Resilience traits in fattening pigs are heritable and associated with tail biting, lameness and mortality

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Session 28 "Breeding for improved animal health and welfare"

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Background

"A few decades ago, we used to refer to these robustness traits as "secondary traits"—and by now, they have evolved to hot item #1 in livestock breeding"

Quantifying resilience/robustness

- Deviations from longitudinal data trajectories
  - Weight

However, little research has on the link between these new resilience traits with actual resilience indicators

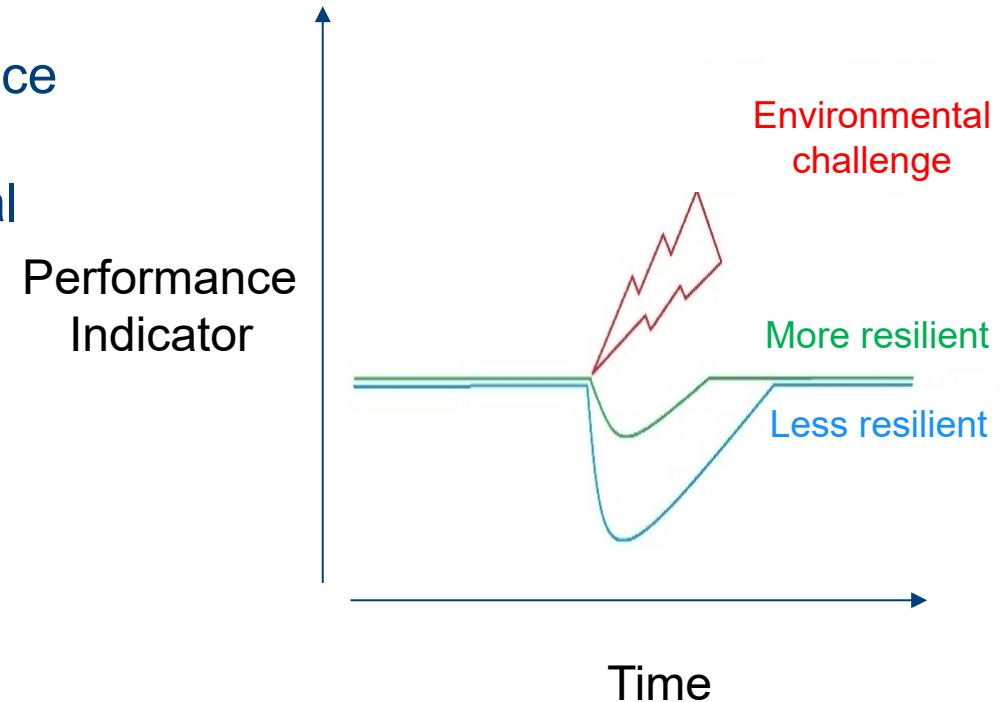 Knap, P. W. (2020). *J. Anim. Breed. Genet.*, *137*(4), 343-344.

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General resilience hypothesis

Animals have a theoretical 'optimal' performance

A challenge will create a deviation from optimal

More resilient animals
- o Less severe deviation
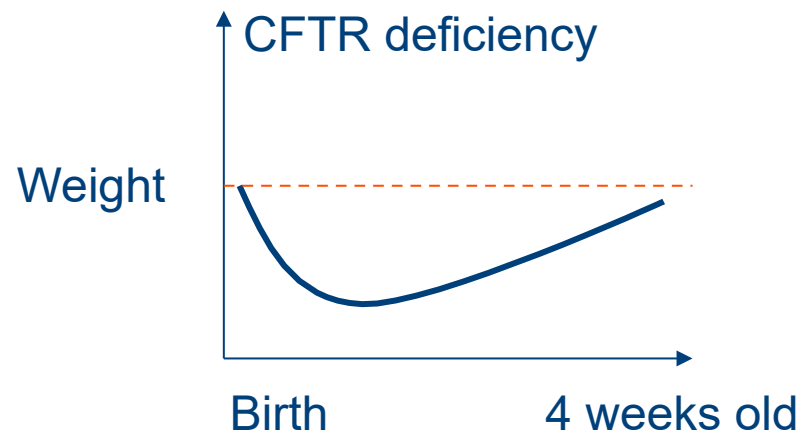- o Quick recovery to optimal state

