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Institute of Animal Science

DEVELOPMENT OF A SELECTION INDEX FOR RESILIENCE IN GERMAN HOLSTEIN

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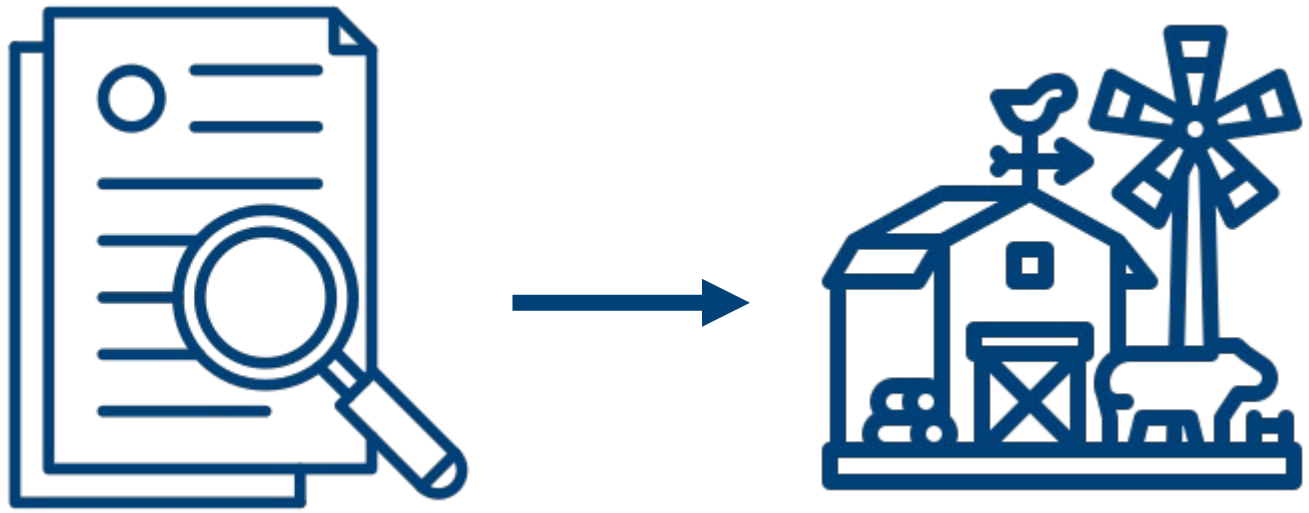
Florence, 04th September 2024

STUDY AIM



Transfer of **scientific knowledge** about resilience indicator traits to breeding value estimation **in dairy farming**

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RESILIENCE

„The ability of an individual to cope with short-term disturbances and to perform as before with equilibrium restored.“

based on Colditz and Hine 2016 & Berghof et al. 2019

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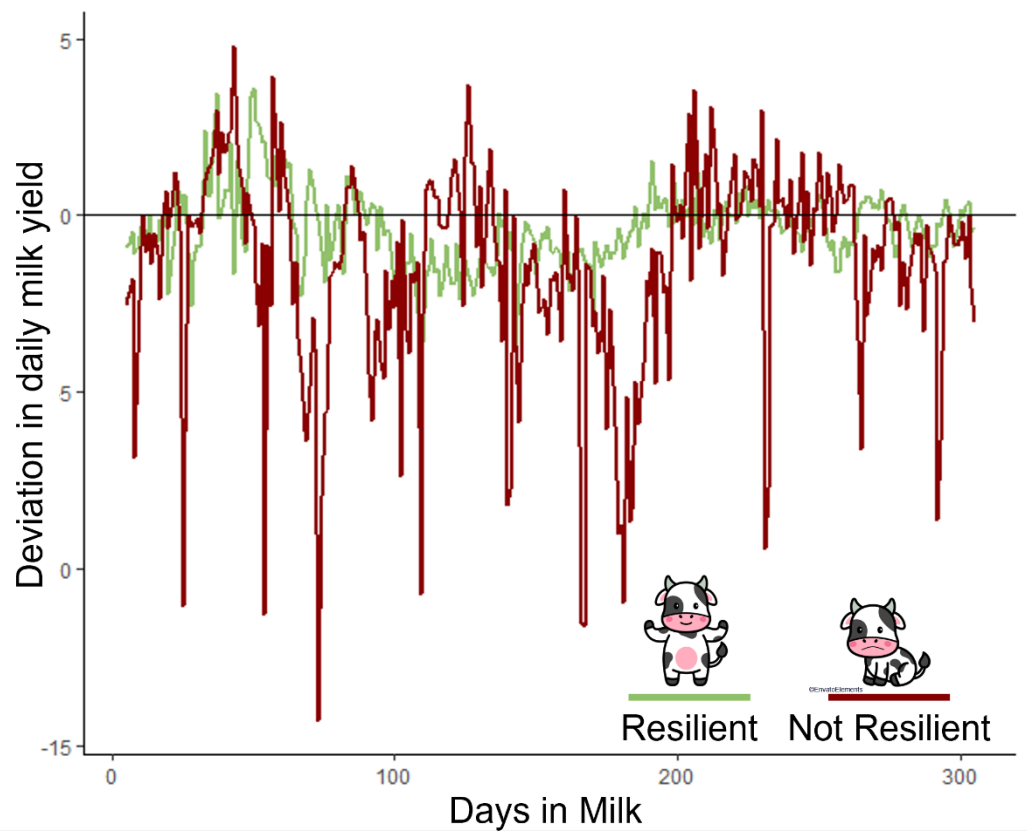
PHENOTYPING AND MEASURING

