Can daily rumination time be used to breed for resilient Holstein cows?

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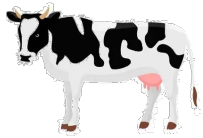
Introduction - Environment → Cow → Environment

Climate Change

Intensive farming

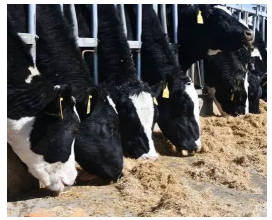


Sensitive cows

Breeding

Resilient cows

Farm profit



Labor costs

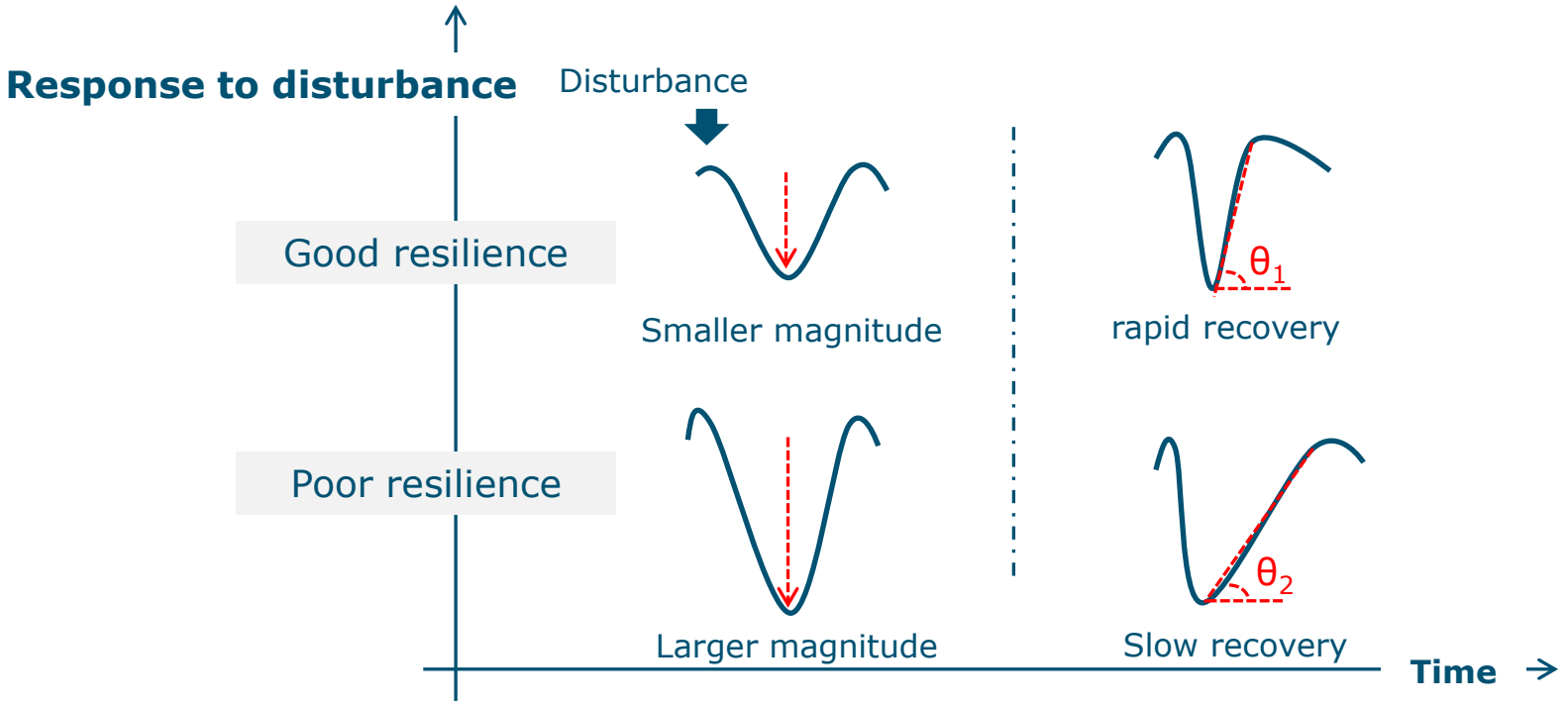
Antibiotic resistance

- Improving resilience results in more sustainable dairy farming
- Resilience can be improved by breeding