Performance Indicator

Environmental challenge

More resilient

Less resilient

Time

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Genetic basis of resilience: case example

Annemone Gorssen Winters

Hazel Gorssen Winters

Fullsibs - genotyped
Parents with good breeding value

CFTR deficiency

Weight

Birth   4 weeks old

CFTR normal

Weight

Birth   4 weeks old

No babies were harmed in this experiment, some parents were…

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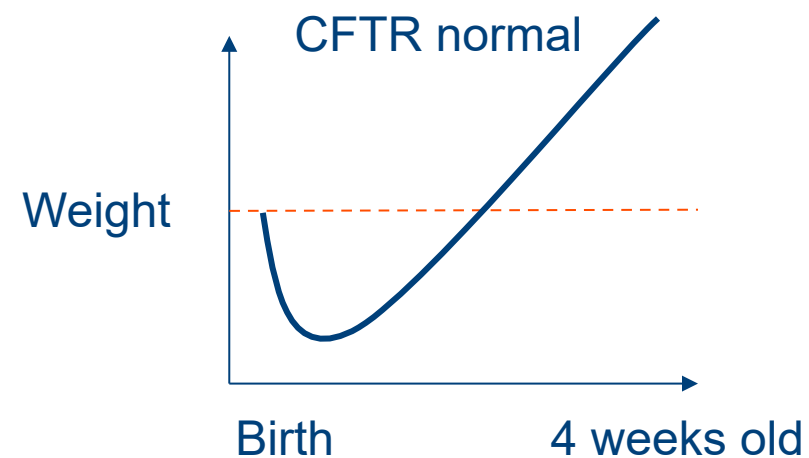
Research objectives

1. Quantify resilience from weight data of growing pigs and resilience indicators

2. Estimate genetic parameters

3. Statistical association between resilience traits and resilience indicators

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Material
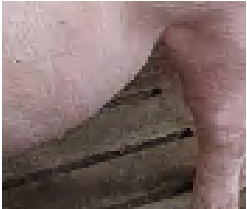
Longitudinal weight data of 1919 growing pigs in experimental farm

- At least one weight record every two weeks during fattening phase
  - 17066 weight records in total (±9 records per pig)
  - Minimum five records per pig
  - Recording of physical abnormalities
- Piétrain sire (N=133) and commercial dam (N=266)

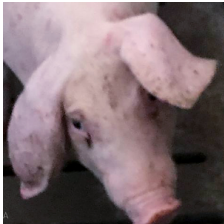# Scoring physical abnormalities

Trait	Normal	Mild-Moderate	Severe
Tail Biting wounds			
Ear Biting Wounds			
Ear Swelling or hematomas			
Umbilical hernia			

