Using digestive efficiency to improve feed efficiency in pig breeding schemes

Vanille Déru[1,2], Marie-José Mercat[3], David Picard[3], Bruno Ligonesche[4], Loïc Flatrès-Grall[5], Florence Ytournel[6], Florian Herry[6], Joël Bidanel[3], Maxime Banville[3], Hélène Gilbert[2]

vanille.deru@inrae.fr

[1] Alliance R&D, 35651 Le Rheu, France

[2] INRAE, 31320 Auzeville-Tolosane, France

[3] IFIP-Institut du Porc, 35651 Le Rheu, France

[4] Nucléus SAS, 35650 Le Rheu, France

[5] Axiom, 37310 Azay-sur-Indre, France

[6] Choice Genetics, 35170 Bruz, France

EAAP Annual Meeting, Lyon, France, August 28

Context of the study

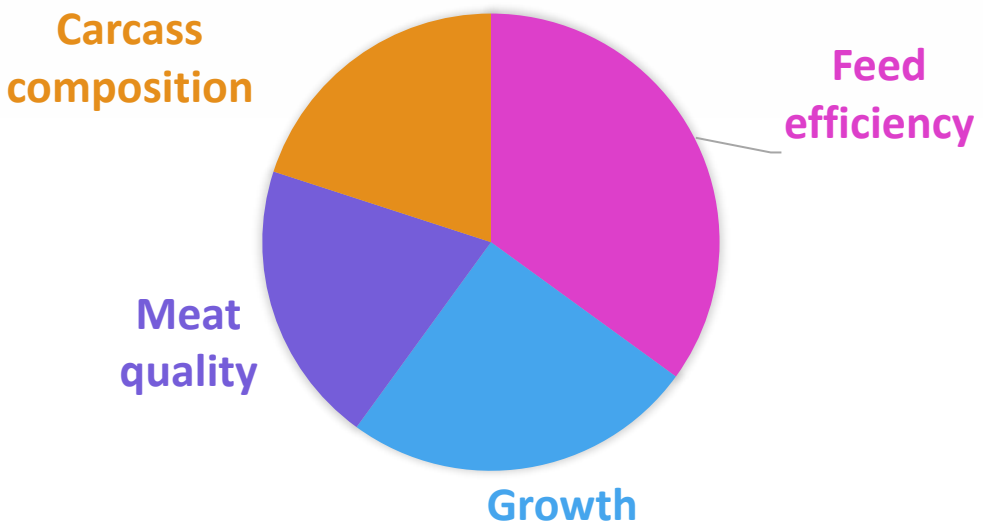
Improving feed efficiency:

» A critical topic for the sustainability of pig farms

» Accounting for 30-50% of the selection objective in pig sire lines

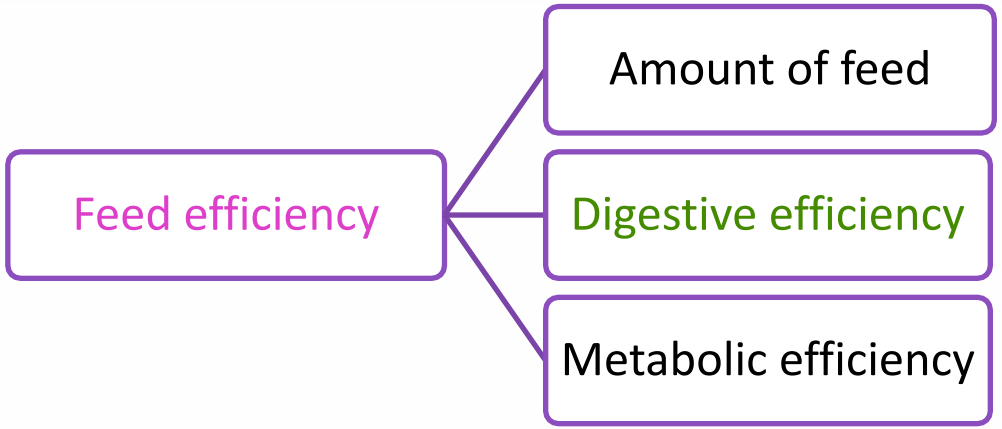
» Selection criterion is Feed Conversion Ratio (FCR)

Traits weight in sire population objective:



ALLIANCE R&D Innovation Durable en Génétique Porcine

Context of the study



(Carré et al., 2008)

