The Life-Functions Ratio: a new indicator trait of trade-offs to go beyond genetic correlations

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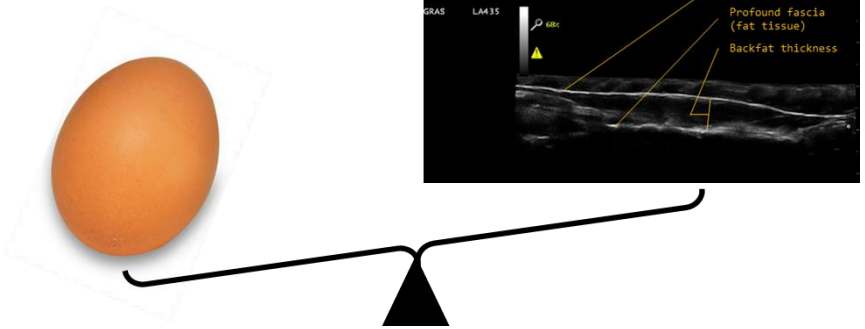

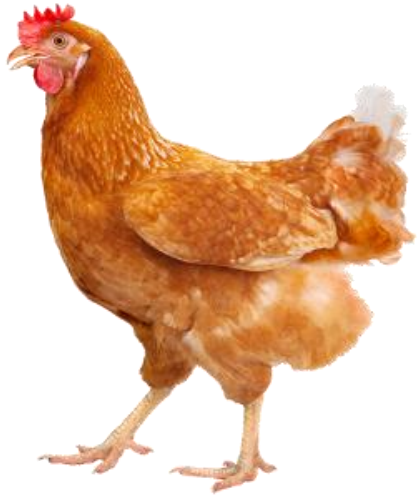

The Life-Functions Ratio: a new indicator trait of trade-offs to go beyond genetic correlations