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Methods

Quality control and statistical associations via custom R-script

Genetic analyses via remlf90 software: $y = Xb + Za + Wc + e$

- Animal effect (a)
- Fixed effects (b)
  - Sex
  - Parity of the dam
  - Maximum age
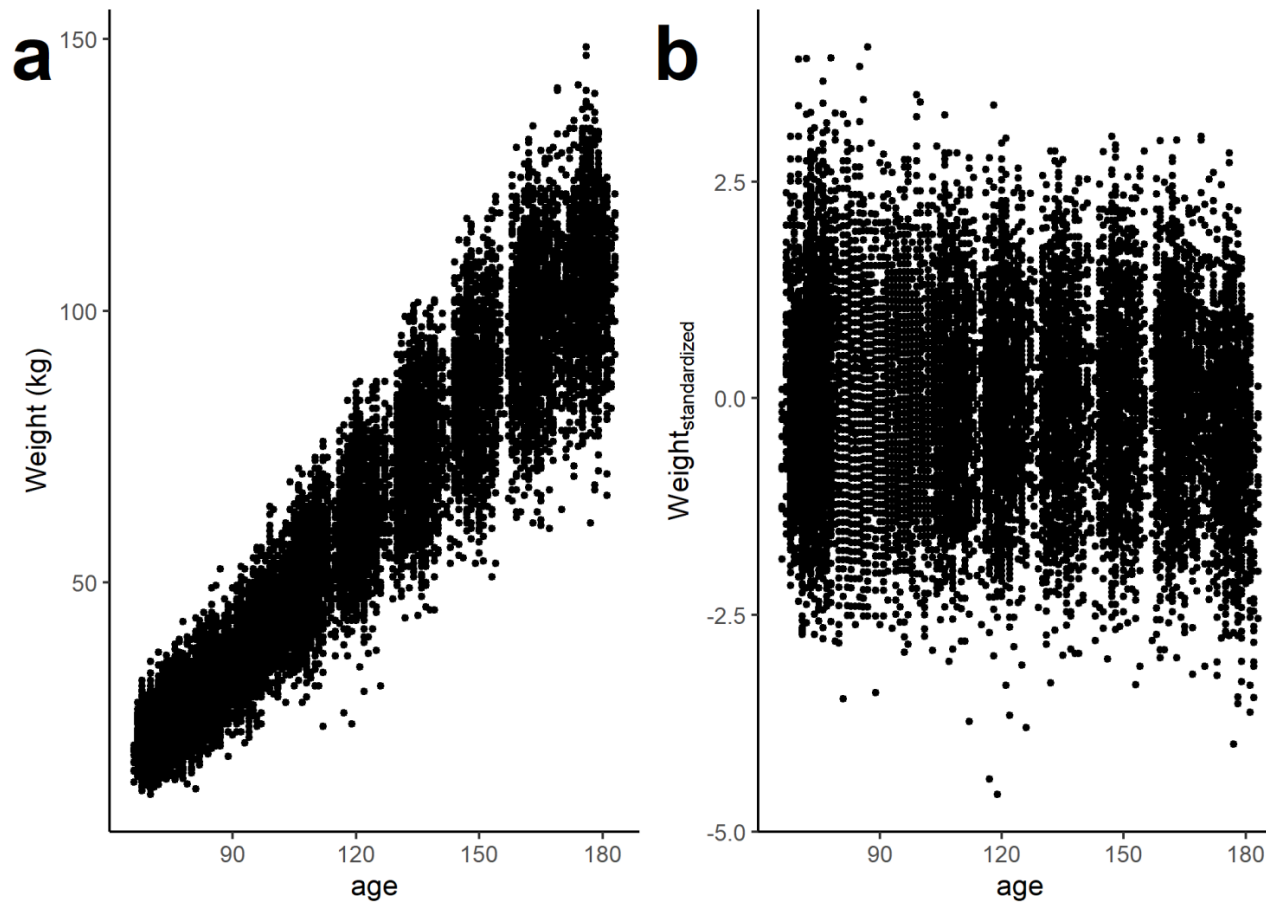 - Mean time between consecutive records
- Pen effect (c)
  - Pen of ±13 pigs (mix of fullsibs and halfsibs)

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Evolution of weight trajectory

Observed weights (a) versus standardized weights per age group (b)

Quantifying resilience from weight data

Deviations of observed vs expected

- Natural logarithm of variance (lnvar)

