Genetic variation in macro- and micro-environmental sensitivity for milk yield in Swedish Holsteins

H. A. Mulder, L. Rönnegård, S. Wijga, W. F. Fikse, R. F. Veerkamp, E. Strandberg

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Acknowledgement

- RobustMilk, EU project
- www.robustmilk.eu
- The Swedish Dairy Association (Svensk Mjölk, Stockholm, Sweden)

WAGENINGEN UNIVERSITY
WAGENINGEN UR

ROBUSTMILK

Introduction

What is macro- and micro-environmental sensitivity?

- Genetics of macro-environmental sensitivity
  - Environmental change is known, e.g. feed, soil, herd
  - Measured as G x E (e.g. rg) or slope of a reaction norm
- Genetics of micro-environmental sensitivity
  - Environmental change is unknown; can be animal specific
  - Measured as difference in environmental variance

Introduction: empirical evidence

- Genetic variation in macro-environmental sensitivity
  - Genotype by environment interaction
  - Many studies have found non-unity genetic correlations
  - Significant variance in slope of reaction norm
- Genetic variation in micro-environmental sensitivity
  - Genetic heterogeneity of environmental variance
    - Hill and Mulder (2010)
- Not much known about relationship between both types of environmental sensitivity

Objective

- To estimate genetic variance in macro- and micro-environmental sensitivity in Swedish Holsteins

- To estimate genetic correlations between macro- and micro-environmental sensitivity
  - Lactation milk yield

Material and Methods

- Swedish Holsteins
- 142,565 first lactation records
  - 305-day milk yield calculated with Test Interval Method
- 762 sires; at least 2 generations of male ancestors were traced back for sires
  - On average 187 daughters per sire

The quantitative genetic model

- Combine linear reaction norm with heterogeneous environmental variance
- $P = \mu + A_{int} + A_{sl}x + \exp(\sigma_E^2 + 0.5A_v)\, e$
- $\mathbf{G} = \begin{bmatrix} \sigma^2_{A_{int}} & \sigma_{A_{int},A_{sl}} & \sigma_{A_{int},A_v} \\ & \sigma^2_{A_{sl}} & \sigma_{A_{sl},A_v} \\ & & \sigma^2_{A_v} \end{bmatrix}$

- A_{int} = breeding value for intercept
- A_{sl} = breeding value for slope of linear reaction norm
- A_v = breeding value for environmental variance

Statistical model

- DHGLM in ASREML (Rönnegård et al., 2010; Felleki et al., 2012)
- Sire model – most information comes from half-sibs in different environments (Mulder et al., 2013; GSE 45:23)
- $\mathbf{y} = \mathbf{Xb} + \mathbf{Zs_{int}} + \mathbf{Z_x s_{sl}} + \mathbf{e}$
  - Herd-year mean was used as covariate in reaction norm
- $\boldsymbol{V(e)} = \exp(\mathbf{Xb} + \mathbf{Wh_v} + \mathbf{Zs_v})$
  - Random herd-year-season effect
- Algorithm iterates between both models until convergence

