Agricultural Institute of Slovenia

University *of Ljubljana*
Biotechnical Faculty

Environmental sensitivity for dairy traits in Slovenian Holstein population

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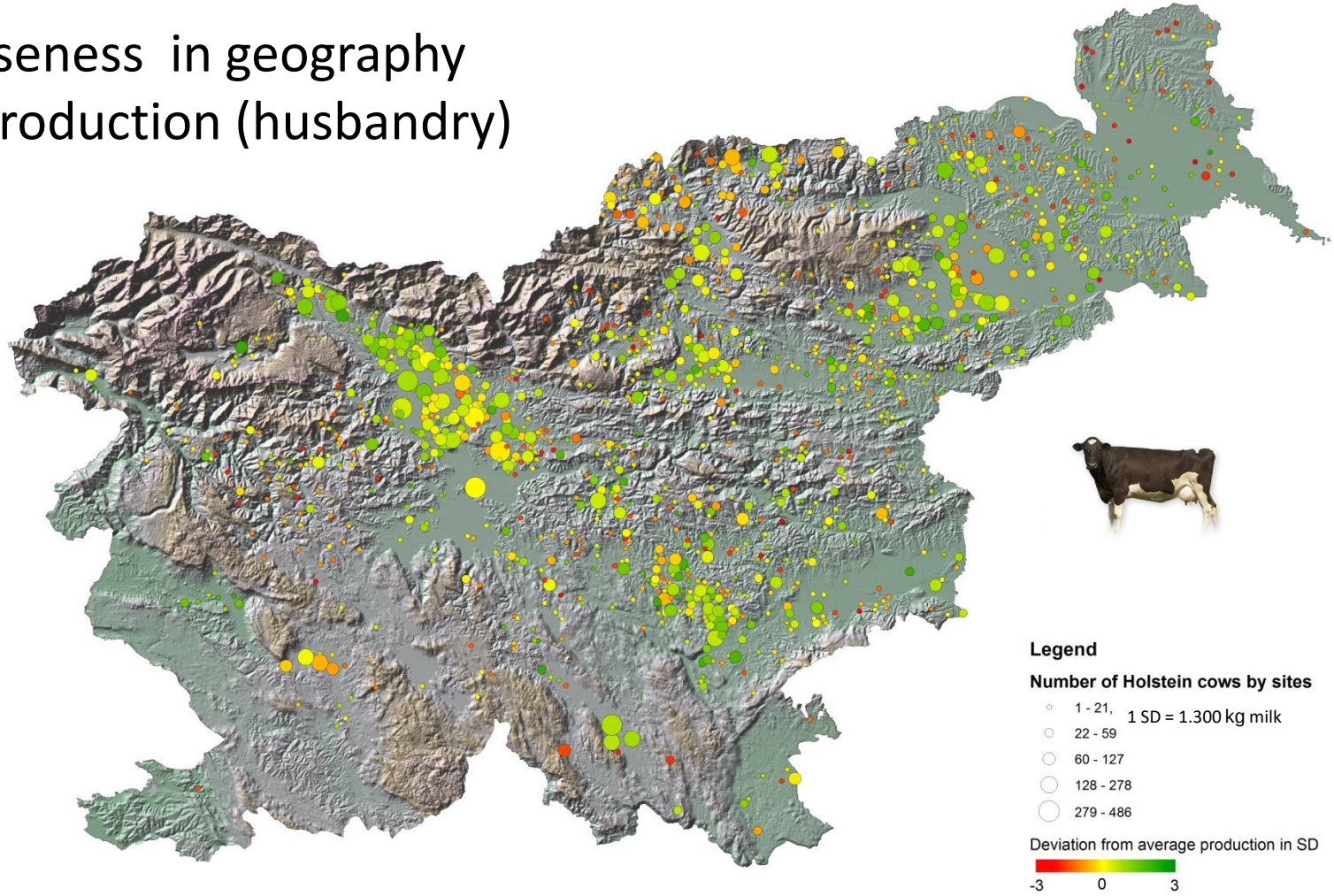
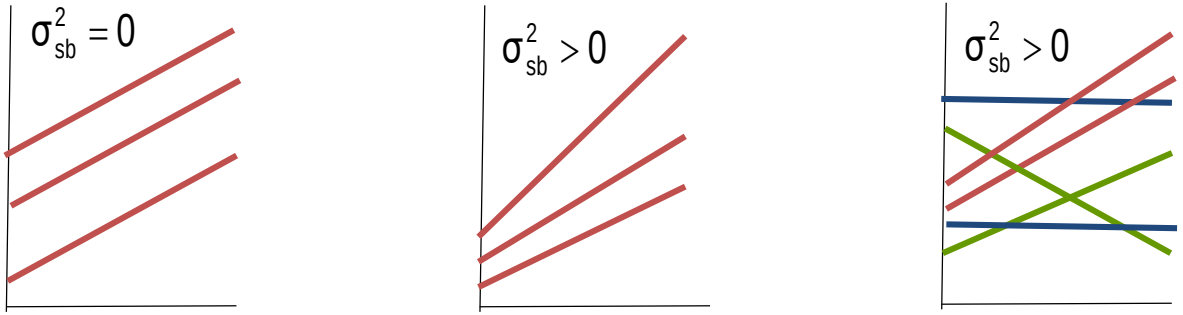
Aim

