

Resilience indicators for sustainable breeding of Chinese Holstein cows

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Supervisors :

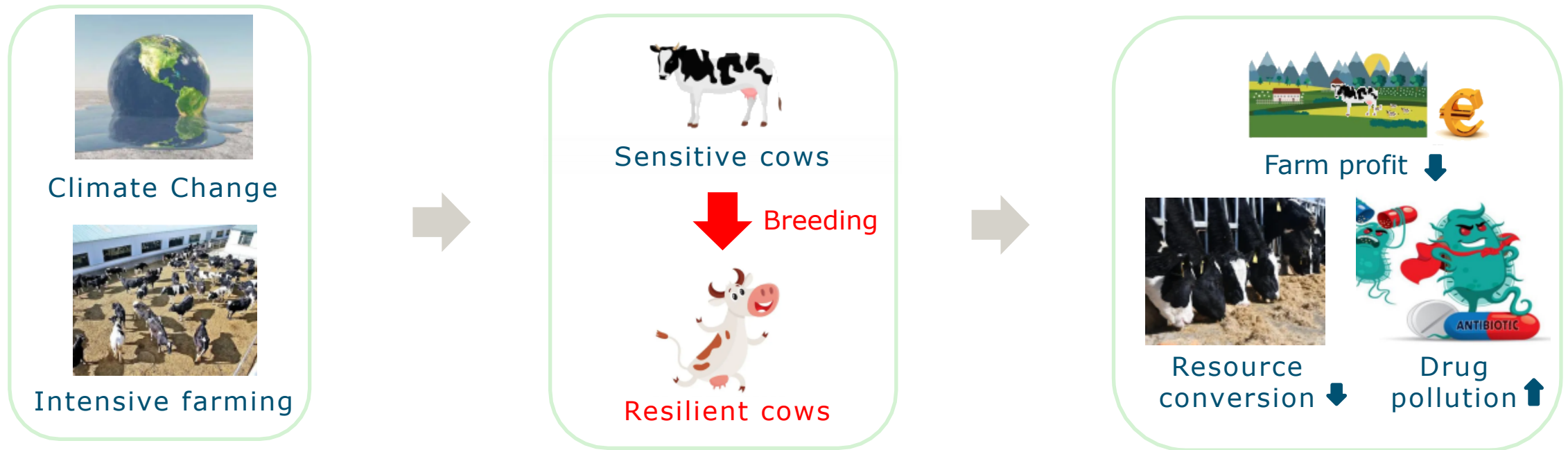
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Environment -> Cow -> Environment