1. Observed weights vs predicted gompertz weights
   - lnvar$_{weight}$

2. Standardized weights per age
   - lnvar$_{weight\_standardized}$

➜ Higher lnvar, lower resilience

➜ More deviations from optimal performance
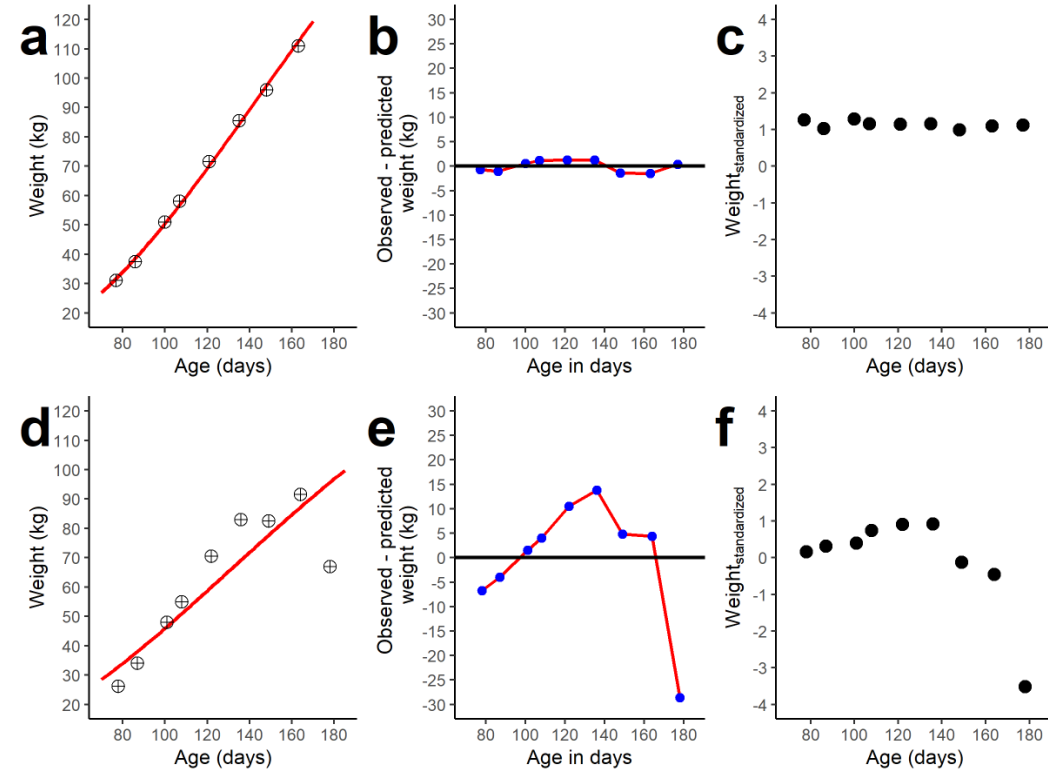
Heritability estimates

Resilience indicators moderately heritable

- o Good prospects for selection

Tail wound and ear wound score low to moderately heritable

- o Large pen effect (c^2)
  - • 53,5% for tail wound score
  - • 24,5% for ear wound score
- ➔ 'outbreak' usually at the pen level

Lameness, umbilical hernia and mortality were lowly heritable

- o Binary traits
- o Low prevalence
- ➔ Can we select on Invar$_{weight}$ and exploit correlated response?

Trait	Heritability (SE)
Lnvar$_{weight}$	36,3 (8,3)
Lnvar$_{weight\ standardized}$	30,6 (10,0)

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Significant associations between weight resilience traits and mortality, lameness and tail wound scores

