



RÉPUBLIQUE  
FRANÇAISE

*Liberté  
Égalité  
Fraternité*



# Genetic determinism of resilience to unrecorded challenges in pigs

75th EAAP, 04<sup>th</sup> September 2024, Florence, Italy

Tomasi Tusingwiire

[tomasi.tusingwiire@inrae.fr](mailto:tomasi.tusingwiire@inrae.fr)

PhD student, INRAE, GenPhySE, Toulouse, France

Supervisors: Zulma Vitezica, Celine Carillier and Catherine Larzul

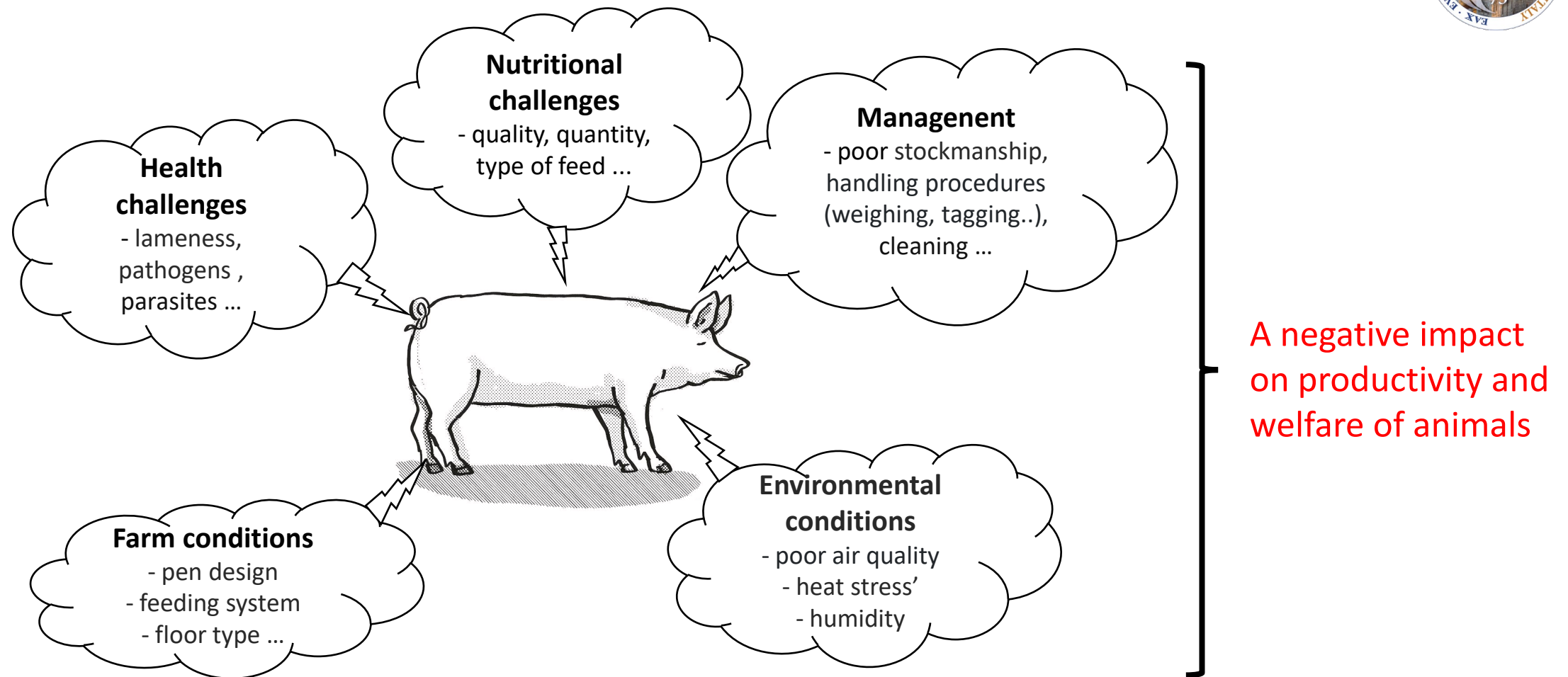


Nucléus  
L'innovation pour l'excellence





- Pigs in selection farms live under a monitored and controlled environment





- In real production conditions, some of these factors and their **origin** are **unknown**
- We need to select “**resilient**” pigs – Pigs that are able to maintain their performance under variable environmental conditions