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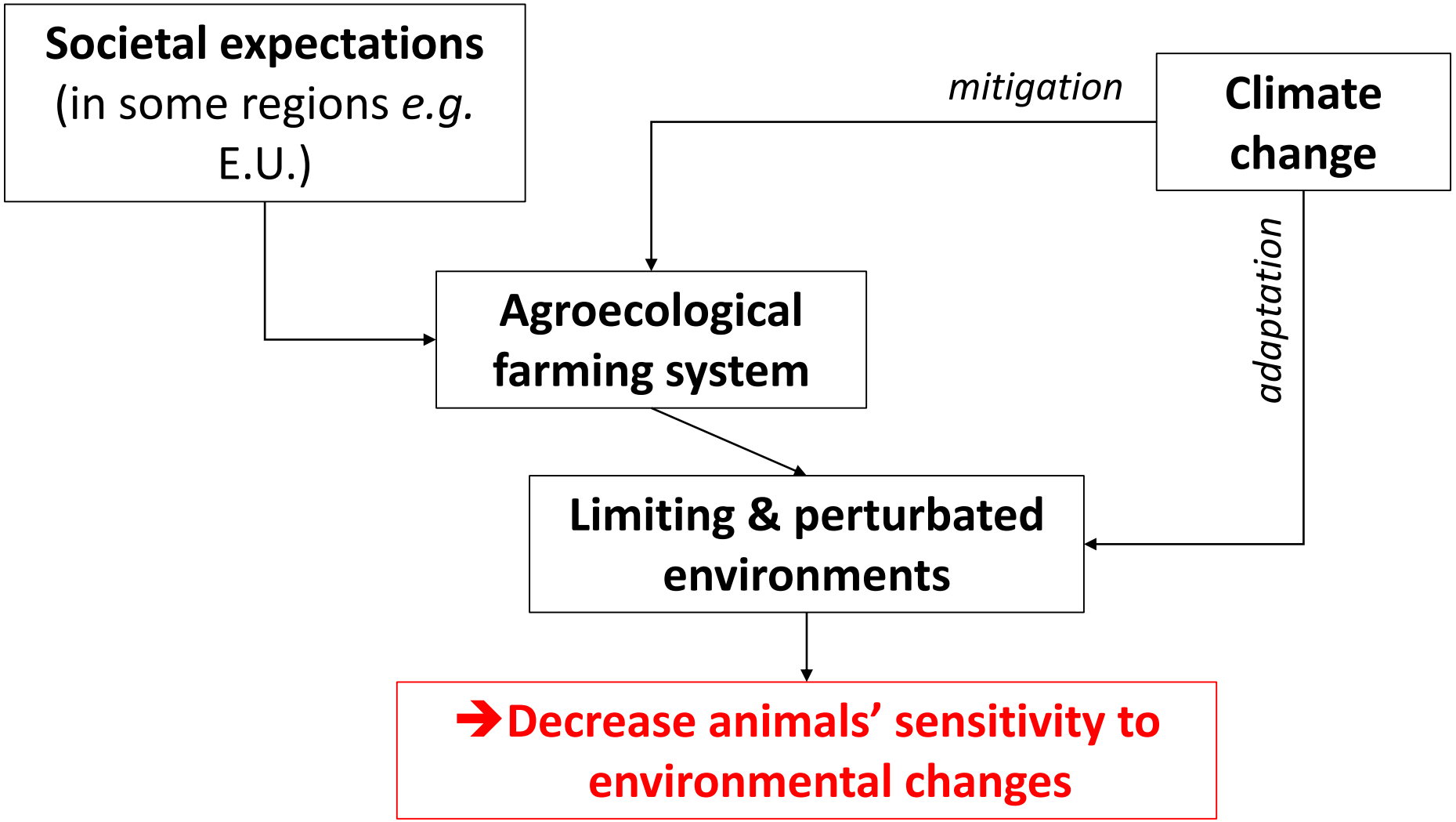
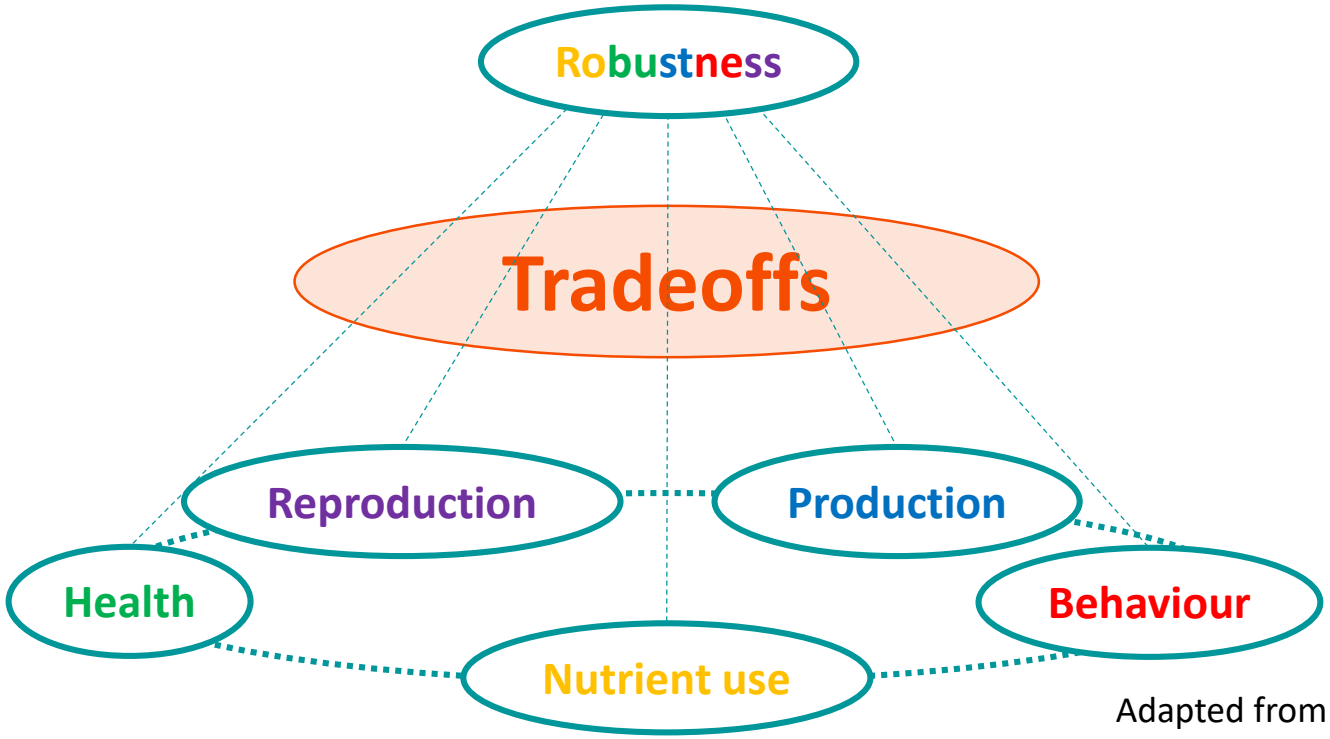
Animals need to cope with environmental perturbations