- Diverseness in geography and production (husbandry)



Reaction norm method

- RN model - phenotypic expression of genotype in different environments as a (linear) function of environment
  - GxE indicator - genetic variation in a slope of linear RN (σ^2_{sb})



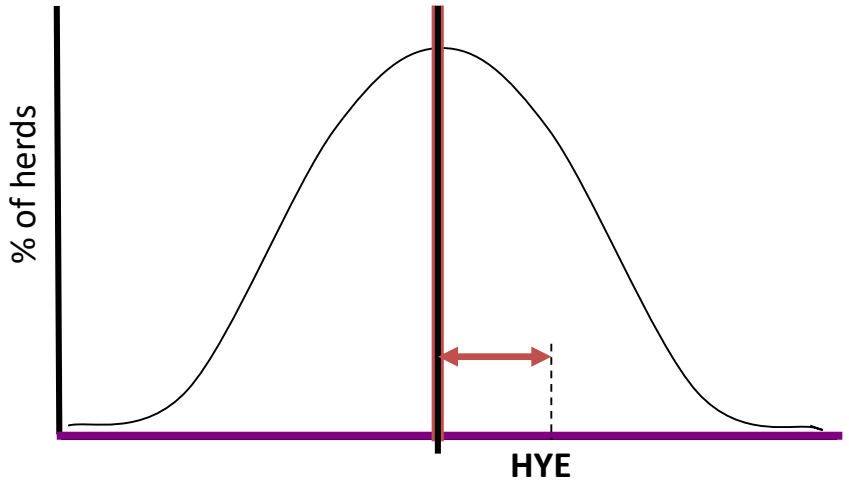
  - Shape of GxE - genetic correlation between level and slope (r_{gab}) ($r_{gab} < 1 \rightarrow$ reranking)

Data

- Milk (MILK), protein (PROT), fat (FAT) yield in 305d lactations
- At least 50 daughter records/sire
- Challenge to ensure sufficient data structure

Period	1L	3L
20 (‘90-’09)	38,365	129,505
10 (‘00-’09)	28,609	95,919

- **Environmental variable**
  - deviation
  of herd-year average
  from the overall mean



Model and variances

$y_{ijlmno} = \mu \{+ C_i\} + A_j + b_x x_{mn} + s_{am} + s_{bm} x_{mn} \{+ p_{no}\} + e_{ijmno}$