(Berghof, *et al*., 2019; Luiz, *et al*., 2020)

Introduction - Resilience

Resilient cows are little affected by disturbances / rapidly recover to the normal



(Colditz and Hine, 2016; Bengtsson *et al*., 2022)

Introduction - Resilience derived from rumination patterns

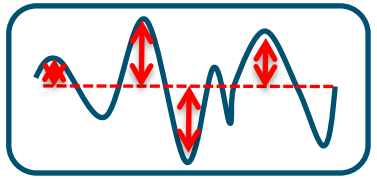
Sensors

Why look at daily rumination time (DRT):

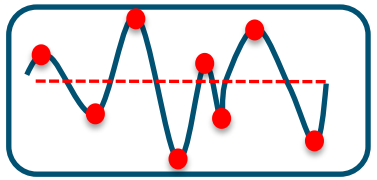
- First and basic activity for ruminants
- Sensitive to disease and other stress
- High heritability (~0.4)

(Herskin *et al*., 2004; Bristow and Holmes, 2007)

Introduction - Resilience indicators



1. Natural log-transformed Variance of deviations (LnVar)



2. Autocorrelation of time series of deviations (Autocorr)

Indicators	Representation	Good resilience		Poor resilience
LnVar	Magnitude	Lower value	<	Higher value
Lag =1 Autocorr	Duration	Close to 0	<	Far from 0

(Berghof *et al.*, 2019)