Acting on tradeoffs to improve robustness

A way to look at environmental sensitivity = Robustness:

multi-performance in **multiple environments**



➔ Genetic improvement of multi-performance:

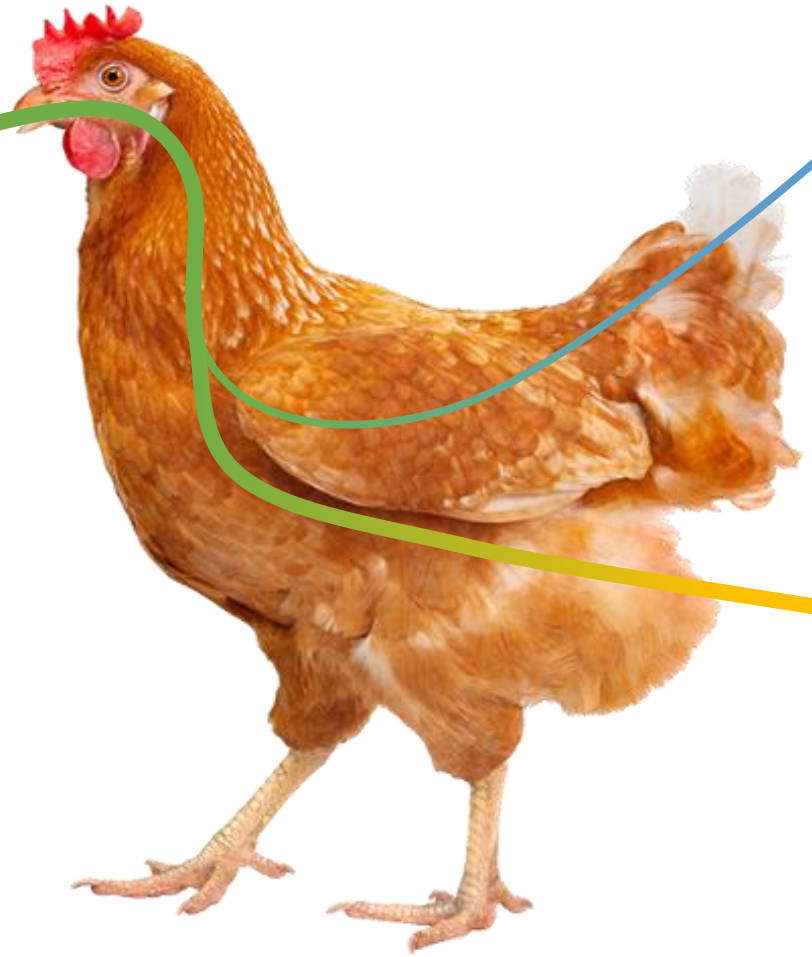
- selection index
- global criterion (e.g. functional longevity)
- tradeoff

Adapted from Friggens et al. (2017)

What is a tradeoff?

Difficult question! Depends a lot on the scale (cell to regions) and on the field (genetics to economics).
A collective expertise in INRAE (Network Compromis, Metaprogram SANBA) confirmed.