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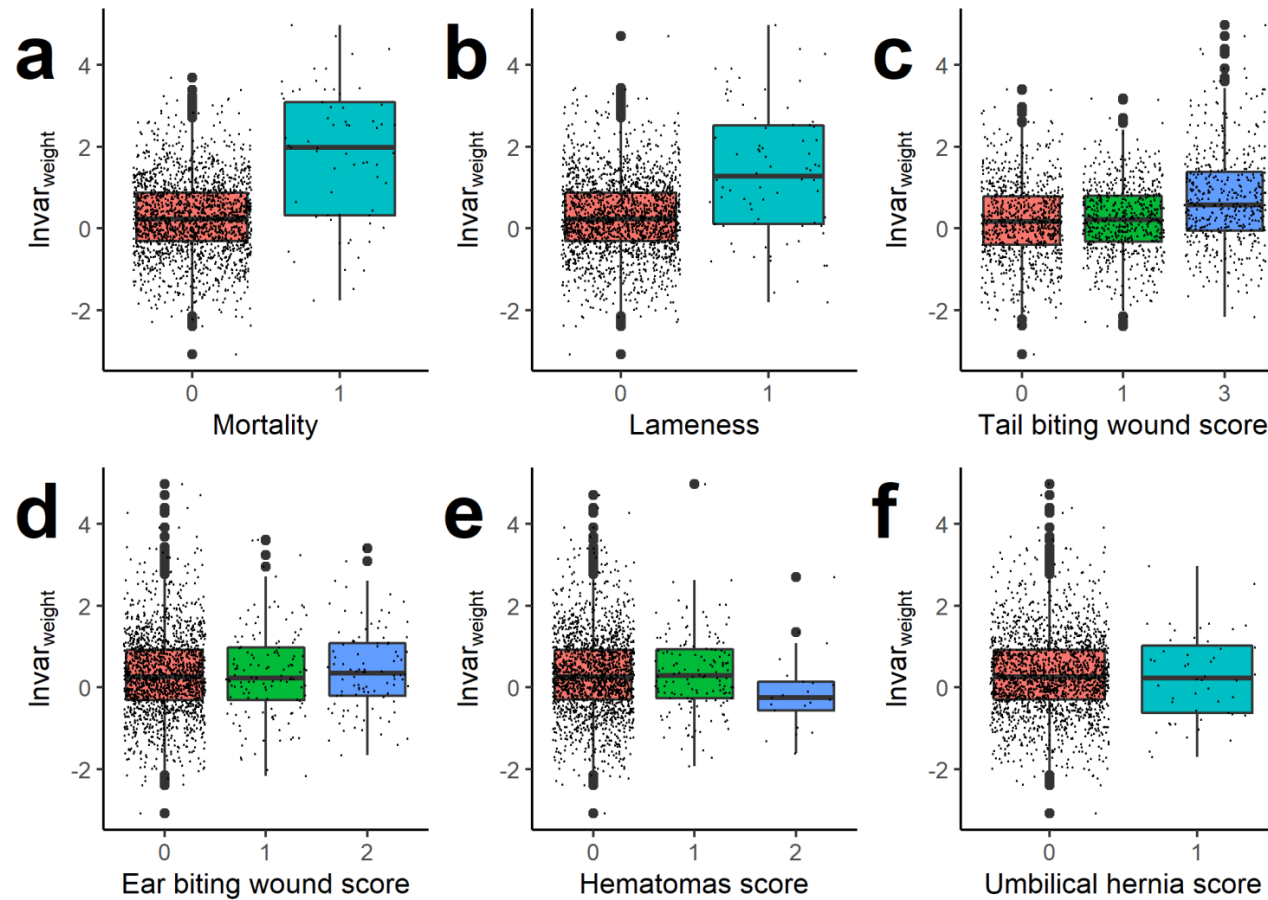
Example of impact of tail biting on weight evolution at pen level
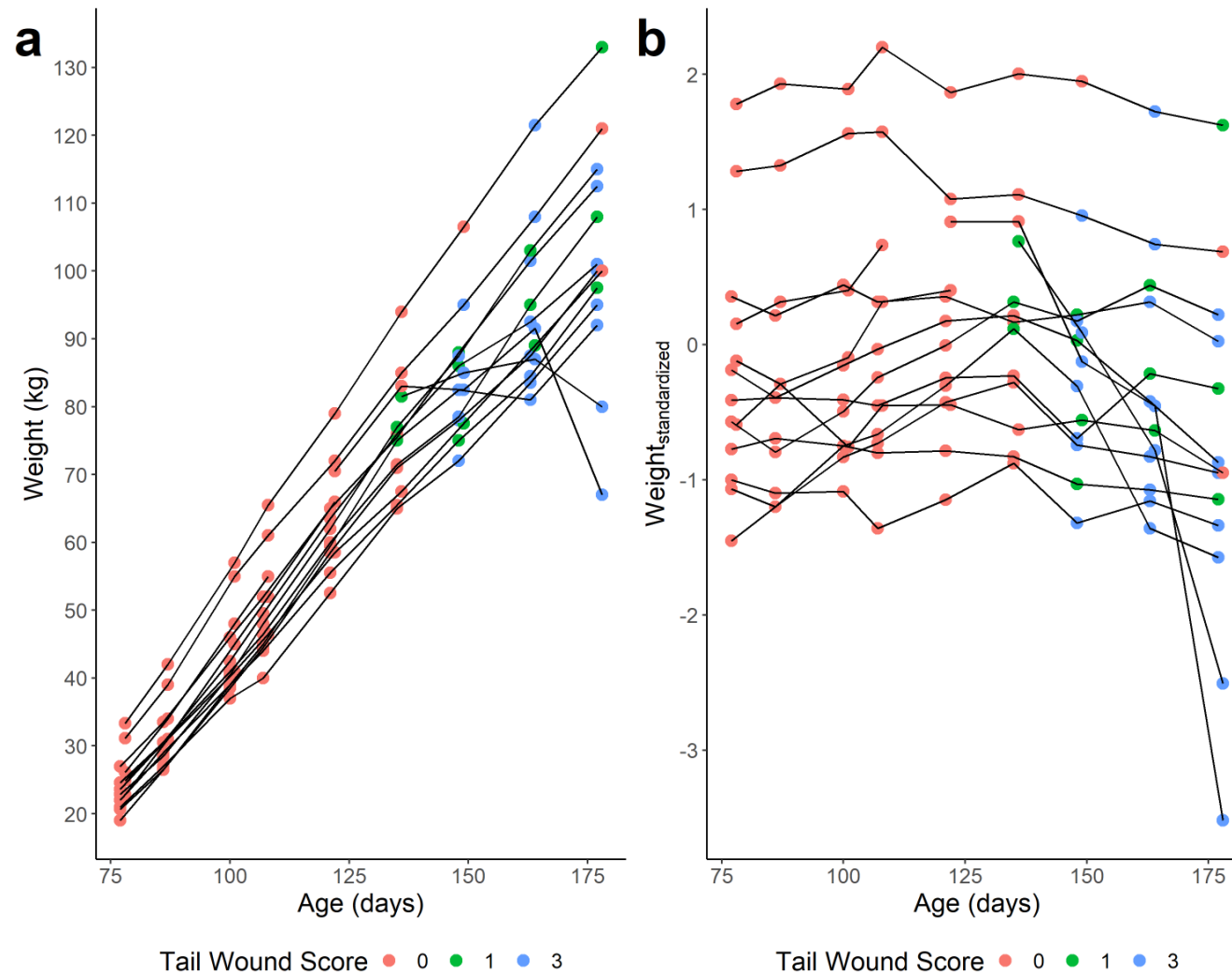
Positive correlations between resilience traits and tail wound scores, mortality and lameness