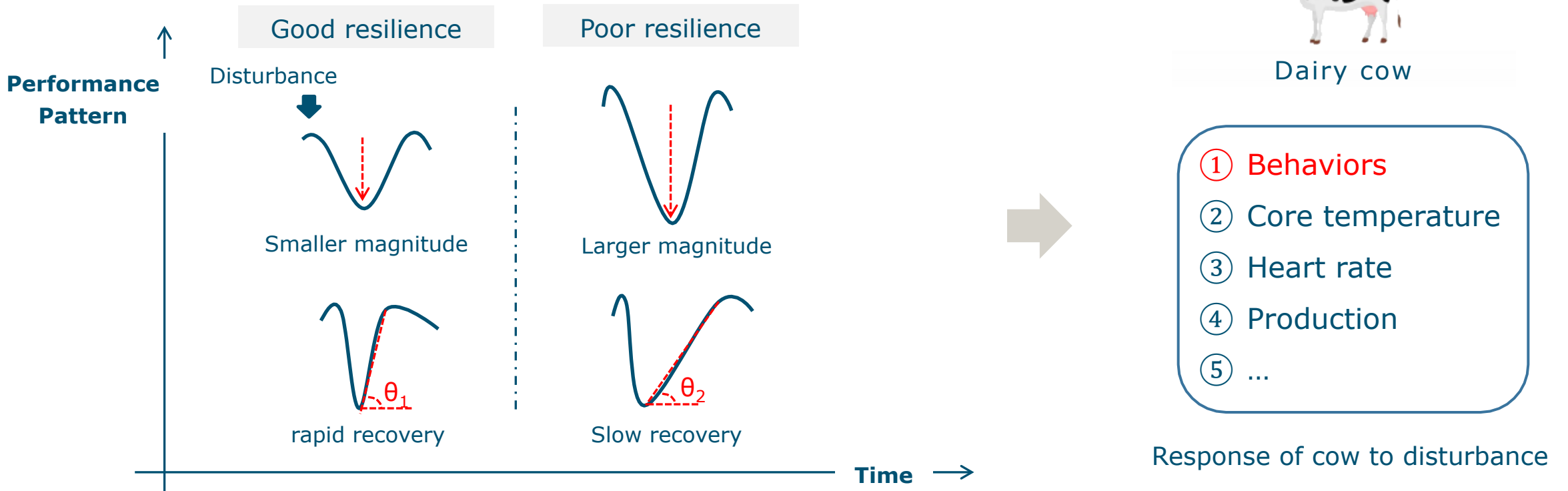


- The situation could be changed by breeding
- Resilient generation is profitable and environmentally friendly

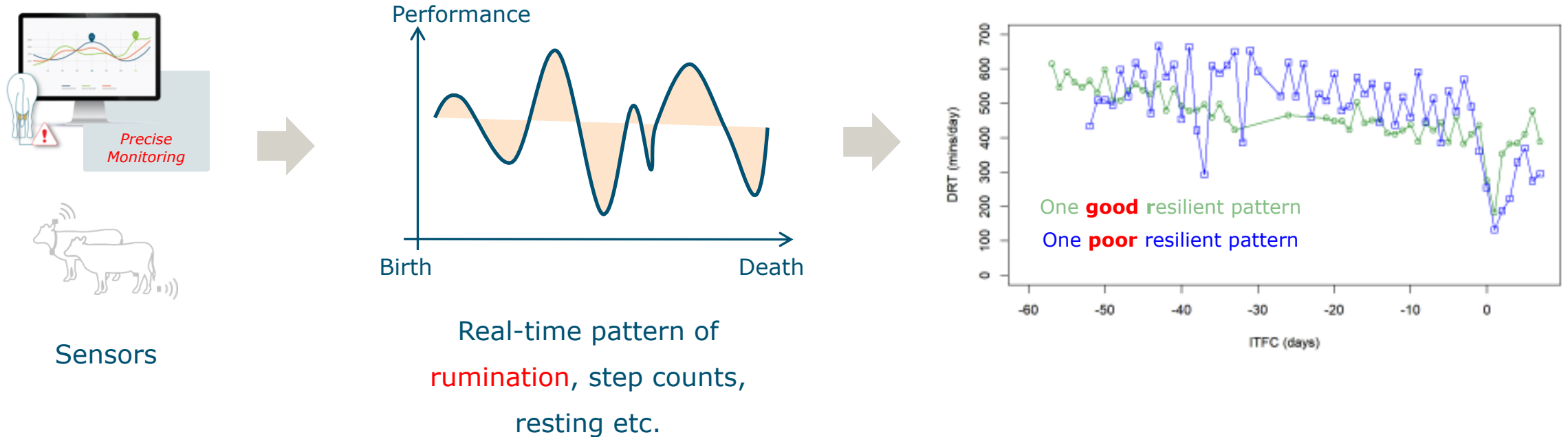
Resilience

Resilient cows:

- Little affected by disturbances or rapidly recover to normal



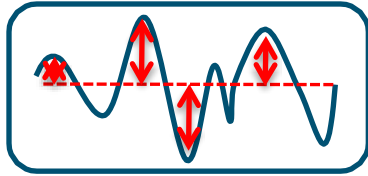
Daily rumination time (DRT) used in this study



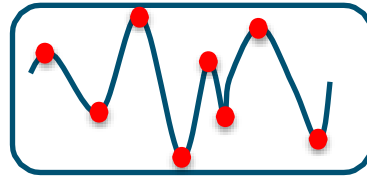
Advantages:

- First and basic activity for ruminants
- Crucial to feed intake, energy intake, and farm profit