- C_i - parity (F)
- A_j - calving age - months (F)
- b_x - regression coeficient for the environment (F)
- x_{mn} - herd environment
- s_{am} - level (R)
- s_{bm} - slope (R)
- p_{no} - permanent environment (R, o = 1, 2,…,7)
- e_{ijmno} - error (R, o = 1, 2,…,7)

$$\mathbf{S_0} = \begin{bmatrix} \sigma^2_{sa} & \sigma_{sab} \\ \sigma_{sab} & \sigma^2_{sb} \end{bmatrix} = \frac{1}{4} \begin{bmatrix} \sigma^2_{aa} & \sigma_{aab} \\ \sigma_{aab} & \sigma^2_{ab} \end{bmatrix} \qquad \text{var} \begin{bmatrix} \mathbf{s} \\ \mathbf{e} \end{bmatrix} = \begin{bmatrix} \mathbf{A}_s \otimes \mathbf{S_0} & \mathbf{0} \\ \mathbf{0} & \text{diag}\{\sigma^2_{eo}\} \end{bmatrix}$$

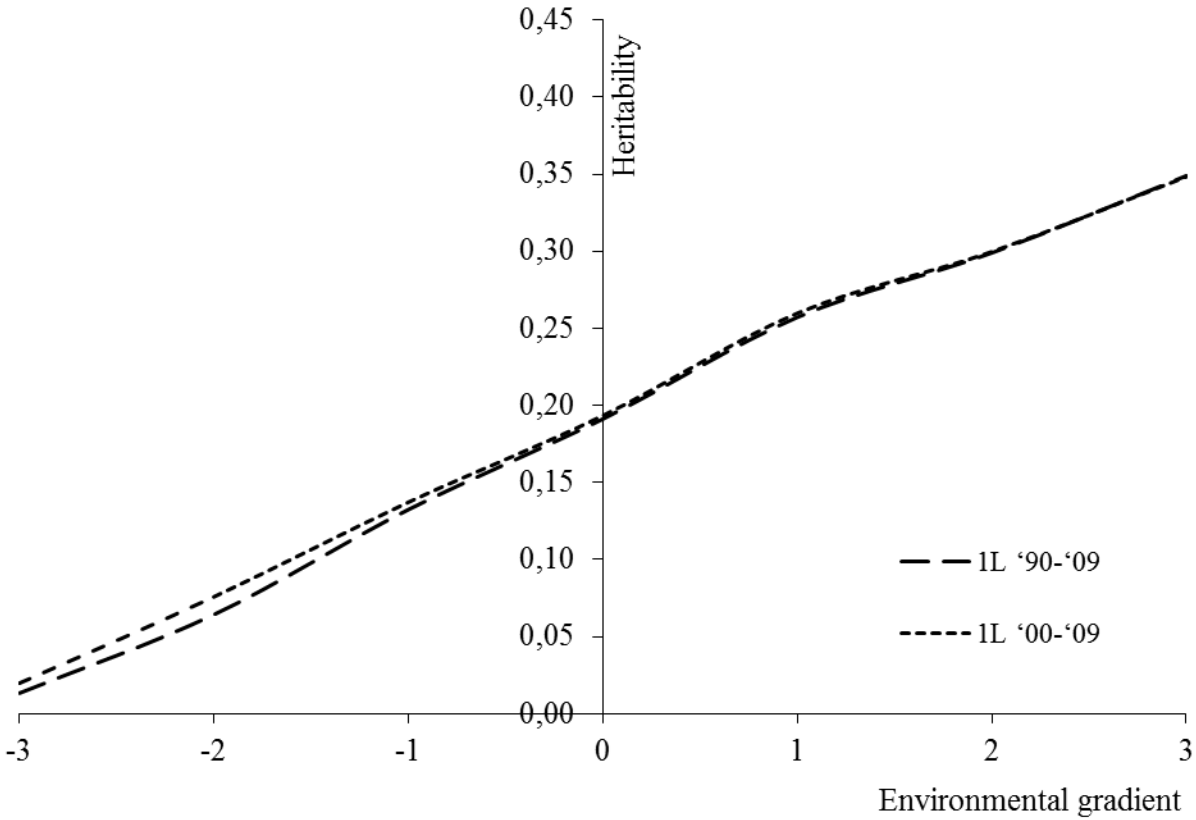
RN parameters

C	Period	Milk		Protein		Fat	
		σ^2_{sb}	r_{gab}	σ^2_{sb}	r_{gab}	σ^2_{sb}	r_{gab}
1.	‘90-‘09	0.0039	1.00	0.0022	0.98	0.0019	0.96
	‘00-‘09	0.0040	1.00	0.0019	0.98	0.0016	1.00
3.	‘90-‘09	0.0028	0.92	0.0019	0.91	0.0017	0.87
	‘00-‘09	0.0028	0.92	0.0018	0.92	0.0019	0.80

- $\sigma^2_{sb} > 0$ (up to 40×10-4)
- $r_{gab} \geq 0.80$
- C1 ≈ C3
- P10 ≈ P20