Selection for resilience traits would decrease incidence of tail biting, mortality and lameness.

Correlation	Lnvar_{weight}		$\text{Lnvar}_{weight\_standardized}$	
	Phenotypic	Genetic (se)	Phenotypic	Genetic (se)
Tail wound	0,21**	0,39 (0,25)	0,09**	0,12 (0,36)
Ear wound	0,02	-0,02 (0,26)	0,06*	0,36 (0,29)
Hematomas	-0,02	-0,38 (0,21)	0,05	-0,04 (0,22)
Lameness	0,12**	0,64 (0,05)	0,19**	0,24 (0,66)
Mortality	0,27**	0,66 (0,07)	0,21**	0,20 (0,09)

*$p<0,01$; **$p<0,001$

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Other evidence for relationship between resilience traits and resilience indicators

Putz et al. (2019)

- o Resilience trait based on daily feed intake
- o Crossbred pigs
- o Natural disease challenge

Positive genetic correlations between resilience traits and mortality ($r_g = 0.37-0.75$) and number of treatments ($r_g = 0.56-0.85$)

Putz et al. (2019). *Frontiers in genetics*, *9*, 660.

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The observation period is crucial for link between resilience trait and resilience traits!

- No clear association found with ear biting wounds and hematomas
  - o In our dataset, these events mainly happened before weight recording in growing phase
  - ➔ Challenge happened mostly before weight recordings
  - ➔ Longitudinal weight data from birth until slaughter might capture these effects!