Intake



Body reserves

Eggs

Genetic correlation

☺ = genetic share of the 2 traits

☹ = population

Tradeoff and resource acquisition and allocation

Difficult question! Depends a lot on the scale (cell to regions) and on the field (genetics to economics).
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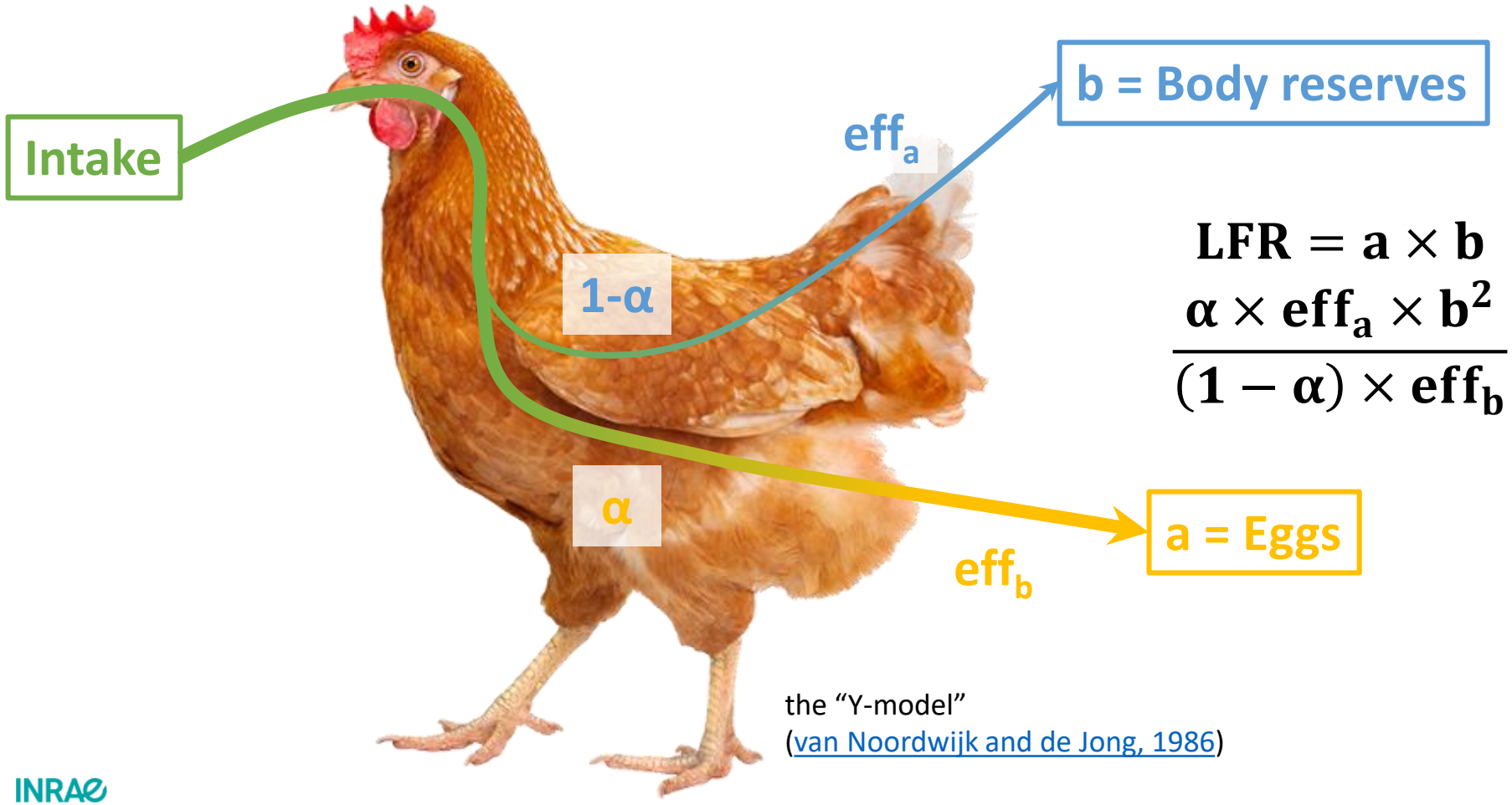


$$LFR = a \times b$$

$$\frac{\alpha \times eff_a \times b^2}{(1-\alpha) \times eff_b}$$

the “Y-model”
(van Noordwijk and de Jong, 1986)

Questions ! AND Answers ?

What is the genetic architecture of tradeoff between eggs and body reserves?