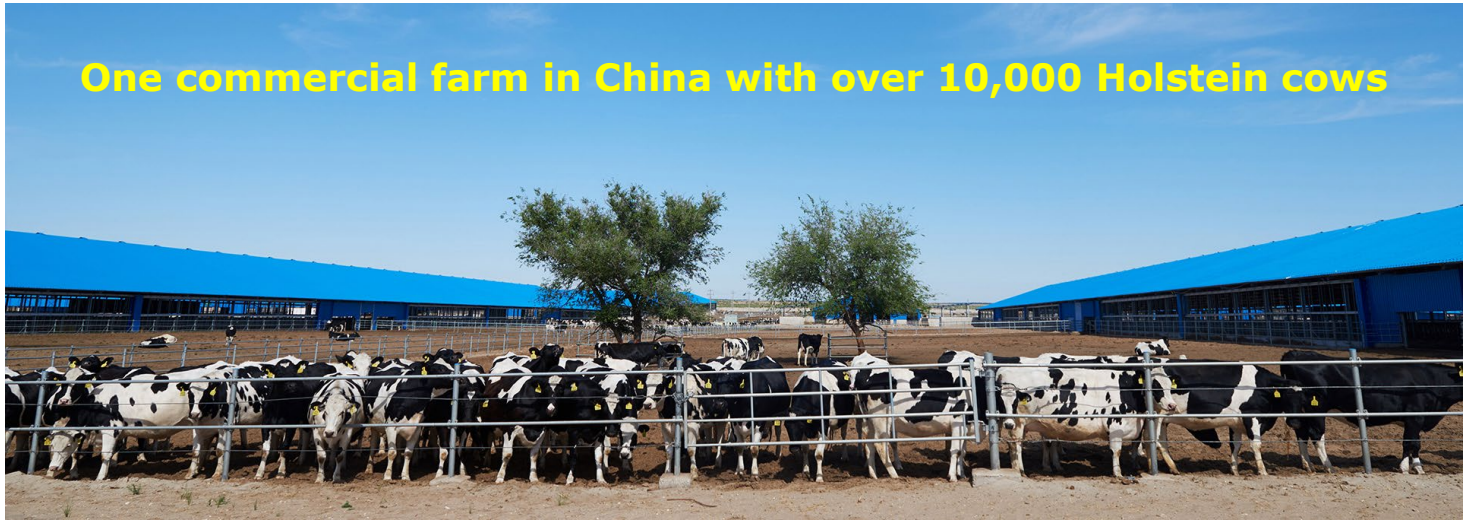
Objectives

① To define resilience indicators based on DRT

② To estimate genetic parameters of DRT-resilience indicators

③ To estimate genetic correlation between DRT-resilience indicators to production, reproduction, and disease performance

Materials



Sensor
(SCR Engineers Ltd)

DRT data was recorded by the SCR tag:

- 9,299 dairy cows ♀ with 14,551 lactations (Parity: 1 ~ 4+)
- 3,075,671 observations
- Recording period: 1~400 DIM (1~100, 250~400 DIM)

Methods

① Obtaining undisturbed pattern

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

② Deviations between real-time and undisturbed DRT patterns

a) LnVar (natural log-transformed Var)

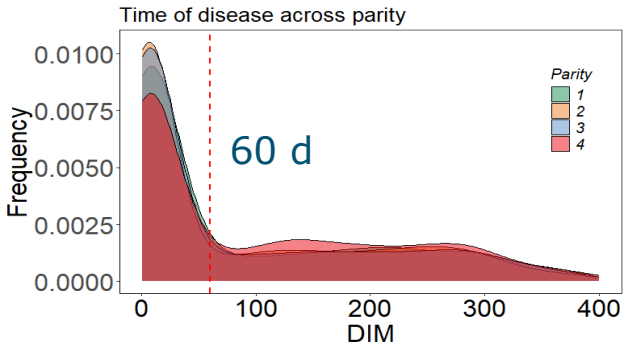
b) Lag-1 Autocorr

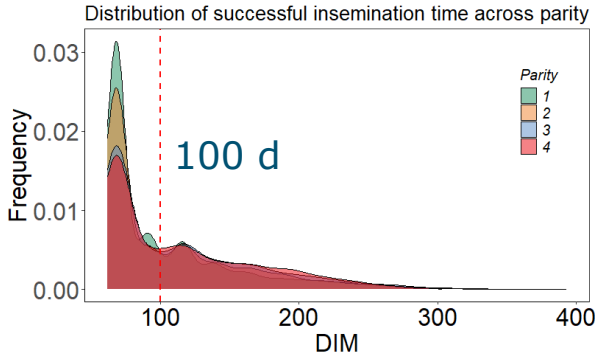
③ Genetic parameters of indicators and their correlations with other traits:

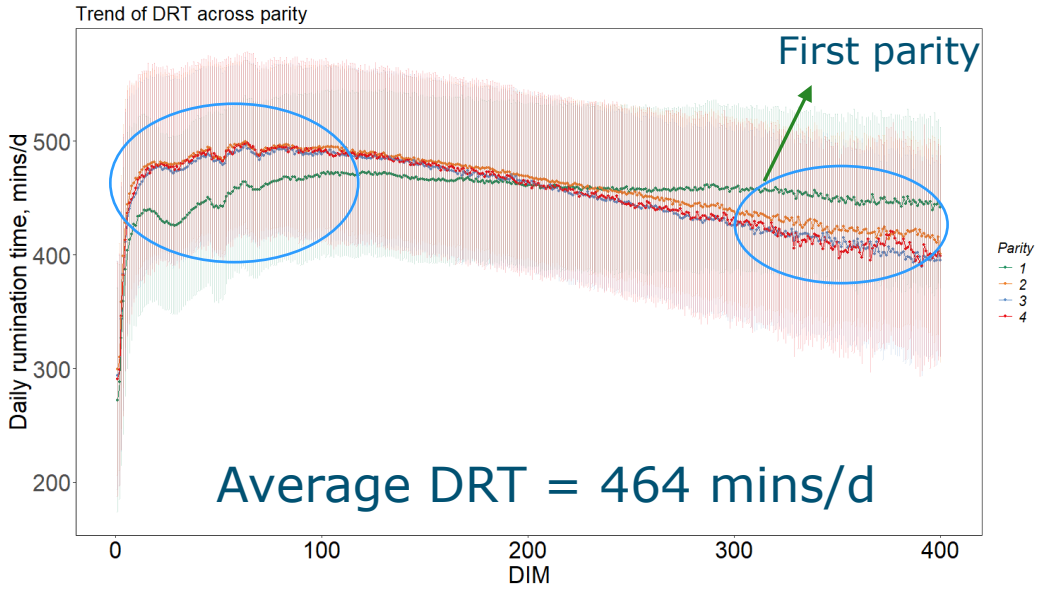
Uni- and bi-variate repeatability animal models