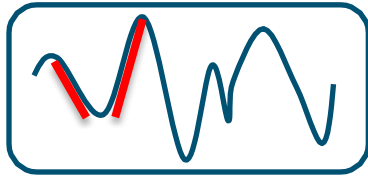
Resilience indicators



1. Variance of deviations (Var)



2. Autocorrelation of time subsequences (r_{auto})



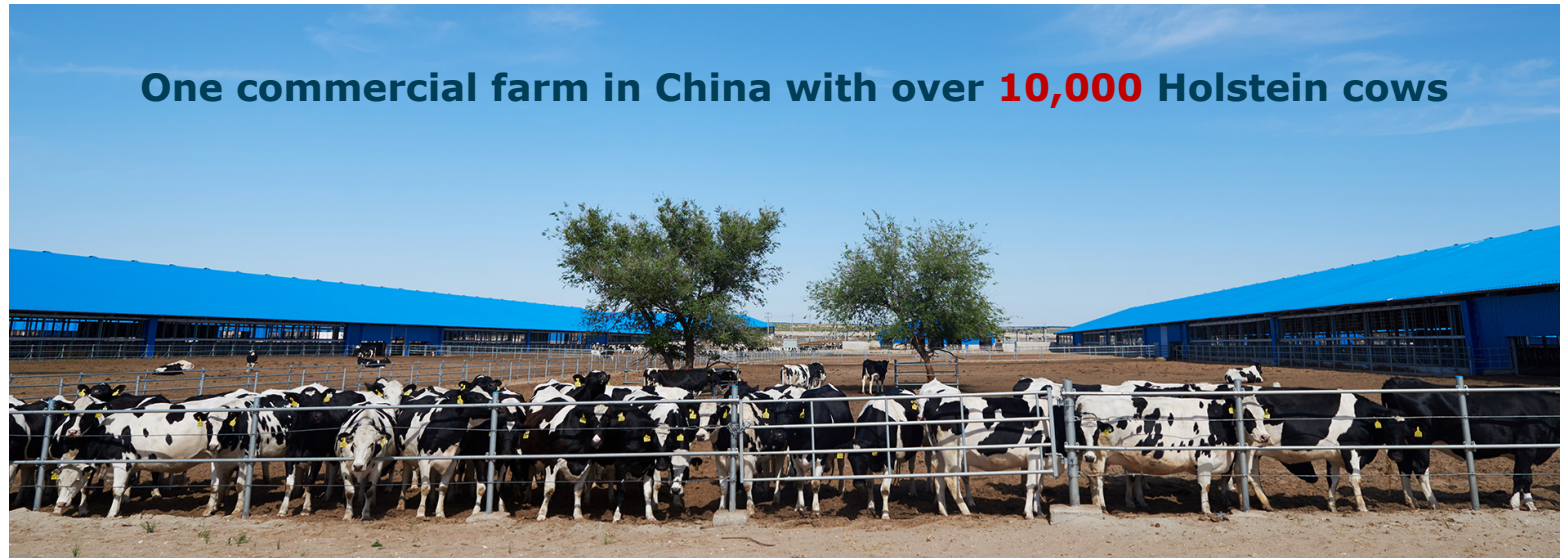
3. Slopes (decrease and increase) of trend

Indicators	Good resilience		Poor resilience
Var	Lower value	<	Higher value
r_{auto}	Close to 0	<	Far from 0
Slope (decrease)	Close to 0	>	Lower value
Slope (increase)	Higher value	>	Close to 0

Objectives

- ❑ To define potential resilience indicators based on daily rumination time (DRT);
- ❑ To assess performance characteristics of resilient individuals.

Material



DRT after quality control:

- 2,246 young stock ♀ (Age: 608 - 873 d)
- DRT Data: 113,813 records
- Recording period: -60 d to 7 d (day 0 means first calving)



Methods

① Random regression models → Genetic variation of DRT

$$y_{ijklmno} = TYM_i + CM_j + Feed_k + \beta_1 Age_{cl} + \sum_{n=0}^Z ITFC_n a_{mn} + \sum_{n=0}^Z ITFC_n pe_{mn} + \varepsilon_{ijklmno}$$