- Genetic parameters

$h^2 = 0.31$

- QTL detection

We identified 3 QTLs

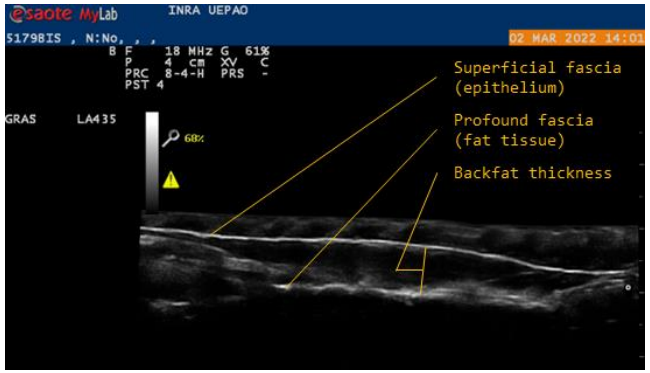
What is the genetic relationship between tradeoff, allocation, and the original traits?

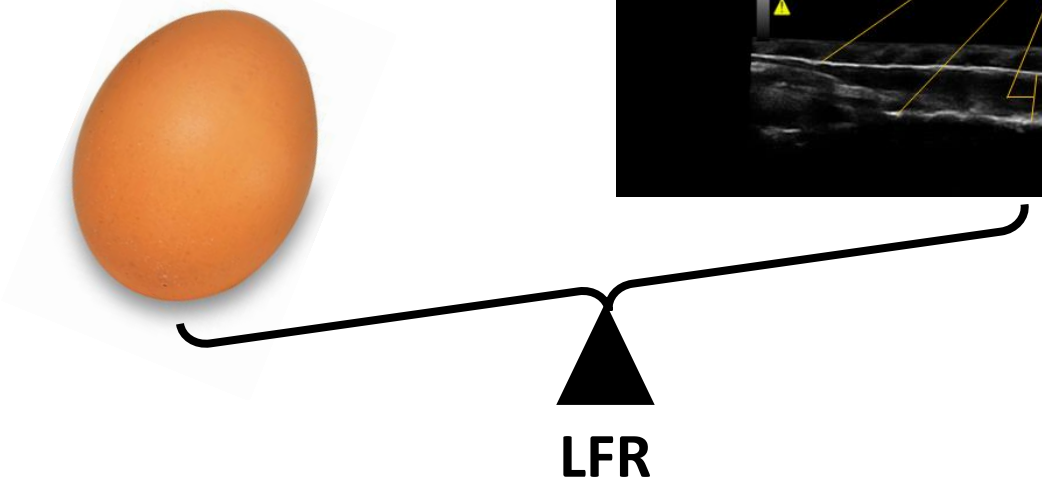
LFR was highly correlated with original traits ($r_g > 0.60$)
LFR was little correlated with α ($r_g = 0.02$)

Materials

Rhode Island line of Novogen (Nucleus + experimental supplement):

- 3 related batches from 2020 to 2022 (n=2,016 hens)
- Genotyped with a 60k SNP bedchip
- Phenotypes recorded (80 wks of age):
  - Egg Number
  - Backfat thickness (ultrasonography)
- Phenotype calculated : LFR





Methods

Variance components estimation with ASREML 4.2:

- Fixed effect of the batch
- Random effects: additive genetic effect (pedigree relationship matrix) and residuals

GWAS with Muller:

Same model with:

- BLUP (fixed additive genetic variance)
- Additional fixed effect: SNP (regression)

Genetic parameters

	α	LFR	Backfat	Eggs
α	**0.18 (0.05)**			
LFR	-0.02 (0.20)	**0.31 (0.07)**		
Backfat	-0.63 (0.13)	0.78 (0.07)	**0.44 (0.07)**	
Eggs	0.59 (0.13)	0.62 (0.11)	0.12 (0.18)	**0.13 (0.04)**

LFR displayed:

- Moderate heritability ➔ room for genetic improvement
- Highly correlated with backfat and eggs ➔ good tradeoff trait
- Not correlated with allocation coefficient ➔ LFR and α relate to different aspects of tradeoff