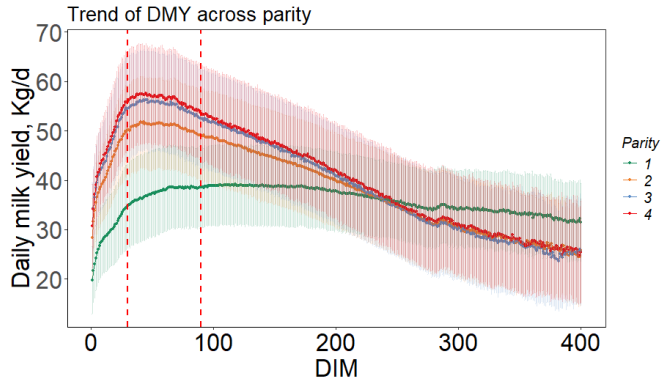
$$y_{ijklm} = BYM_i + CYM_j + Parity_k + a_l + pe_l + \varepsilon_{ijklm}$$

Results: DRT patterns across parities





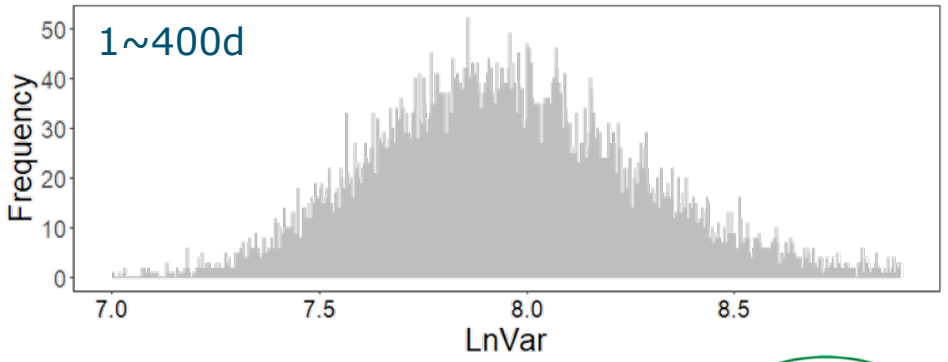


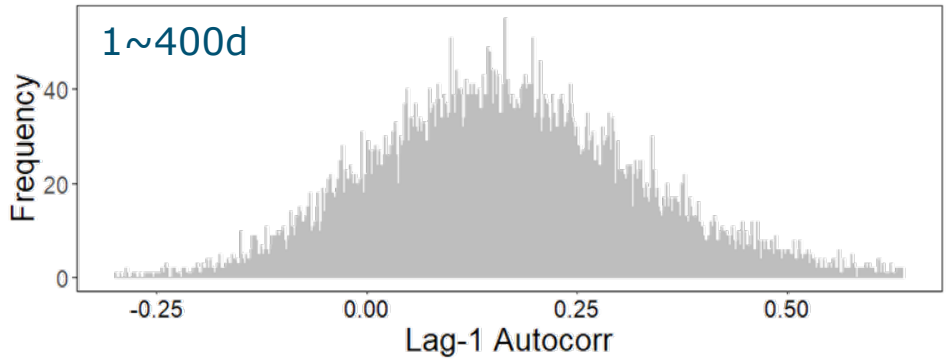


- ✓ Significant fluctuations in the early lactation due to calving, insemination, and disease events
- ✓ These results aligned with other studies, suggesting the data is reliable