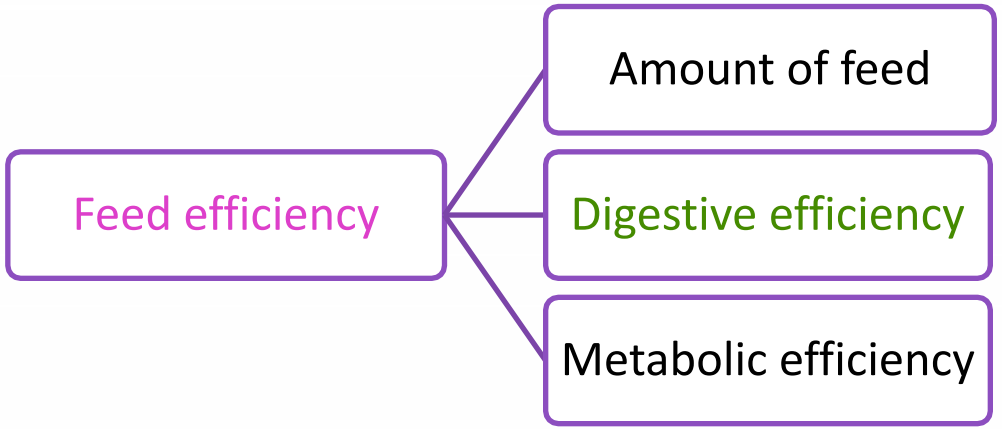
Digestive efficiency, a trait to improve feed efficiency:

» Genetically correlated favorably with feed efficiency traits (Déru et al., 2021)

» Estimated here by digestibility coefficients (DC) obtained by near-infrared spectroscopy:

DC of organic matter | DC of energy | DC of nitrogen

Context of the study



(Carré et al., 2008)

Digestive efficiency, a trait to improve feed efficiency:

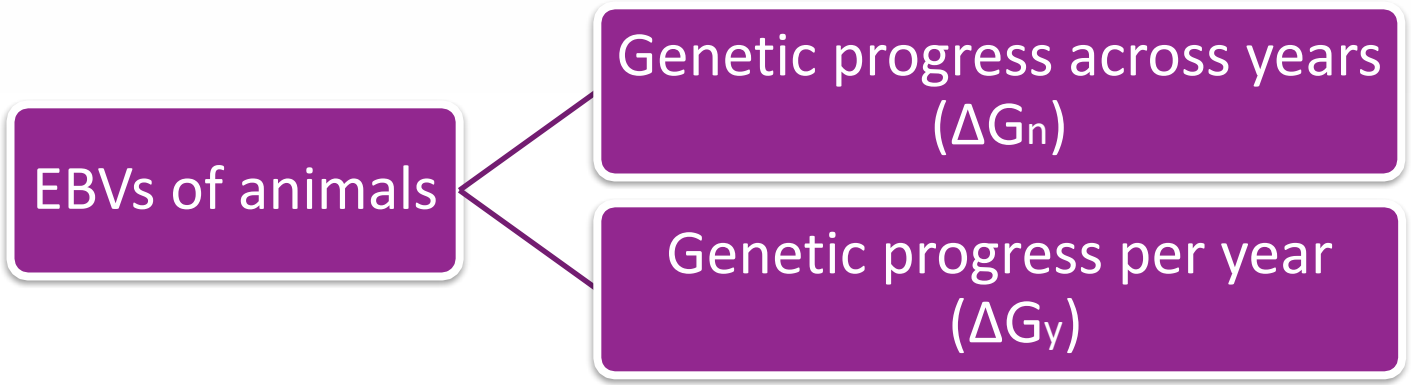
» Genetically correlated favorably with feed efficiency traits (Déru et al., 2021)

» Estimated here by digestibility coefficients (DC) obtained by near-infrared spectroscopy:

What strategy for integrating DC into sire population breeding schemes to improve feed efficiency?

Parameters of simulations and indicators

» Breeding scheme simulated with **AlphaSimR** (Gaynor et al., 2021)
» Five generations of funders selected on phenotypic traits
» 8 generations
» Stochastic simulations: 50 repetitions
» Genetic and phenotypic parameters from a dataset previously available and literature
» For each scenario: indicators were estimated:



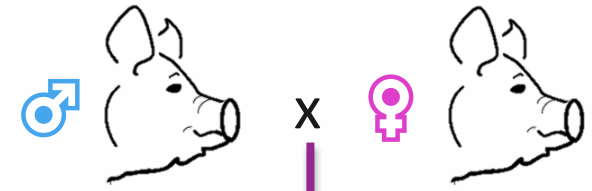
Mean of genetic values of pigs of year n compared to those of year n-1