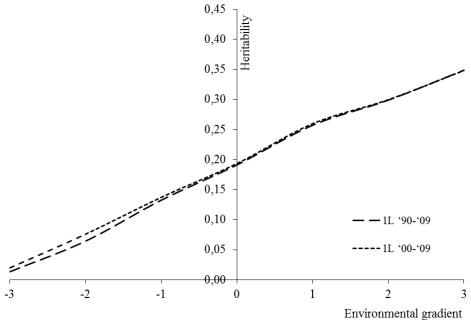
Heritability

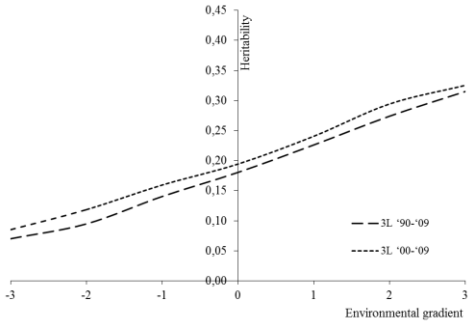
MILK



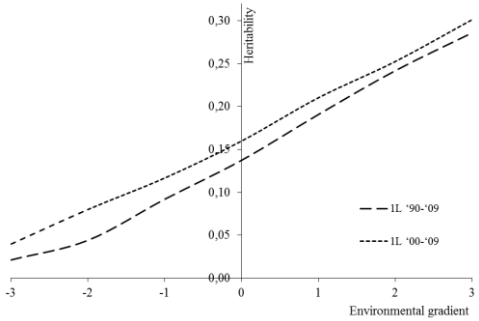
Heritability