Results: ① Resilience indicators

Indicators	Periods	Mean	SD	CV, %
LnVar	1~400 d	7.95	0.31	3.85
	1~100 d	8.11	0.42	5.22
	250~400 d	7.69	0.53	6.91
Lag-1 Autocorr	1~400 d	0.17	0.15	90.89
	1~100 d	0.21	0.22	104.48
	250~400 d	0.03	0.24	735.91





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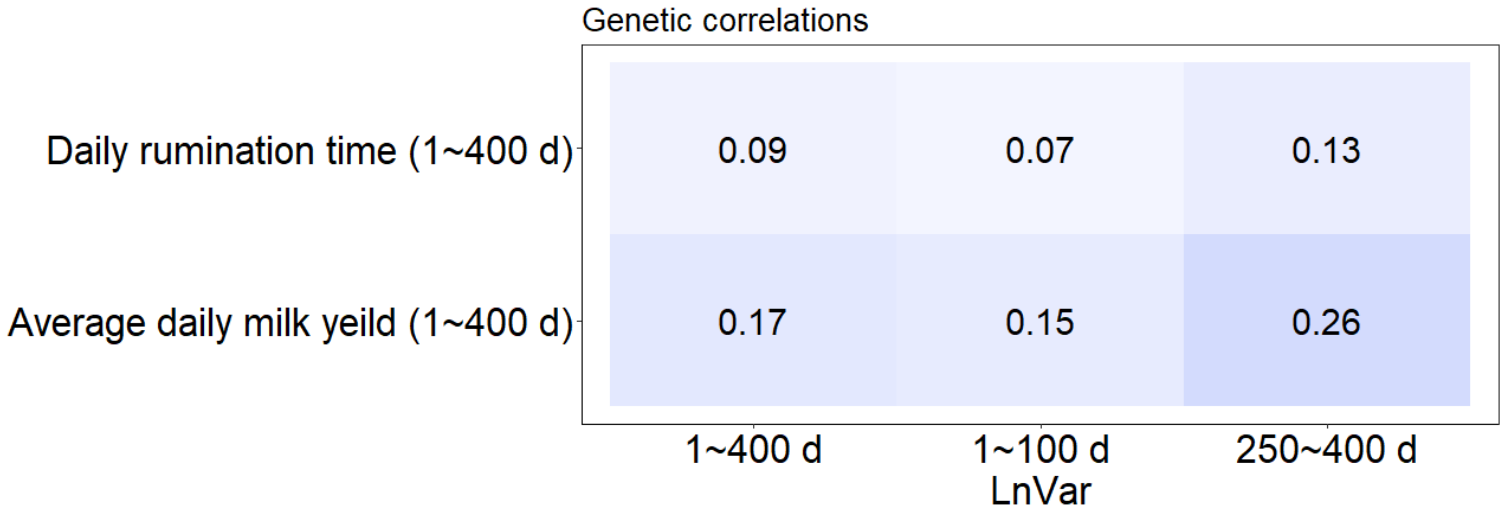
Results: ② Resilience indicators' genetic parameters

Periods	LnVar		Lag-1 Autocorr	
	Heritability	Repeatability	Heritability	Repeatability
1~400 d	0.15 (0.02)	0.32	0.07 (0.01)	0.14
1~100 d	0.06 (0.01)	0.13	0.03 (0.01)	0.05
250~400 d	0.05 (0.01)	0.17	0.02 (0.01)	0.05