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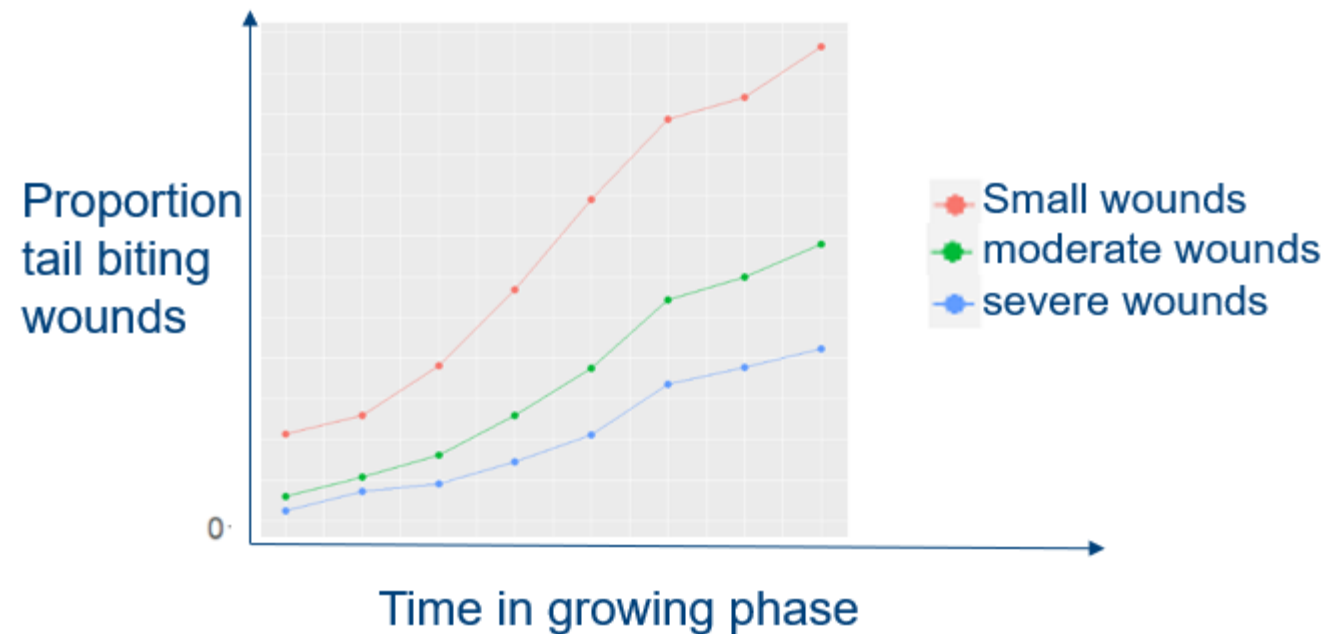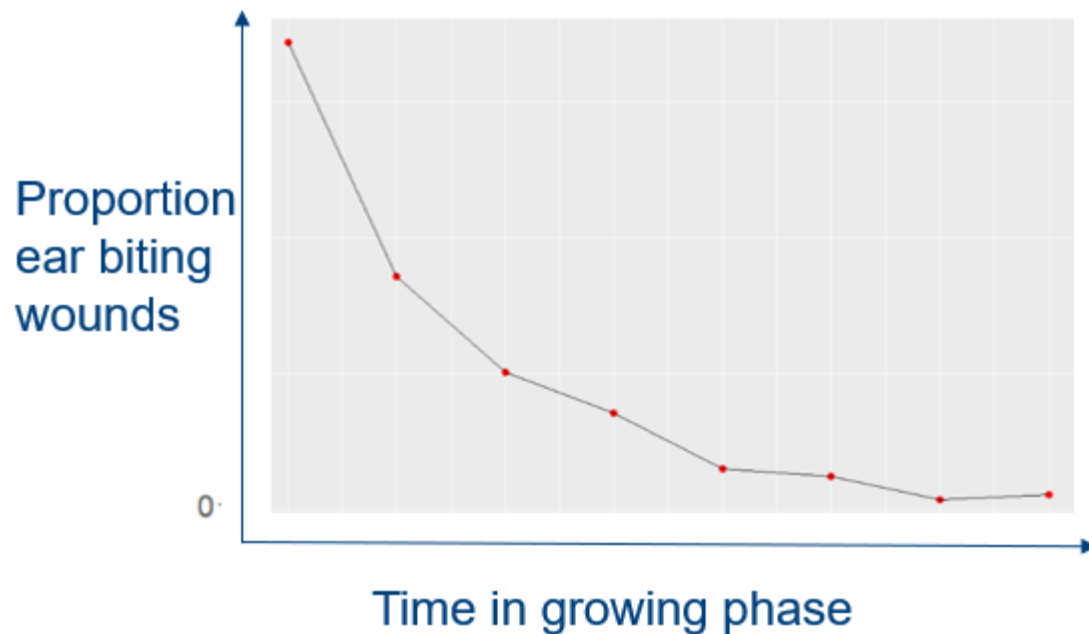
Take-home message

Deviations in longitudinal weight data are moderately heritable

Resilience traits associated with tail biting wounds, lameness and mortality

- Association with specific resilience traits is likely dependend on timing of appearance and weight measurements

Breeding for these resilience traits might offer a practical way to increase pigs' general resilience

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Acknowledgments

o Steven Broekx, Nathalie Cenens, Simon Cardinaels and Hannelore Vermoesen for their help

o Data provider

o Funding

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Thank you for your attention!

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