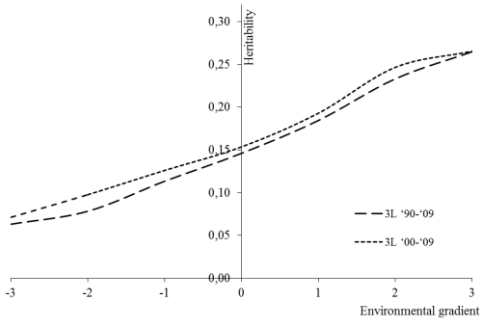
MILK



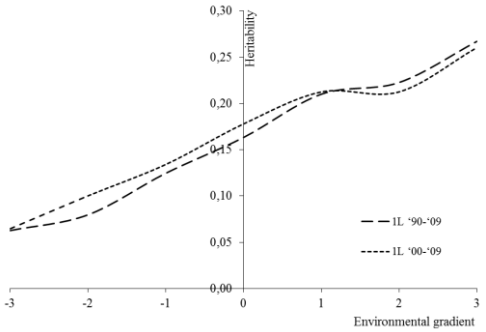


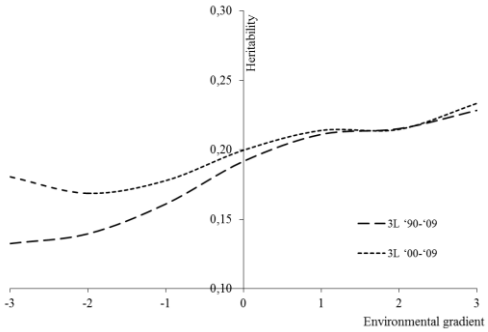
PROT