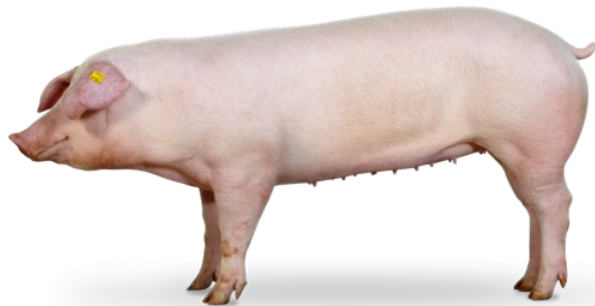
## Objectives

- To estimate the probability that on a given day, there was occurrence of an unrecorded challenge
- To evaluate the genetic determinism of resilience to such events

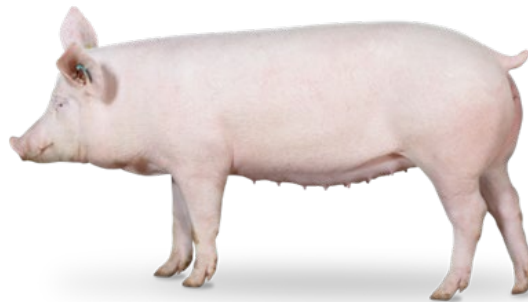


## Pig data

- Data were from Landrace (LA), Large White (LW), and Piétrain (PI), male pigs
- Groups of 10 to 14 animals per pen, same age and weight (~30 kg until ~100 kg)
- Each pen was equipped with an automatic concentrate feeder (ACF)
- Each pig was tagged with a radio-frequency identification (RFID) tag
- Animals in each batch stayed in the pen for about 10 weeks, LW stayed longer (~10 days)



Landrace



Large White



Piétrain



## Pig data

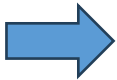
- ACF recorded feed consumed by each animal on each visit
- Seven days of free access to the ACF (“adaptation period”)
- All records of each animal on each day were summed up to obtain daily feed intake (DFI)
- Compute (natural logarithm of) daily coefficient of variation (CV) of DFI per batch



Photo credit: NUCLEUS



Data structure for visit records (Vi) and daily feed intake (DFI, kg) in 3 pig lines

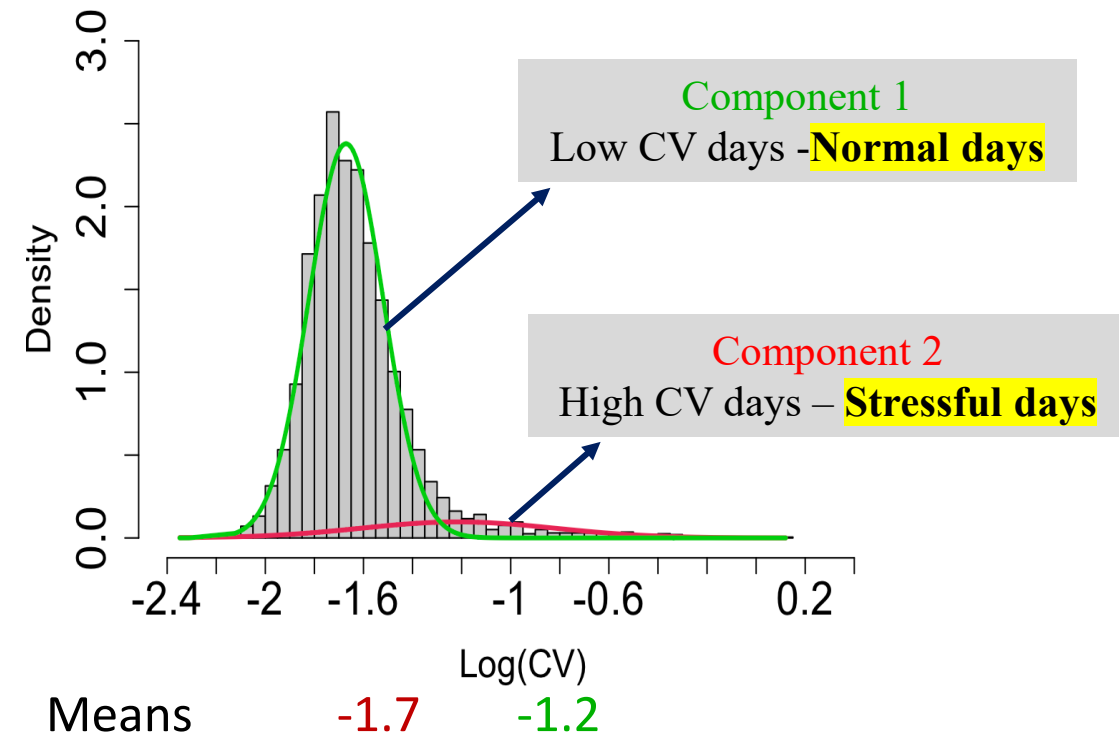
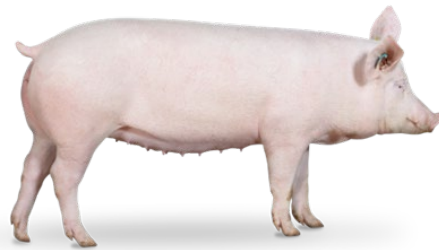


