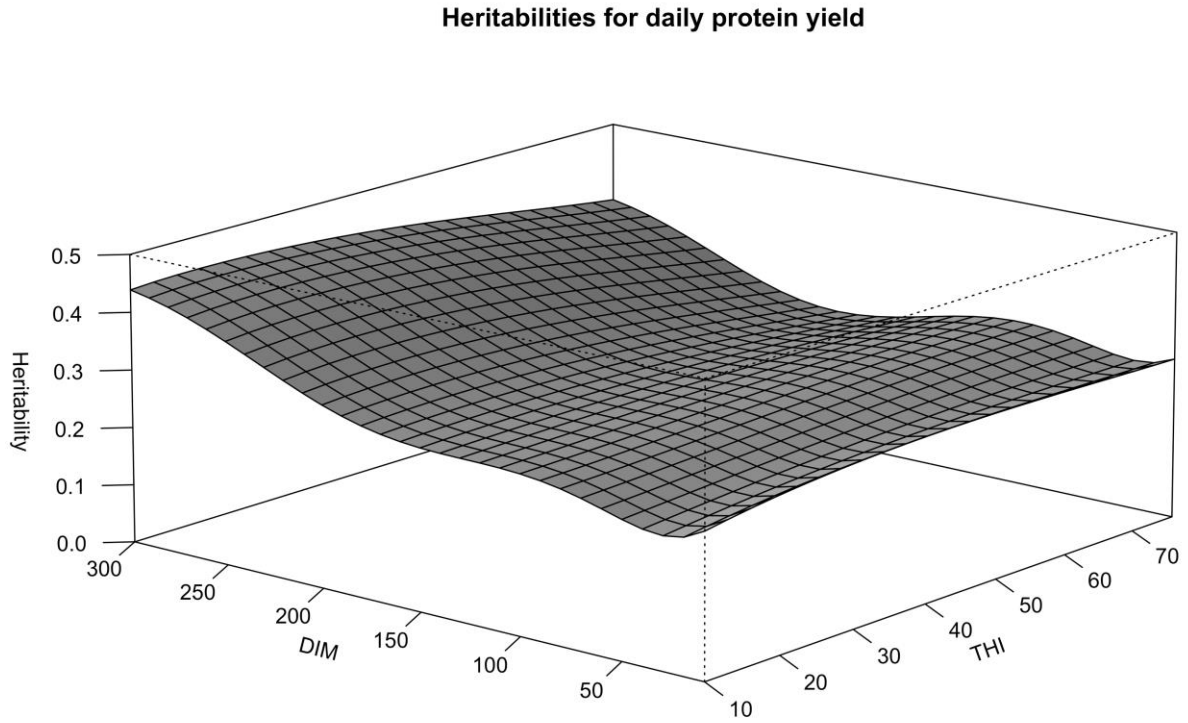


Daily protein yield Lact. > 2, DIM 1-100

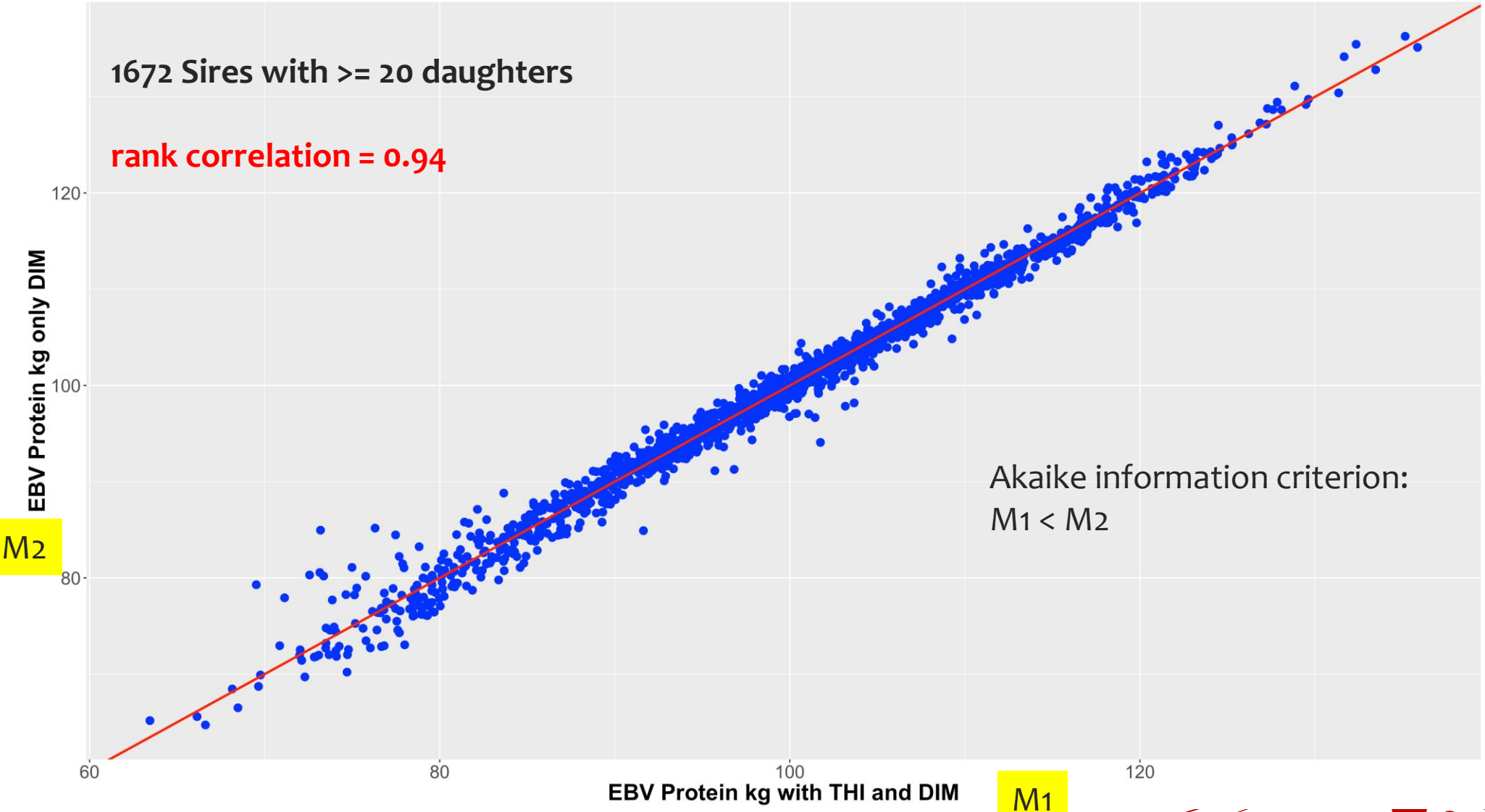


Results II: Genetic parameters





Results III: Comparison of the two models

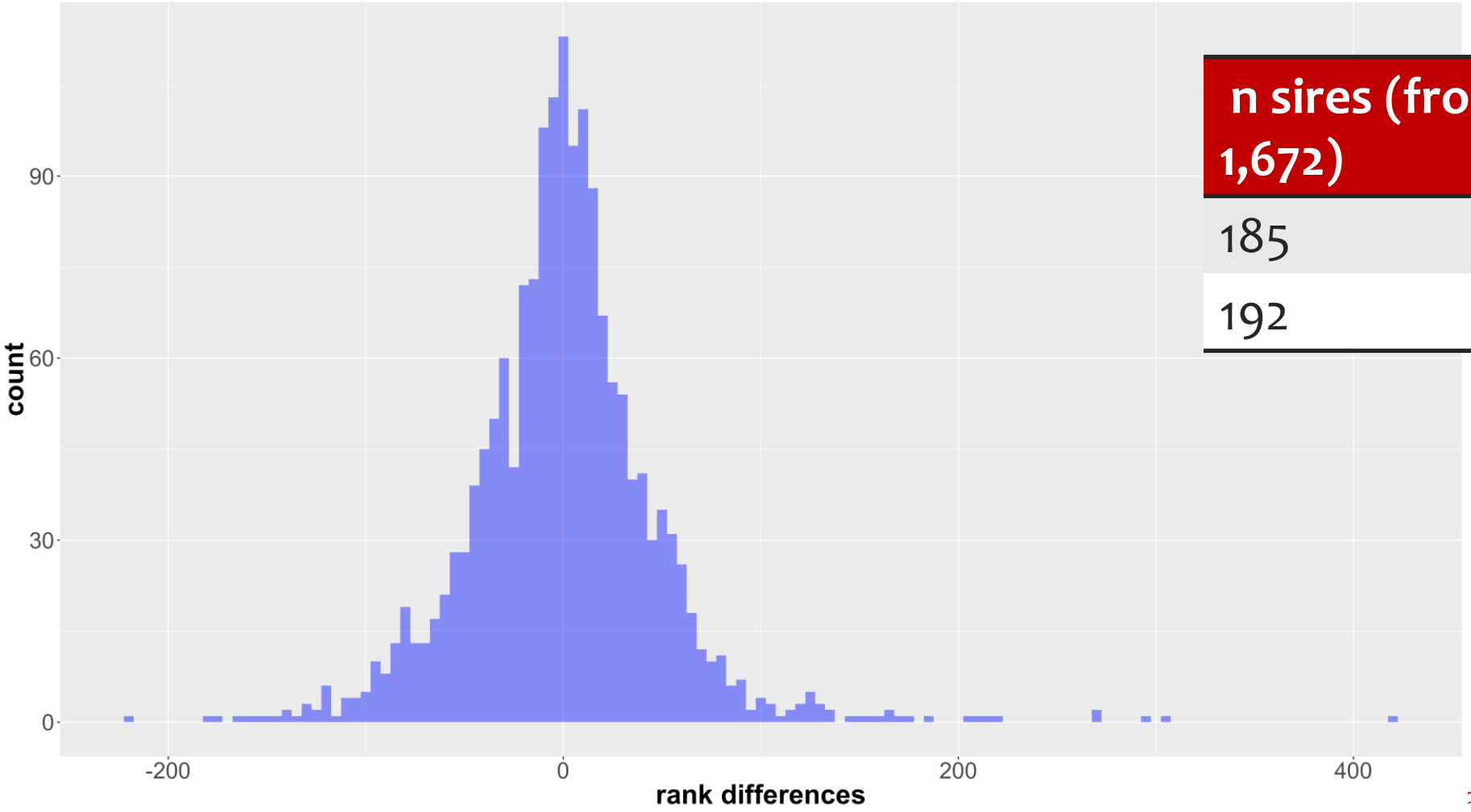


M2

M1

Akaike information criterion:
M1 < M2

Results IV: Comparison of the two models