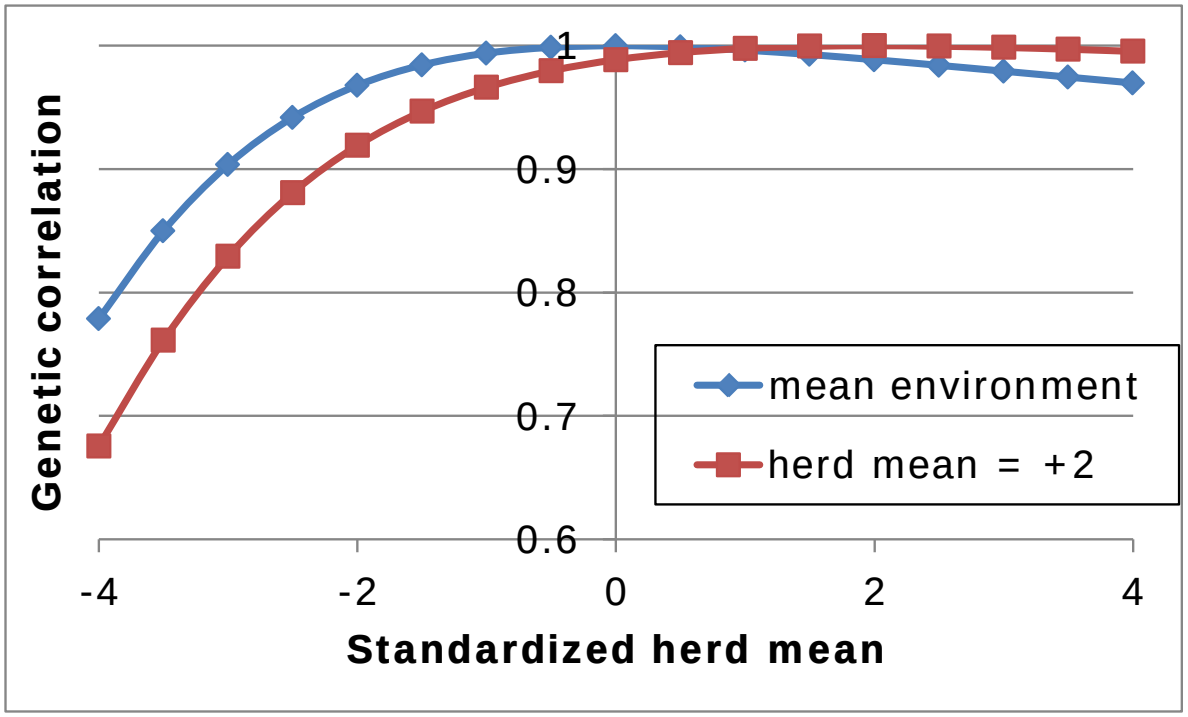
Results

	Estimate	Se
$\sigma^2_{A_{sl}}$	11096	2288
$\sigma^2_{A_v}$	0.043	0.008
$r_{A_{Aint,Asl}}$	0.808	0.062
$r_{A_{Aint,Av}}$	0.626	0.073
$r_{A_{Asl,Av}}$	0.765	0.098

Selection on higher level increases the slope and the variance:

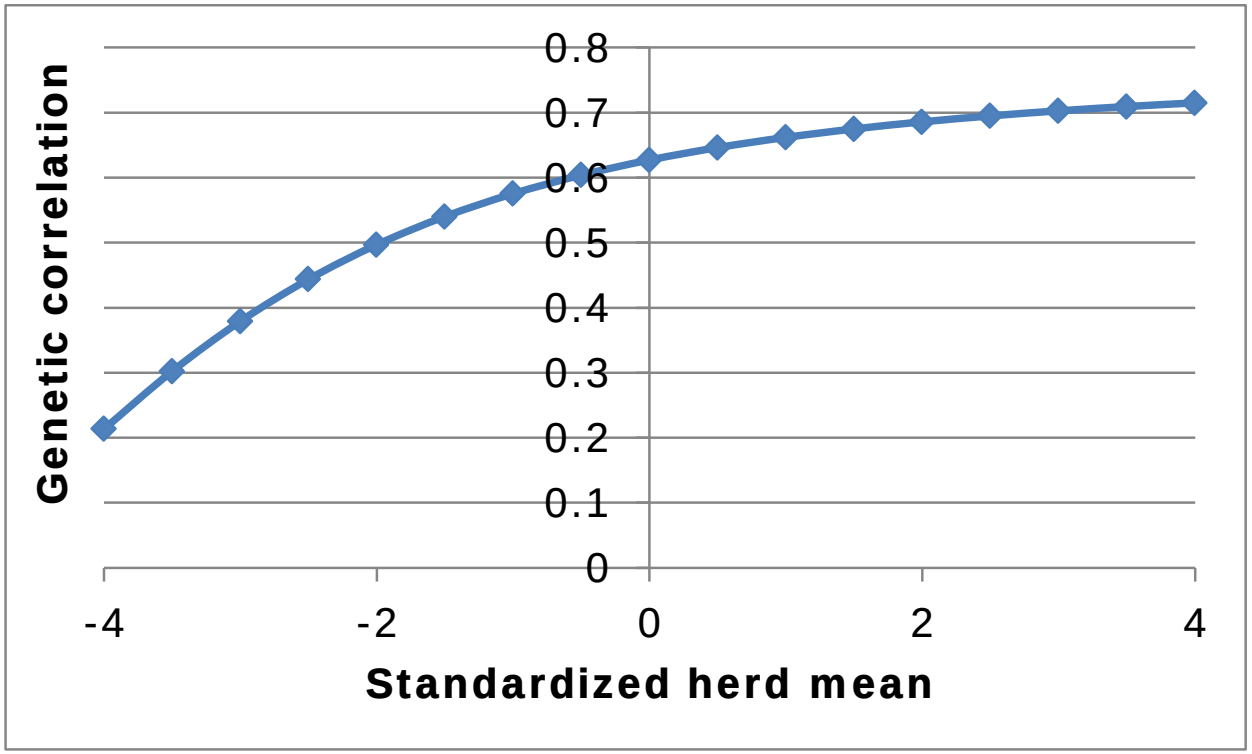
- Cows get more sensitive

Genetic correlation between macro-environments



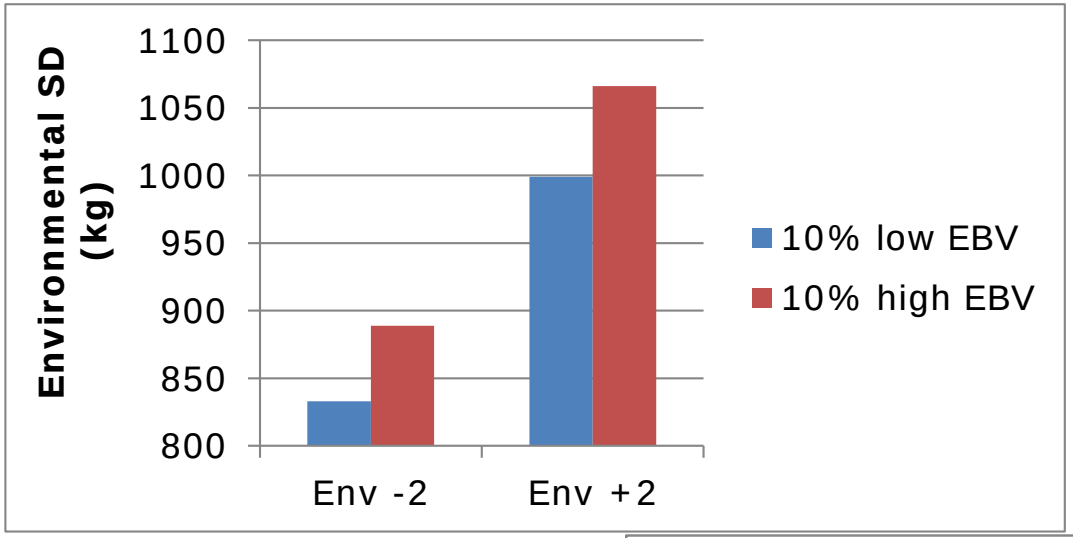
Genetic correlations mostly > 0.9; not much reranking

Genetic correlation between milk yield and micro-environmental sensitivity as a function of environment



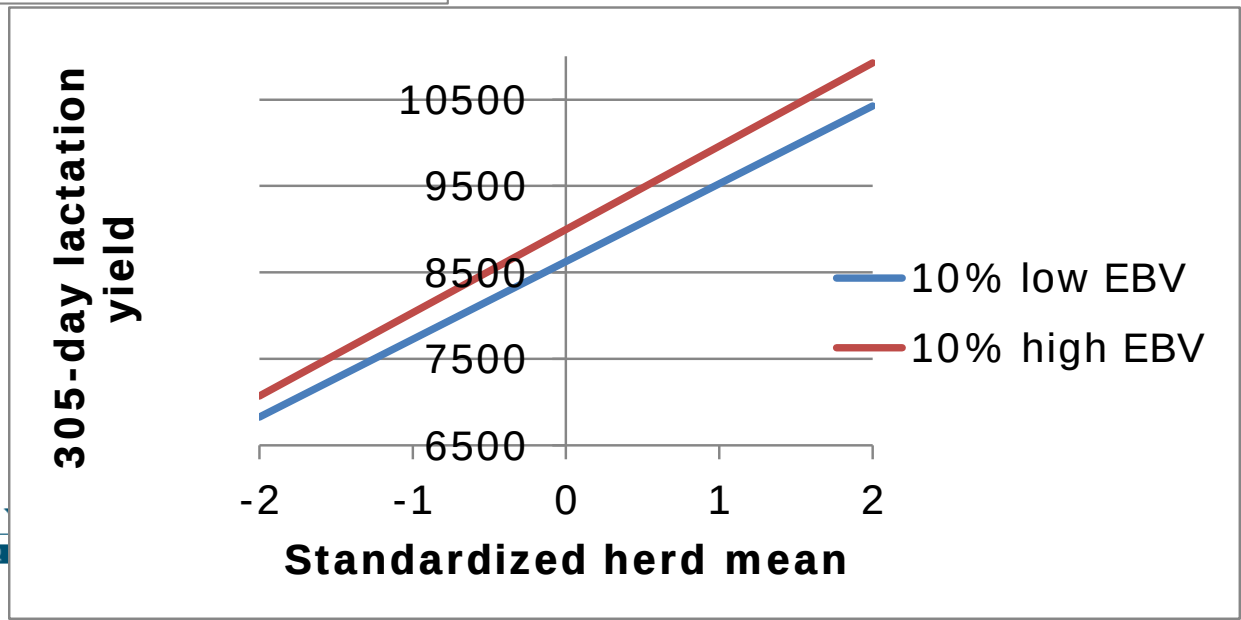
Genetic correlation between milk yield and micro-environmental sensitivity is higher in herds with a higher milk yield

Bulls with high versus low variance: expected performance of daughters



Daughters of bulls with low variance have flatter slopes and a lower average milk yield

Correlated responses in level and slope



WAGENINGEN UNIVERSITY
WAGENINGEN UR

Conclusion

- Existence of genetic variation in macro- and micro-environmental sensitivity in cows
- Macro-environmental and micro-environmental sensitivity are positively correlated for milk yield
  - Selection on lower variance results in a flatter slope
- Selection on higher milk yield leads to higher slope and higher variance
  - Cows are more sensitive, but some room for simultaneous improvement of milk yield and environmental sensitivity

Thank you for your attention!

Han.Mulder@wur.nl

Conclusion

- Existence of genetic variation in macro- and micro-environmental sensitivity in cows
- Macro-environmental and micro-environmental sensitivity are positively correlated for milk yield
  - Selection on lower variance results in a flatter slope
- Selection on higher milk yield leads to higher slope and higher variance
  - Cows are more sensitive, but some room for simultaneous improvement of milk yield and environmental sensitivity