| Breed | Animals in datasets | Number of Vi | Mean Vi (SD) | Number of DFI records | Number of batches | Animals in pedigree |
|-------|---------------------|--------------|--------------|-----------------------|-------------------|---------------------|
| LA    | 1,618               | 2,750,259    | 27.0 (20.2)  | 100,799               | 24                | 3,730               |
| LW    | 2,517               | 9,901,187    | 53.0 (24.2)  | 186,247               | 53                | 5,649               |
| PI    | 4,788               | 6,219,930    | 20.4 (15.5)  | 304,826               | 74                | 9,293               |

- On average, LW has twice as many visits per day than PI or LA
- Only results for LW will be presented

## Estimation of probabilities

- A Gaussian mixture model was fitted for the data consisting of values of  $\log(\text{CV})$  of DFI (3944)<sup>1</sup>
- R package mixtools
- Probabilities (p) of being a “**stressful**” day (**high CV**) or not
- The p for high CV are associated to the occurrence of a challenge<sup>1</sup>



<sup>1</sup>Garcia-Baccino et al., 2021

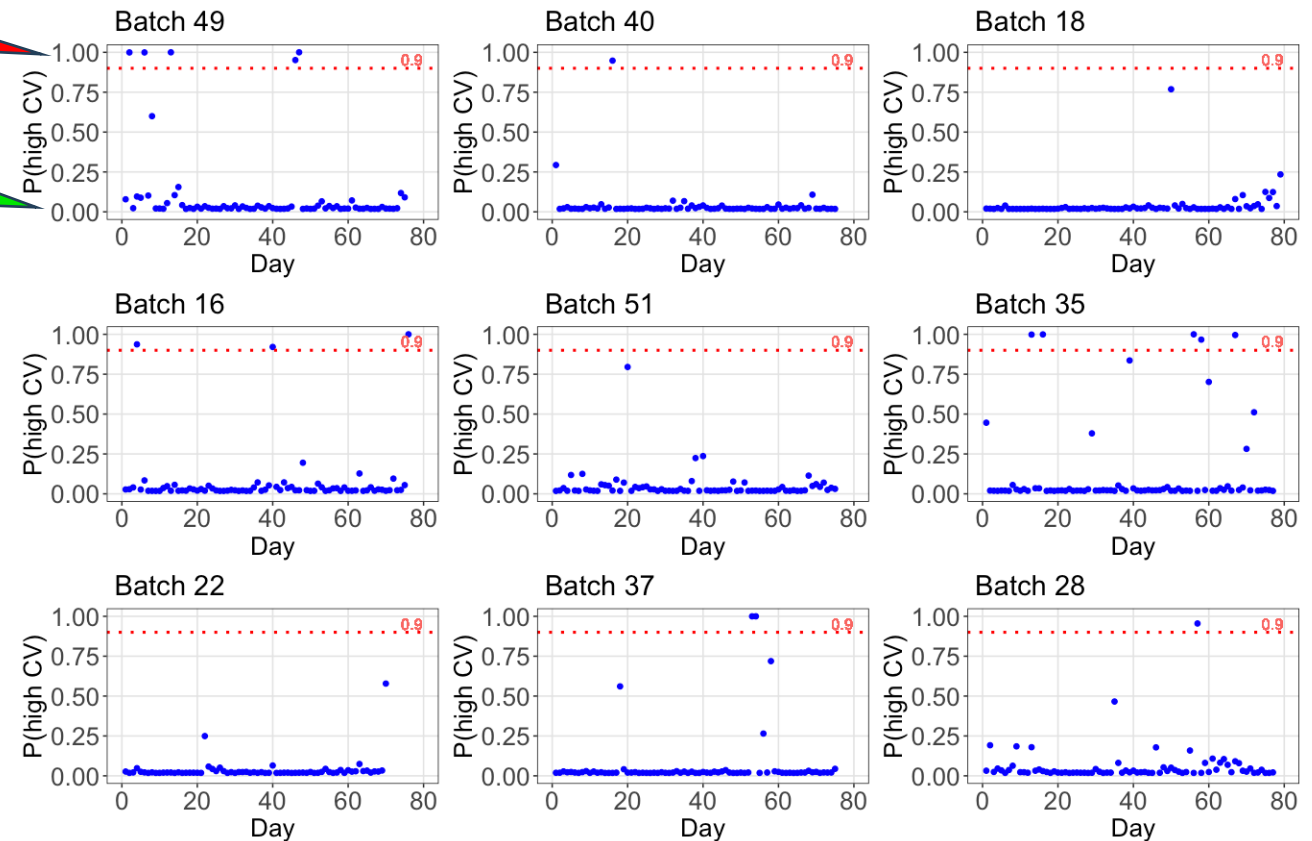


## Probabilities of the occurrence of an environmental challenge

- Mean probability of stressful days=0.10
- ✓ Most of the days were not stressful
- ✓ For the stressful days:
  - Human interventions, Eartagging, tail biting, illness, problem with legs, were some of the activities recorded on some high CV days
- However, some high CV days have no explanation!

Highly Stressful

Less stress





## Genetic analysis

- The probability of the occurrence of a challenge were used as a covariate in a reaction norm animal model (RNAM).

$$y_{ijk} = X_i\beta + a_{0,k} + a_{1,k} * p_j + pe_{0,k} + \dots + e_{ijk}$$

Diagram illustrating the components of the reaction norm animal model (RNAM) equation:

- DFI** (Days from Infection) is associated with  $X_i\beta$ .
- Day, ACF and batch** is associated with  $X_i\beta$ .
- Breeding value (intercept)** is associated with  $a_{0,k}$ .
- Enviromental sensitivity (slope)** is associated with  $a_{1,k}$ .
- Probability of the ocurrence a challenge** is associated with  $p_j$ .
- Permanent environmental effect** is associated with  $pe_{0,k}$ .

- Estimates were obtained with AIREML method (BLUPF90+ software)
- Another animal model (AM) without reaction norms was fitted for comparison



## Genetic parameter estimates

### Model comparison

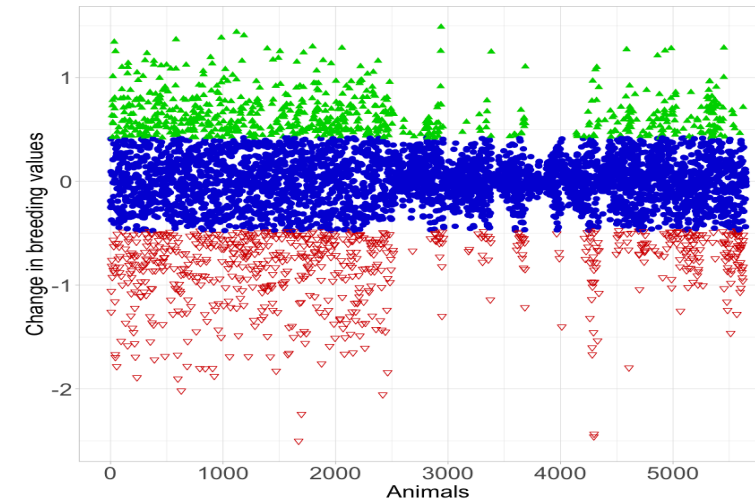
|                   |          |           |
|-------------------|----------|-----------|
| -2 Log likelihood | AM       | 248457.25 |
|                   | RNAM     | 243363.55 |
| LRT               | $\chi^2$ | 5093.70   |
|                   | P-value  | p<0.0001  |