② Obtaining of resilience indicators

a) Variance

Quantile regression: $y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \beta_3 t^3 + \beta_4 t^4 + \varepsilon$

b) Autocorrelation

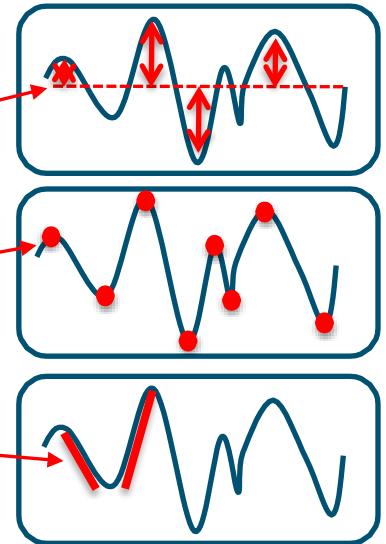
$$r_k = E [(X_i - \mu_i)(X_{i+k} - \mu_{i+k})] / \sigma^2$$

c) Slope (decrease and increase)

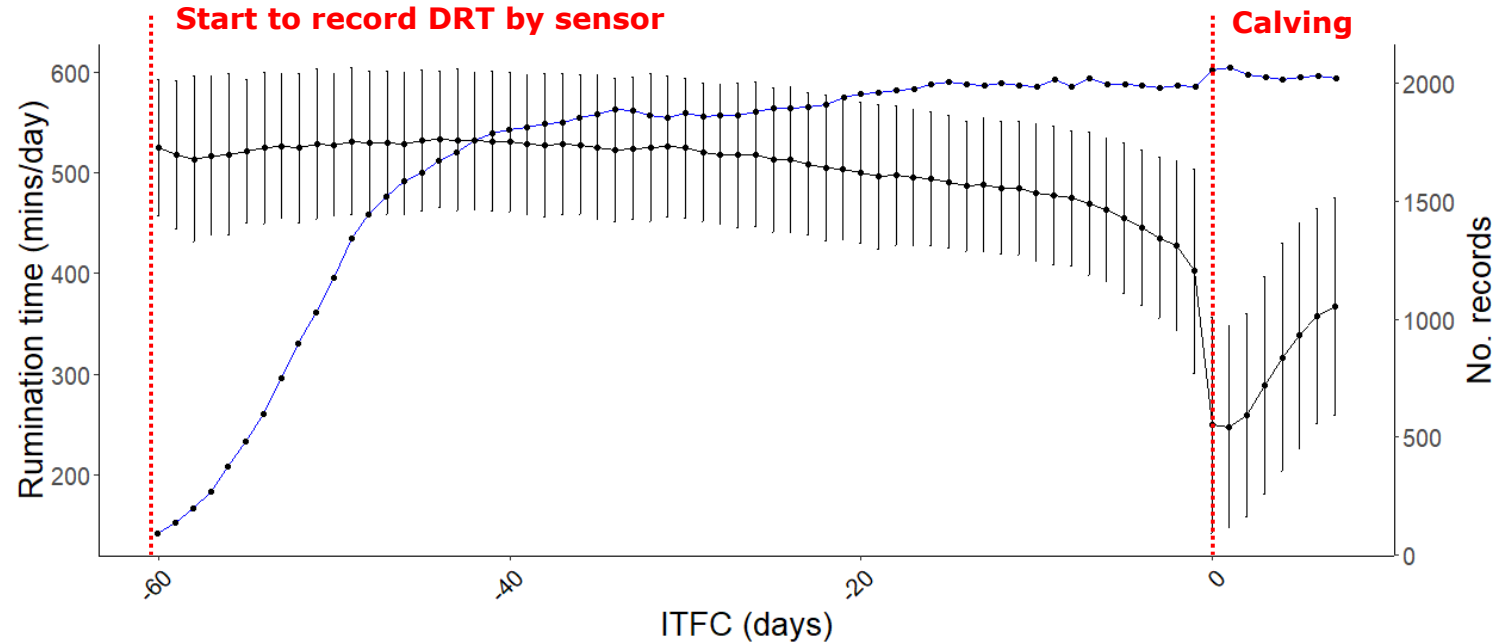
Linear regression: $y_t = \beta_0 + \beta_1 t$