Genome Wide Association Study

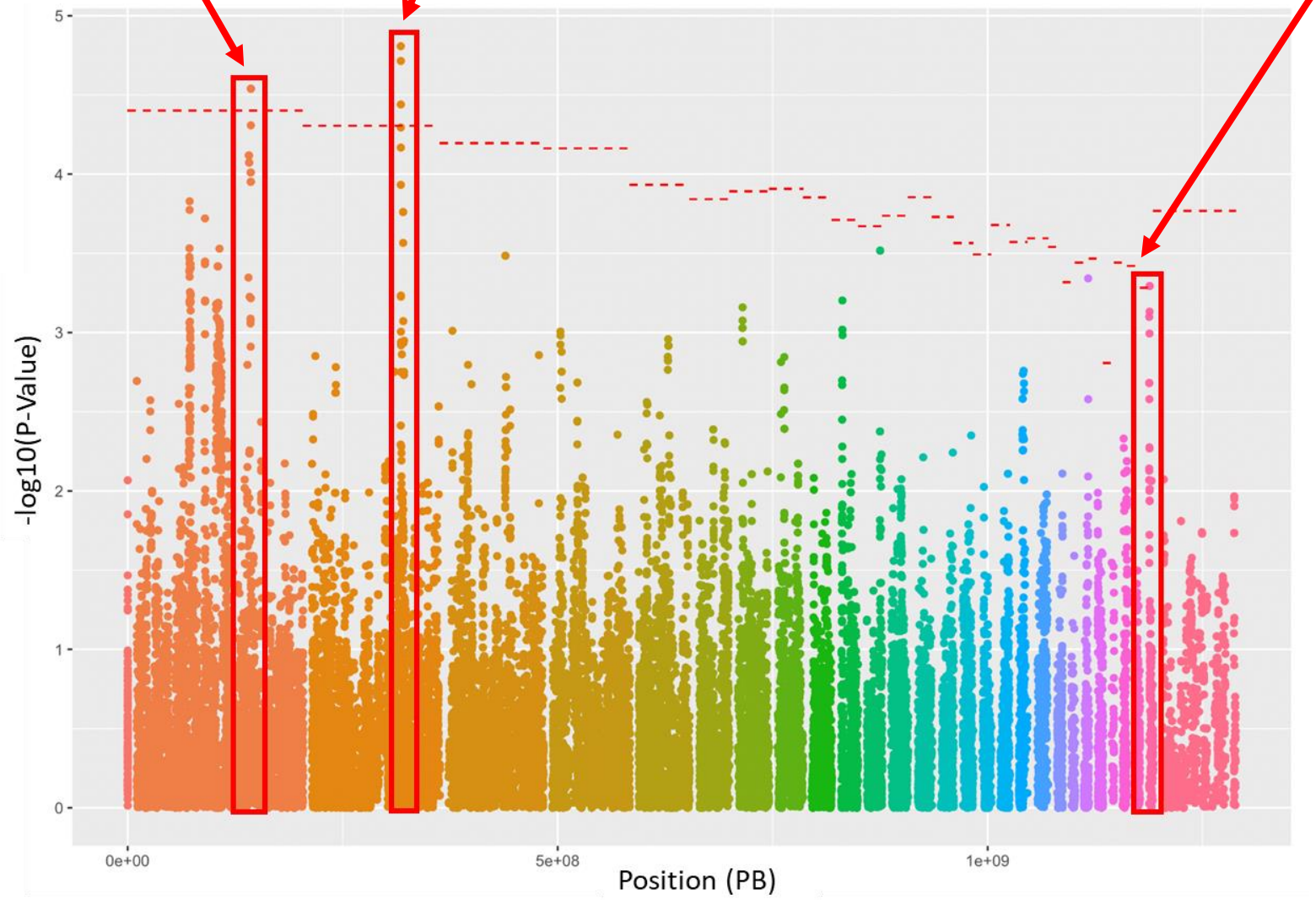
Carbohydrate sulfotransferase 10

energy metabolism
oestrogens

Long non coding RNA

RAN bind protein 3

energy metabolism



Thanks for your attention

What is the genetic architecture of tradeoff between eggs and body reserves?

- Moderate heritability (0.31) ➔ room for genetic improvement
- Highly correlated with backfat and eggs ➔ good tradeoff trait

What is the genetic relationship between tradeoff, allocation, and the original traits?

- Not correlated with allocation coefficient ➔ LFR and α relate to different aspects of tradeoff