- Log(CV) of DFI is a valid indicator for the genetic analysis and may be of **value to select for resilience**
- Low genetic correlation between the intercept and the slope suggests that:
  - hypothetically selecting for decreased DFI would **have a minimal effect** on the animal's sensitivity to environmental conditions

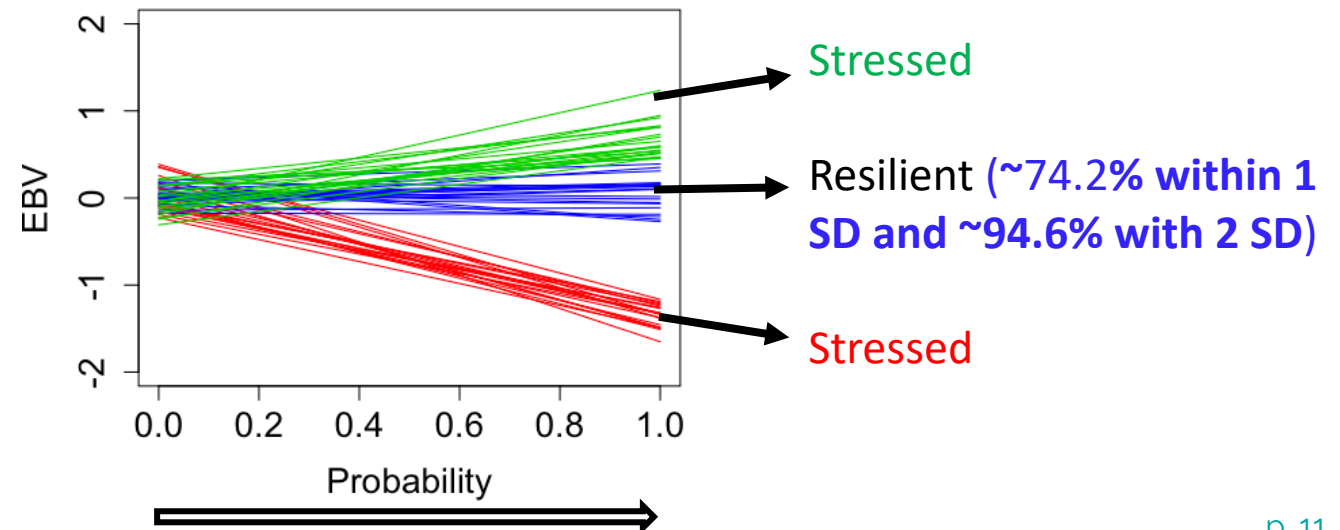
| Parameters          | Model  |                     |
|---------------------|--------|---------------------|
|                     | AM     | RNAM                |
| $\sigma^2_{a0}$     | 0.0471 | 0.046               |
| $\sigma^2_{a1}$     | -      | 0.080               |
| $\sigma_{a0,a1}$    | -      | 0.003               |
| $\sigma^2_{pe0}$    | 0.0259 | 0.027               |
| $\sigma^2_{pe1}$    | -      | 0.200               |
| $\sigma_{pe0, pe1}$ | -      | -0.019              |
| $\sigma^2_e$        | 0.2200 | 0.203               |
| $r_{g(a0,a1)}$      | -      | <b>0.056 ± 0.13</b> |

## Identification of resilient animals

- **Change in EBV** from a non stressful environment to a stressful environment
  - **red**: animals with EBV that decrease
  - **blue**: animals with EBV that tend to remain approximately constant
  - **green**: animals with EBV that increase for higher values of p



20 randomly selected animals from each group





## Some conclusions

- We identified unrecorded challenges in selection farms in pigs using DFI
- Probabilities of high CV can be used in selection for resilience
- Most of the days had a **low probability** of the occurrence of a challenge
- Most of the animals were identified as **resilient pigs**
- Low genetic correlation between the intercept and the slope of DFI
- A hypothetical selection for decreased DFI would have a **minimal effect on the animal's sensitivity** to challenging conditions
- Even though pigs are reared in better controlled breeding systems than ruminants, resilience is still necessary, and in this study we have provided some tools for selection for resilience

# Acknowledgement



[tomasi.tusingwiire@inrae.fr](mailto:tomasi.tusingwiire@inrae.fr)



Photo credit: Zulma Vitezica

Thank you very much for your attention!

INRAE

04<sup>th</sup> September 2024

EAAP Congress 2024, Florence, Italy