③ Animal models → Genetic parameters of indicators

$$y_{ijklm} = BYM_i + CYM_j + \beta_1 n_k + a_i + \varepsilon_{ijklm}$$



Basic description of DRT

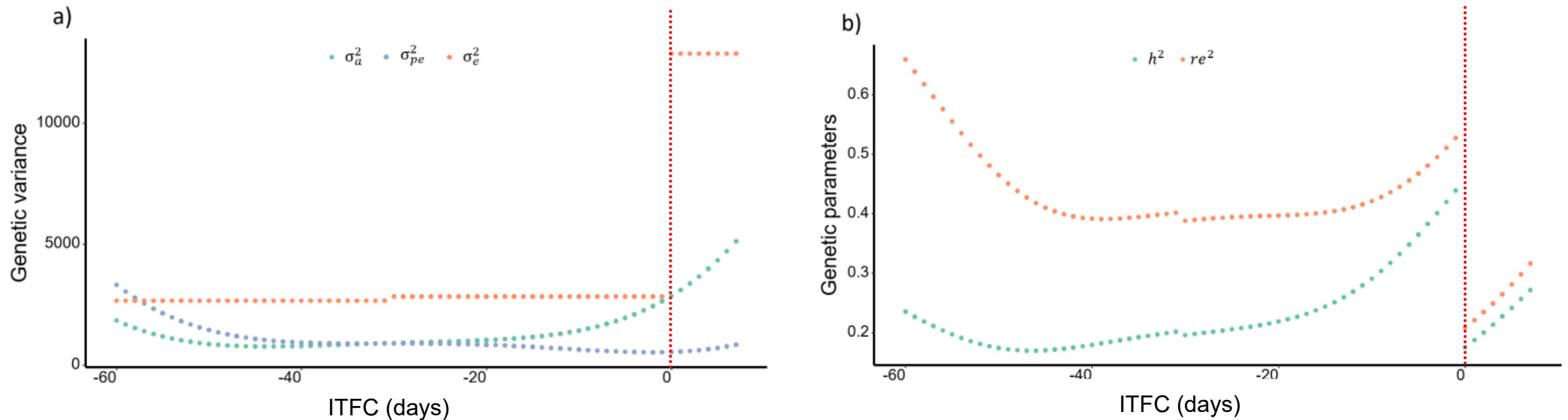


*ITFC: the interval from test day to first calving
Day 0: first calving (delivery) of cow

Black line: DRT value;
Blue line: Number of records

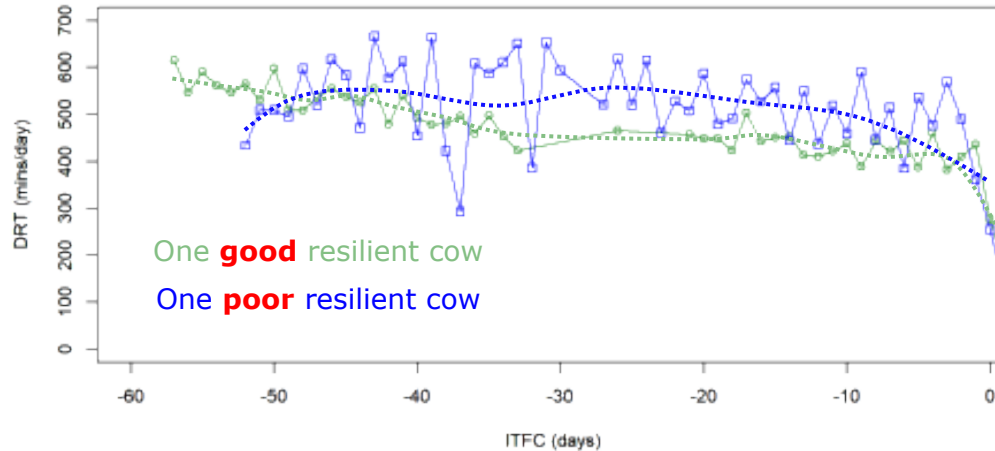
✓ Range was 2 to 791 mins/day; mean was 474 min/day (= 7.90 h)

