DETECTING UNRECORDED ENVIRONMENTAL CHALLENGES AND EVALUATING GENETIC DETERMINISM OF RESILIENCE IN LAMBS

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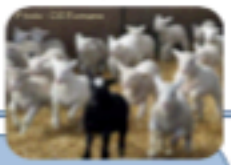


Objectives

1. To present a simple and practical data-driven approach to estimate the probability that at a given date there was an unrecorded environmental challenge occurring, using a mixture model of phenotypic variances.
2. To evaluate genetic determinism of resilience to these events, using these probabilities as covariates in a reaction norm model.
3. To illustrate the method using the example of an ovine dataset with daily feed intake (DFI) records.

Conclusions

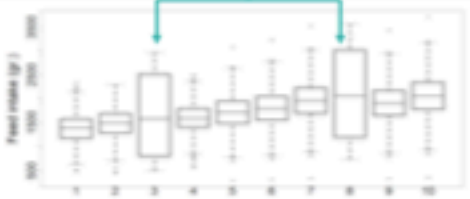
- The method is promising and seems viable to identify unrecorded environmental challenges events, useful when selecting resilient animals and only productive data are available.
- It is general enough to be applied to a wide variety of phenotypic records from different species and useful when dealing with large datasets.
- In the ovine example, the negative correlation between the level and slope shows that a hypothetical selection for increased or decreased DFI would result in increased susceptibility to stress for feed intake.

Introduction

- Resilient animals are capable of remaining productive under different environmental conditions.
- Detection of environmental challenges affecting the entire population can provide a unique opportunity to select animals more resilient to those events.
- Under real productive rearing conditions, challenge events are sometimes unrecorded and from unknown source.
- The effect of environmental challenges on animal performance can be observed indirectly, through changes in variability patterns in repeated records of performance over time.

Method

1. **Fit a mixture model** to raw data. On output, there may be two (or more) components. The component with larger variance is associated to stress or challenge.
2. Include the probability of belonging to the "stressful" component as a covariate in a **reaction norm animal model**.



Example of a boxplot showing two highly variable days in terms of performance.

Ovine dataset analysis

- 951 Romane male lambs, all with the same age (12 weeks).
- Phenotyped for feed intake recorded using automatic concentrate feeders (ACF) at the INRAE Sapinière experimental farm (Osmoy, France).
- Phenotypes were recorded over an 8-year period (2009-2016). All animals within each year were tested under the same environmental conditions, in winter during 8 weeks.
- 51,832 daily feed intake (DFI) records were available.
- 5114 animals in the pedigree.
- Phenotypes (DFI) were analyzed using a linear Reaction Norm Animal Model:

Combination of year and ACF fixed effects.

Regression on the day j to take into account the effect of growing over DFI

p_j is the probability that at day j there was an unrecorded environmental challenge occurring

residual

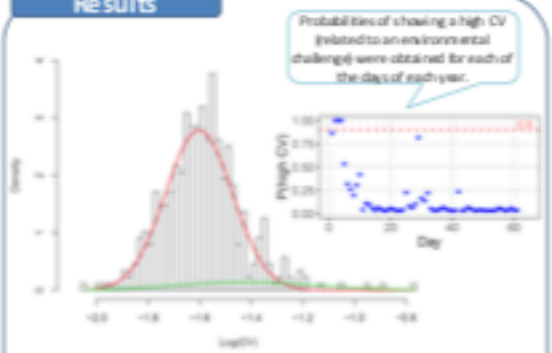
$$y_{ijk} = yearACF_i + b_1 day_j + a_{0,k} + a_{1,k} * p_j + pe_{0,k} + pe_{1,k} * p_j + \epsilon_{ijk}$$

DFI (in kg) in yearACF i, day j for animal k

$a_{0,k}$ = breeding value (BV) for level of DFI, (classical BV, environment-independent)
$a_{1,k}$ = BV for slope (environmental sensitivity) of DFI

$pe_{0,k}$ and $pe_{1,k}$: permanent environmental effects, intercept and slope, respectively

Results



Two component (red and green) normal mixture fitted on the log-transformed CV of DFI.

We estimated probabilities of occurrence of unrecorded environmental challenges.

These probabilities proved to be informative and useful to include as a covariate in a reaction norm animal model.

We estimated BV for environmental sensitivity of the genetic potential for DFI of the animals.

The level and slope showed to be negatively correlated (-0.46 ± 0.21).

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