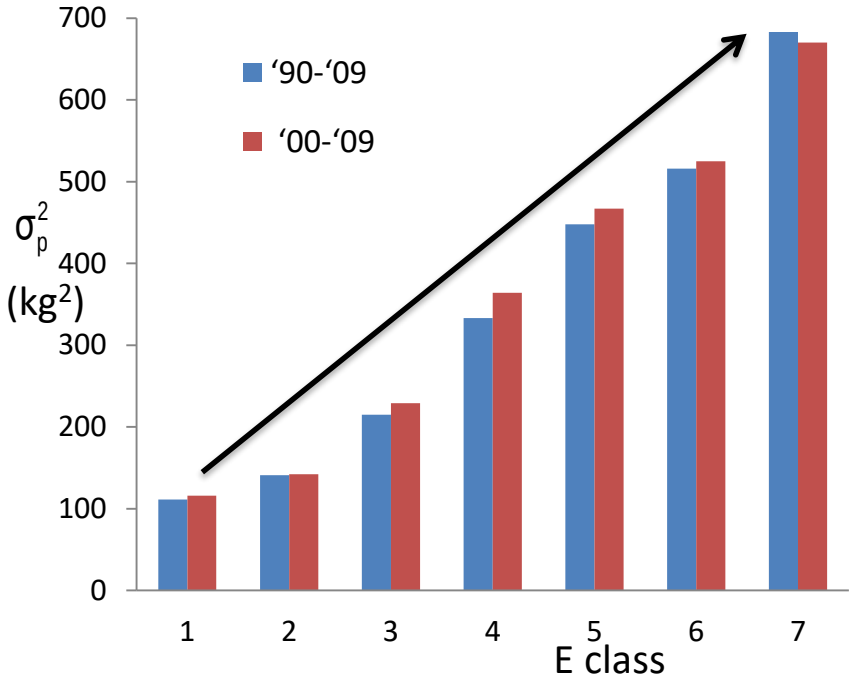


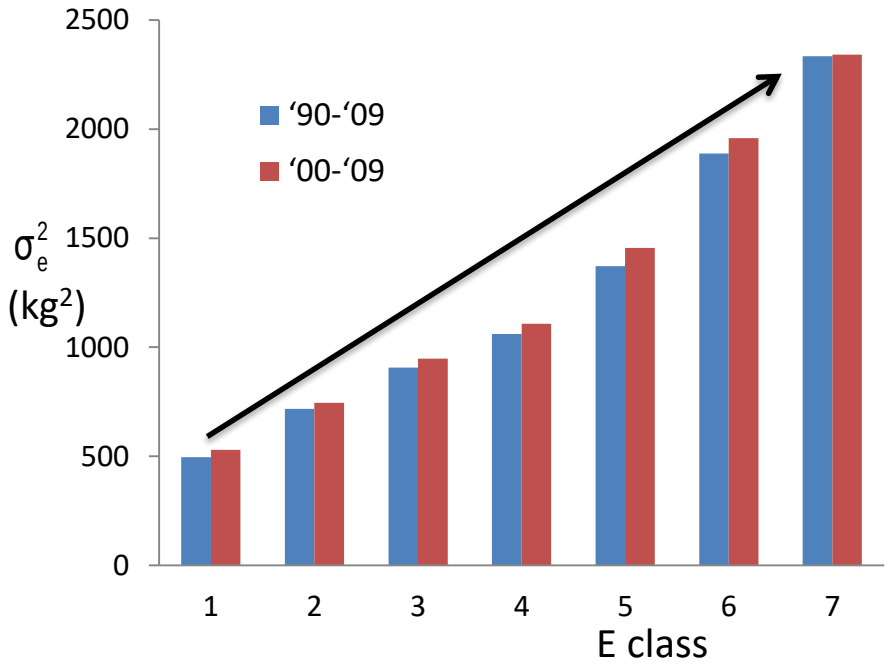
FAT





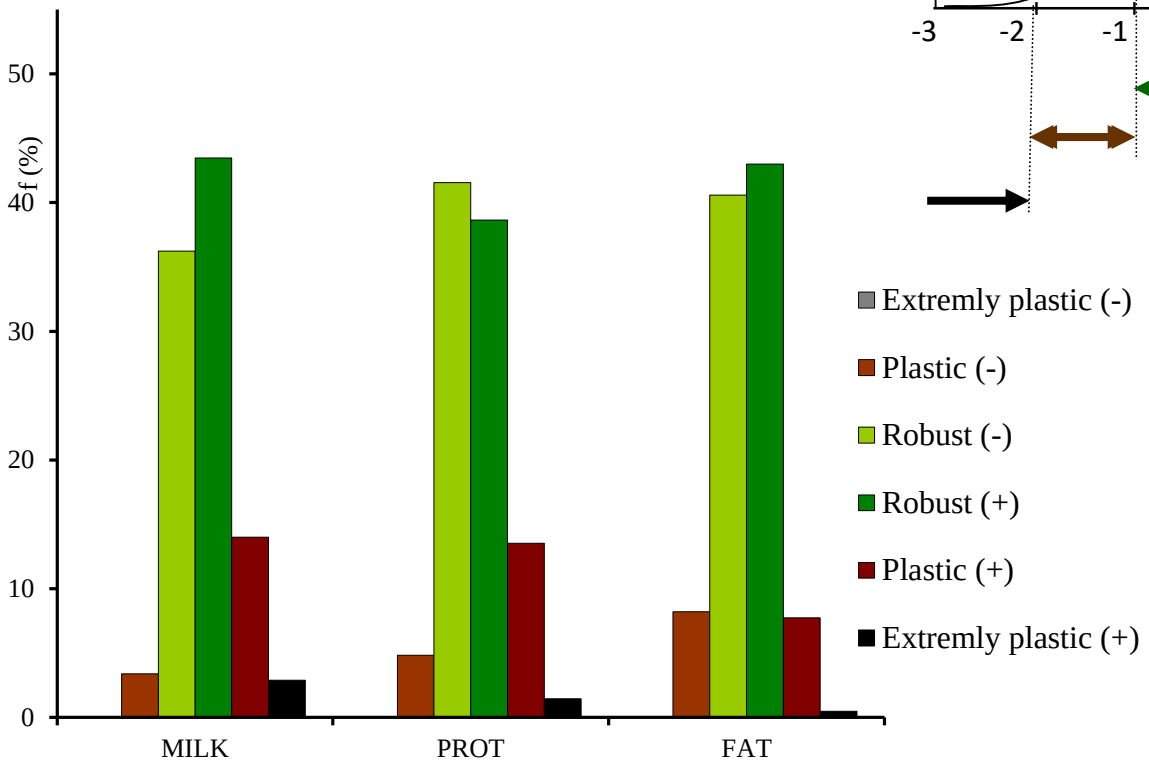
Permanent environment and residual variances