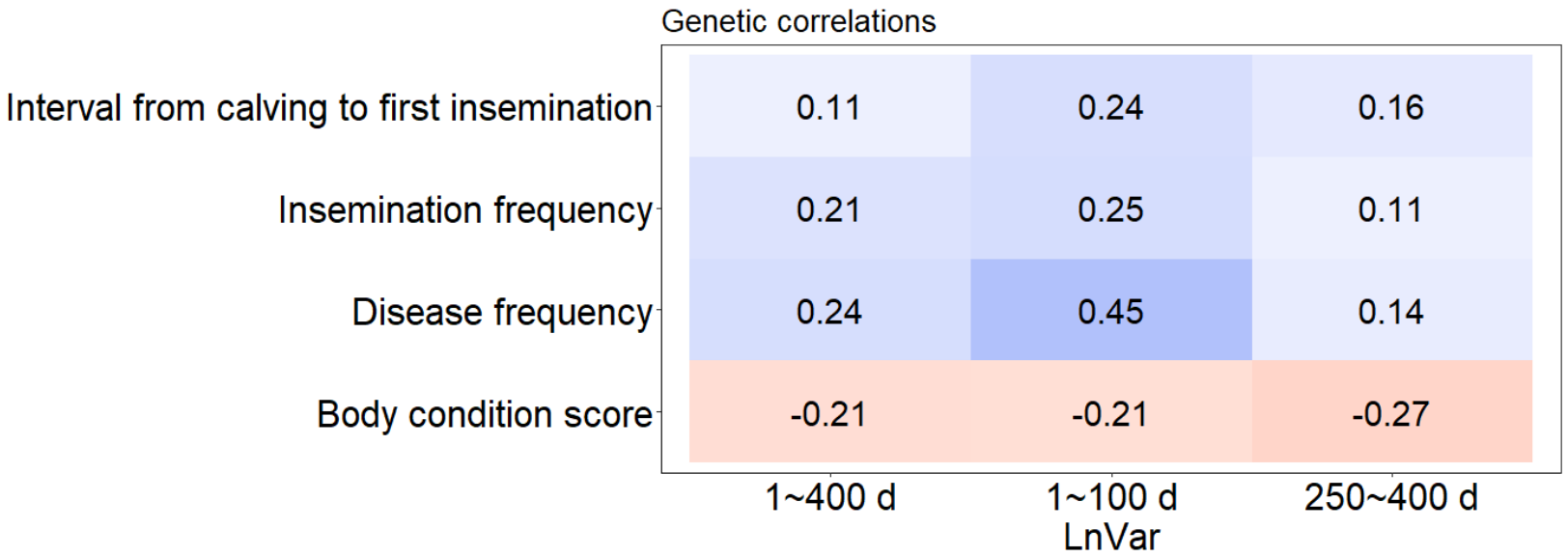
- ✓ Heritability and repeatability were lower during 1~100 and 250~400 d
  - ✓ Due to higher residual variance → Many unknown environmental factors
- ✓ Genetic correlation was 0.16 between two indicators during 1~400 d

Results: ③ Genetic correlations of LnVar with other traits



- ✓ Genetic correlations were close to 0 between LnVar and daily rumination time
- ✓ Positive but low genetic correlations were found between LnVar and average daily milk yield

Results: ③ Genetic correlations of LnVar with other traits



- ✓ LnVar during 1~400 d had a low to moderate genetic correlation (-0.21 to 0.24) with other traits
- ✓ Cow with low LnVar had better fertility, lower disease incidence, and higher body condition score

Take home messages

① Resilience indicators can be derived from daily rumination time patterns in Holstein dairy cows

② Resilience indicators have a low (Lag-1 Autocorr) to moderate (LnVar) heritability, and can be used in breeding

③ Resilient cows tend to have better fertility, higher disease resistance, and higher body condition score

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Thanks for your attention!

Q&A

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