- Phenotyping and measuring resilience pose a challenge
- Applicati ts
  - **Examp**
- Assumpt
  - An anir gitudinally measu
  - Clear definition of the period under consideration for comparability
  - **Example:** A cow's daily milk yield during a lactation period drops due to several reasons like heatwaves, changing food quality or social stressors

Our Study

Analysing the daily milk yield of dairy cows of the German Holstein breed

RESILIENCE INDICATOR TRAITS – VARIANCE

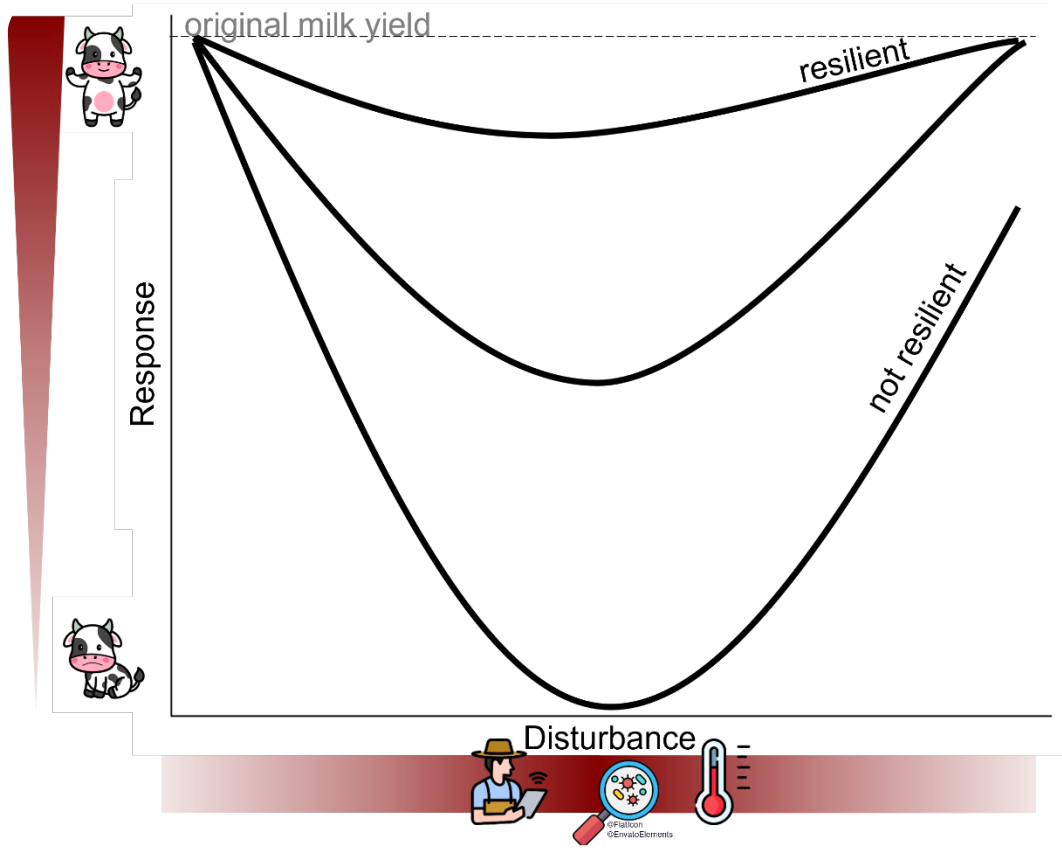


- Showing the fluctuation in performance
- Analyses in previous studies described
  (Poppe et al. 2020; Chen et al. 2022; Keßler et al. 2024)
  - moderate heritabilities
  - desirable genetic correlations with performance traits*
  - desirable genetic correlations with health traits