Genetic parameters of DRT for each day

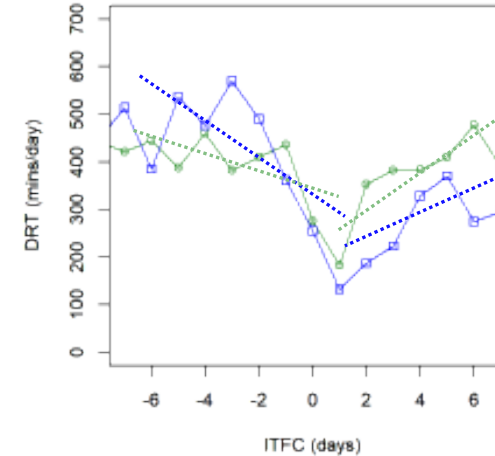


- ✓ Daily rumination time have moderate heritability (h^2) and repeatability (re^2)
- ✓ Variation pattern is extremely different around day of calving

Deriving resilience indicators



2,116 Young stocks' Var and r_{auto}



1,954 Young stocks' slopes

Description of resilience indicators from two periods (-60 to -1 and -7 to 7 days)

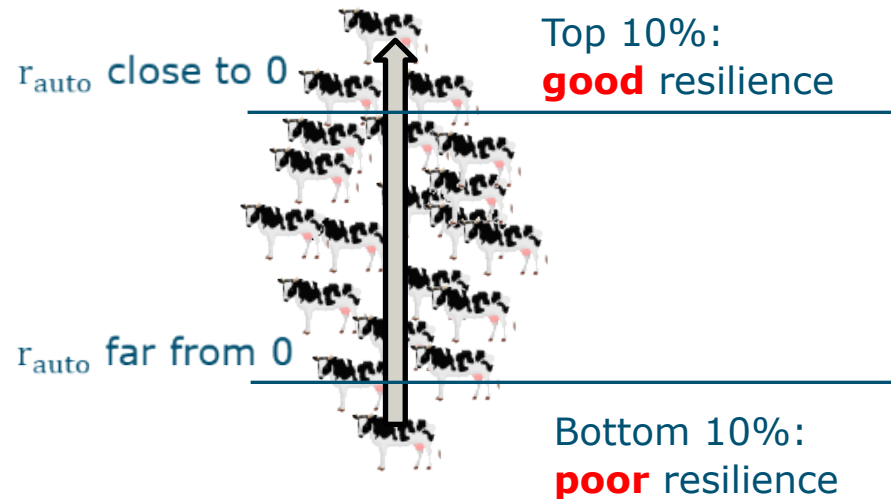
Periods	Indicators	Min	Max
-60 to -1 d	Var	647.30	10,910
	r_{auto}	-0.50	0.87
-7 to 7 d	Slope (decrease)	-129.30	8.10
	Slope (increase)	-13.94	252.00

Good vs poor resilience based on r_{auto}

The characteristics of resilient individual ?

- Fertility?
- Health?
- Other aspects?

Grouping: estimated breeding values (inherited part to next generation)



Young stock (Phenotype):

2 fertility performances and 1 disease performance

Sire (GEBV):

2 feed performance, 1 productive performance and 1 body conformation



Good vs poor resilience

Young stocks' performance	Good resilience ($r_{\text{auto}} = -0.007$)		Poor resilience ($r_{\text{auto}} = -0.062$)	Difference
Ease calving at 1 st calving	76%	>	66%	10%***
Successful insemination at first time	57%	>	53%	4%
Disease incidence	26%	<	30%	-4%

Data from farm; number of used records is 424; ***: p -value <0.01 with t-test

Sire performance	Good resilience ($r_{\text{auto}} = -0.002$)		Poor resilience ($r_{\text{auto}} = -0.052$)	Difference
Feed efficiency	71.92	>	61.13	10.79
Feed saved	79.09	>	-48.83	127.92***
Productive life (month)	1.54	>	0.78	0.76
Body Strength	0.15	>	-0.29	0.44***

Data from CDCB; number of used records is 108; ***: p -value <0.01 with t-test

Take home messages

- ① Resilience indicators can be derived from daily rumination time (DRT) patterns in Holstein heifers
 - ② Four indicators are heritable and could be used in the genetic selection
 - ③ Resilient cows tend to have better fertility, easier calving, higher resistance to disease, and higher feed efficiency
- ▣ Implications: contribute to profitable and environmentally friendly



Acknowledgements

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Thanks for your attention!
Q&A