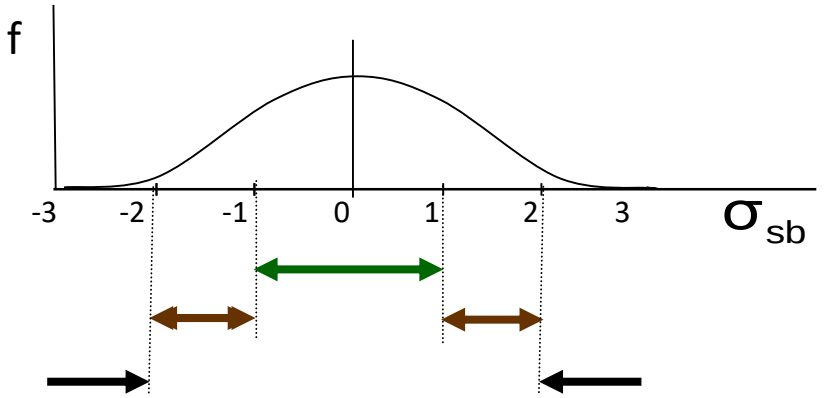




Plasticity

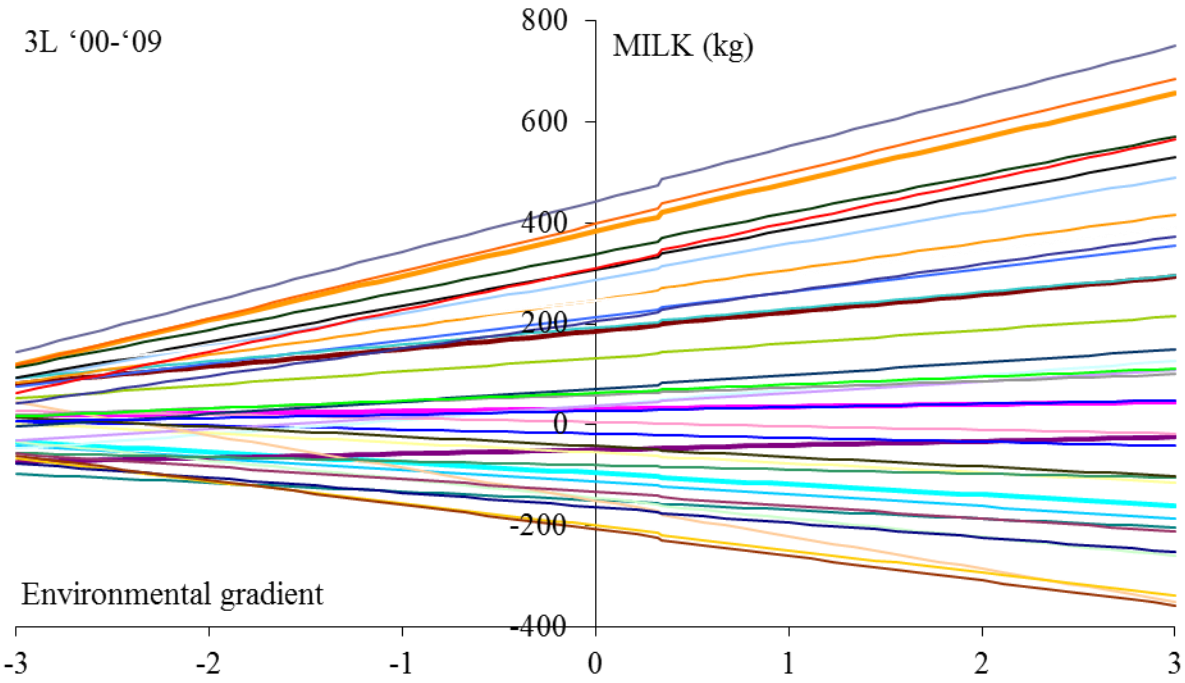
$$y_{ijlmno} = \ldots + s_{am} + s_{bm}\, x_{mn} + \ldots$$