* when corrected for the performance level

RESILIENCE INDICATOR TRAITS – AUTOCORRELATION

- Indication of the duration of the recovery phase after a disturbance
- Analyses in previous studies described (Poppe et al. 2020; Keßler et al. 2024)
  - low heritabilities
  - less significant genetic correlations with performance traits
  - weak, but desirable correlations with health traits



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METHODS – MATERIALS

KlimaFit
PROJECT

Baden-Württemberg
GERMANY

48
FARMS

2206
GERMAN HOLSTEIN

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METHODS – RESILIENCE INDICATOR TRAITS

- Calculation based on daily milk yield (DMY) of day 10 to 305 per lactation
- Modelling of the predicted daily milk yield with p-spline interpolation
- Exclusion of disturbed days

v	Ln Variance of absolute DMY
v_d	Ln Variance of deviation between observed and predicted absolute DMY
v_r	Ln Variance of relative DMY
v_{rd}	Ln Variance of deviation between observed and predicted relative DMY
r_{Auto}	Autocorrelation of deviation between observed and predicted absolute DMY

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METHODS – STATISTICAL ANALYSES

$$\boldsymbol{y = Xb + Zu + Wpe + e}$$

y	vector of phenotypic observations
b	vector of fixed effects (Age at first calving, Lactation, Herd-Year-Season, Completeness of Lactation)
u	vector of additive genetic effects; $u \sim N(0, A\sigma_u^2)$
pe	vector of permanent environment effects
e	vector of residual effects
W, X, Z	incidence matrices

All analyses were performed using ASReml R.

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METHODS – SELECTION INDEX

- Composition of selection index resilience $SI_{resilience}$:

$$SI_{resilience} = w_v * EBV_v + w_{v_d} * EBV_{v_d} + w_{v_r} * EBV_{v_r} + w_{v_{rd}} * EBV_{v_{rd}} + w_{r_{Auto}} * EBV_{r_{Auto}}$$

- Maximisation of joint breeding response R of $SI_{resilience}$ with the selection index health SI_{health} (provided by vit) using the L-BFGS algorithm:

$$R = \sqrt{h^2_{SI_{resilience}}} * r_{x_{SI_{resilience}} y_{SI_{health}}}$$

$h^2_{SI_{resilience}}$ heritability of $SI_{resilience}$, with $h^2_{SI} = \frac{V_A}{V_P} = \frac{w^T \Omega_A w}{w^T \Omega_P w}$

$r_{x_{SI_{resilience}} y_{SI_{health}}}$ Pearson correlation between $SI_{resilience}$ and SI_{health}

Selection index adapted from Mrode, 2005

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RESULTS - OPTIMISED SELECTION INDEX RESILIENCE

- Showing selection indices with maximum joint breeding response $R_{SI_{health}}$ with different numbers of integrated resilience indicator traits

Selection index resilience consisting of					$h^2_{SI_{resilience}}$	r	$R_{SI_{health}}$
v	v_d	r_{Auto}	v_r	v_{rd}			
-1.377	1.925	-0.076	1.809	-1.281	0.227	0.467	0.222
-1.219	1.730		1.624	-1.135	0.224	0.468	0.221
-0.319	0.753		0.566		0.201	0.491	0.220
	0.654		0.346		0.196	0.492	0.218

→ Minor deviations in joint breeding response $R_{SI_{health}}$ between differently composed selection indices $SI_{resilience}$ indicate a weak optimum