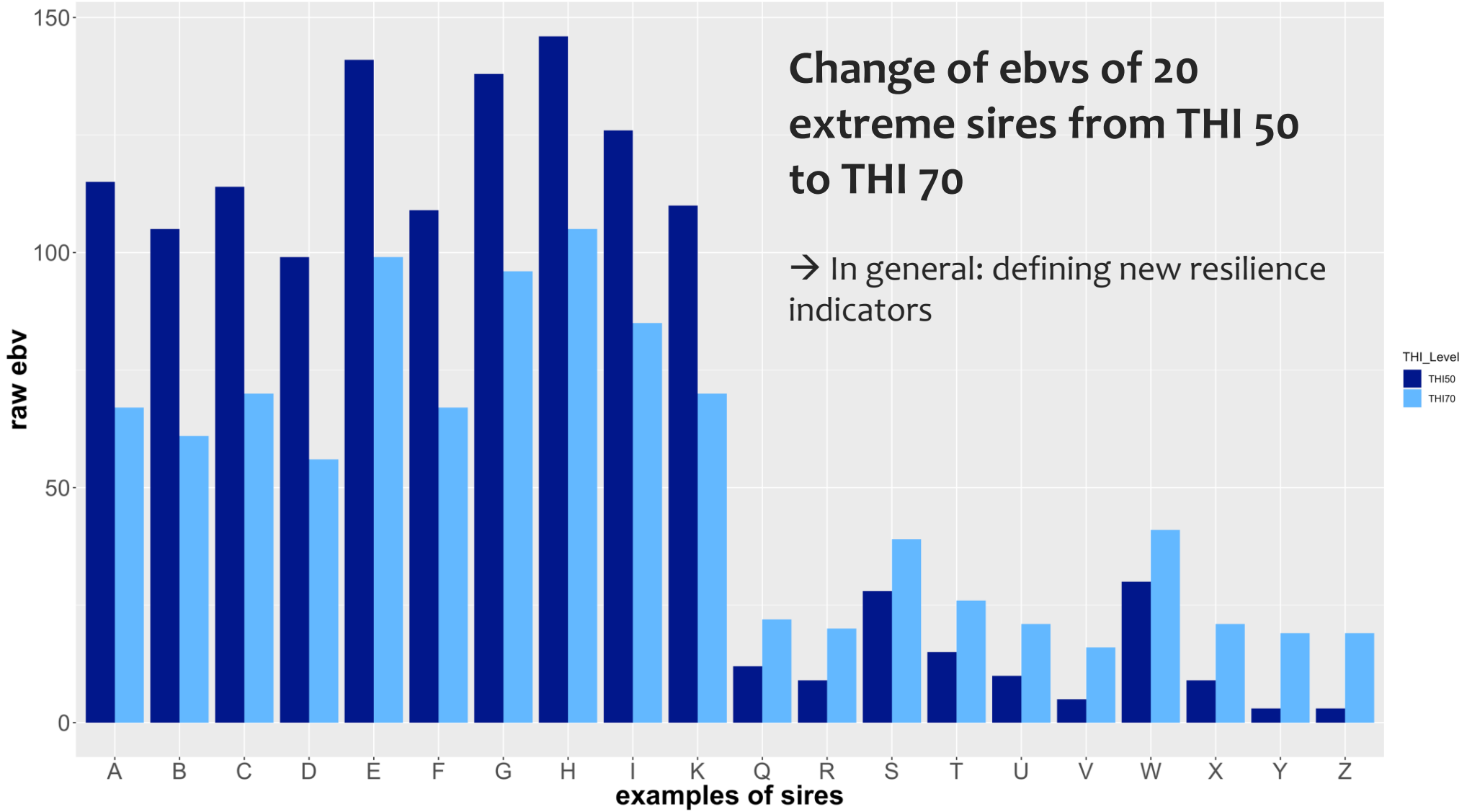


n sires (from 1,672)	n ranks (gain or loss)
185	+ 50
192	- 50

Conclusion/Discussion I

- Genetic parameters agree with literature (e.g. Kirsanova et al., 2019 or Bohlouly et al., 2019) and Swiss routine evaluation
- Lowest r_a: 0.75 → GxE (Robertson, 1959 and Boelling, 2003)
- Rank correlation is low → large reranking
- Validation
  - breed
  - traits
- Development of resilience indicators
  → next slide

Conclusion/Discussion II



Change of ebvs of 20 extreme sires from THI 50 to THI 70

→ In general: defining new resilience indicators

Thanks

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- All **pictures** in this presentation: ©swissherdbook and ©diegruene