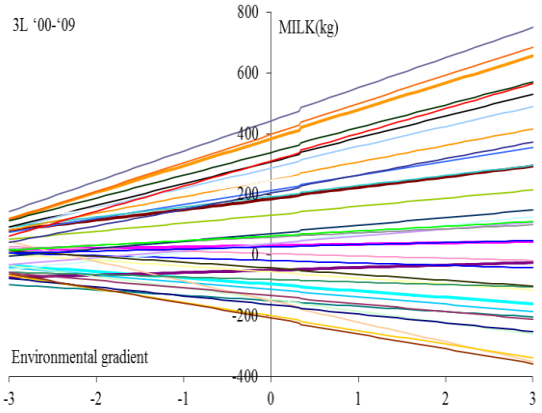
(Mattar et al., 2011)

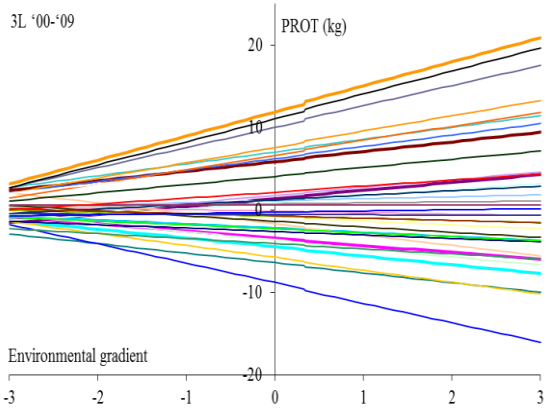
Reaction norms

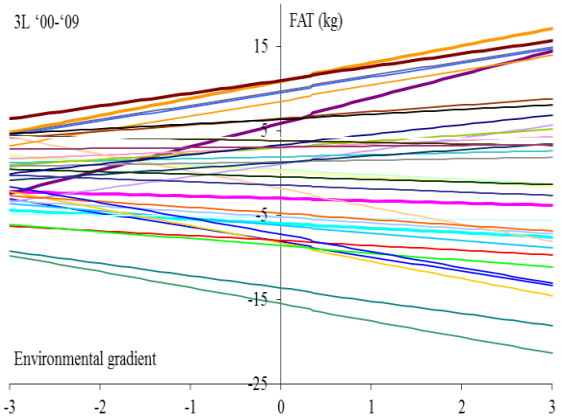


- Robustness, scaling, re-ranking

Reaction norms

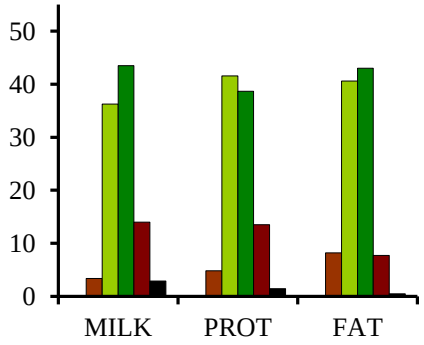






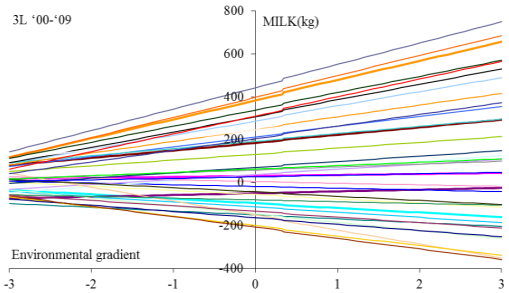
Conclusions

- Evidence for the presence of genetic variability of ES
- $\sigma^2_{sb} > 0$
- $r_{gab} \geq 0.80$ - higher response of animals with high genetic merit
- BV confirm genetic variability of phenotypic plasticity
  - expecting better phenotype of daughters in better E (> 50 %)



Conclusions

- Low/barren environments
  - Genetic abilities suitable for barren Es differ from those suitable for average or high Es
  - High-production animals cannot exploit their genetic potential
  - Increase in production not achieved by investing in animals with high BV without simultaneously improving the E



Conclusion

Thank you for your attention!