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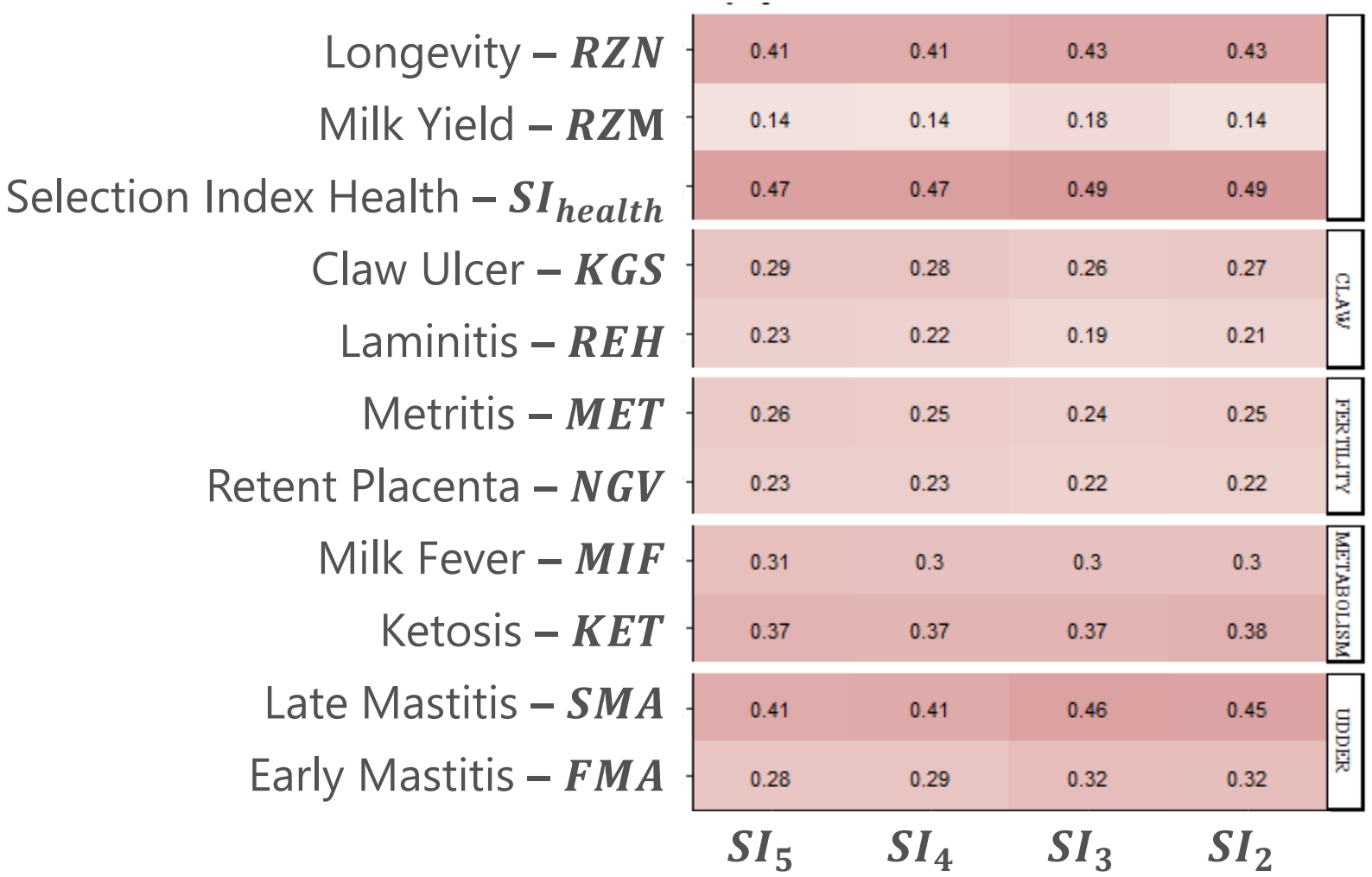
RESULTS – CORRELATION TO ESTABLISHED TRAITS

- Pearson Correlation between resilience indicator traits and indices with established EBVs for health



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DISCUSSION – SELECTION INDEX RESILIENCE

- Correlations between resilience indicator and health traits were desirable
  - **Resilient animals are healthier**
  - Results similar to previous studies (Poppe et al. 2020; Chen et al. 2022)
- Optimization of the selection index resilience based on maximizing the joint breeding response with SI_{health}
  - Mapping of the most comprehensive, precise resilience possible, as SI_{health} consists of 13 individual health traits
- Selection index resilience should consist of two resilience indicator traits
  - Joint breeding response increases only slightly
  - Advantages due to less computational effort and increased comprehensibility

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DISCUSSION – REASONS FOR BREED FOR RESILIENCE

- Response to unmeasurable external influences (Poppe et al. 2021)
  - Unknown, external influences such as heat waves are currently not recorded and the response of individuals to them is not taken into account in selection decisions
- Antagonism between performance and health (Heringstad and Larsgard, 2010; Heringstad et al. 2007)
  - Performance and health traits are undesirably correlated with each other, causing the EBVs of a trait group to decrease in the case of biased selection
- Poor collection of health data
  - Health data is rarely collected, partly incomplete and sometimes subjective
- *Assumption*: Improvement in economic profit (Berghof et al. 2018; Poppe et al. 2022)
  - Stable and homogeneous herds are easier to manage and resilient individuals are more profitable

CONCLUSION

Breeding for increased resilience is possible. A selection index, which should consist of two resilience indicator traits, is suitable for this purpose.

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EIP-PROJECT „KLIMAFIT“

Baden-Württemberg

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UND VERBRAUCHERSCHUTZ

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THANK YOU FOR YOUR ATTENTION

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