The average genetic progress per year for each trait

Expressed in genetic standard deviation units

ALLIANCE R&D Innovation Durable en Génétique Porcine

Reference breeding scheme



n = 168 x n = 1,500

10,500 offsprings

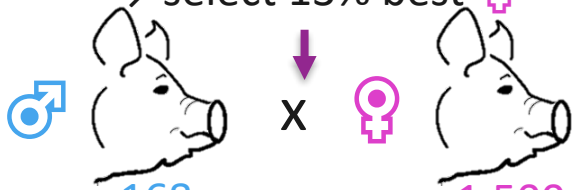
3,000 ♂ without automatic feeders	5,000 ♀ without automatic feeders
2,000 ♂ with automatic feeders	500 ♀ in station

BLUP genetic evaluation with BLUPF90 (Misztal *et al., 2018*) **via the blupADC interface** *(Mei et al., 2021)*

→ select 1% best ♂ without automatic feeders

→ select 2% best ♂ with automatic feeders

→ select 13% best ♀



n = 168 x n = 1,500

Update the reproducers

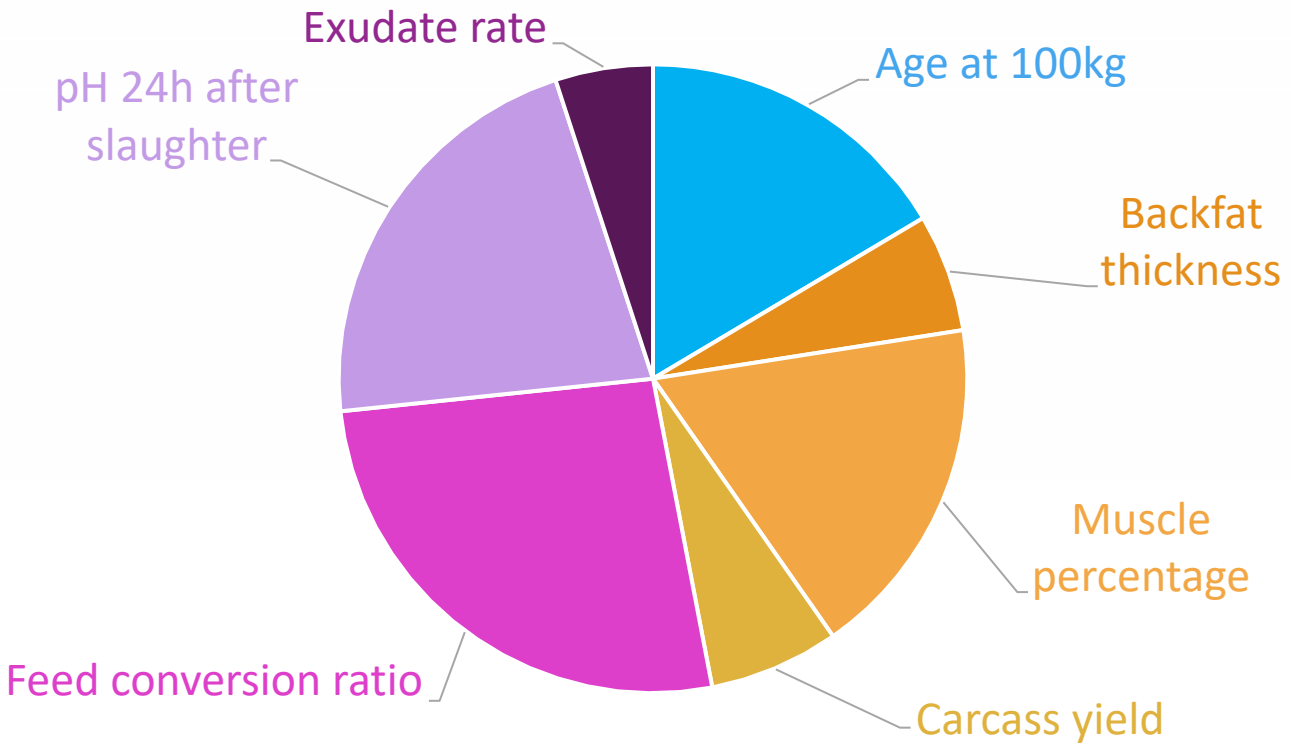
ALLIANCE RD Innovation Durable en Génétique Porcine

Selection objective

» Consensus selection objective from the three French pig breeding companies for a pig sire line

» 7 traits included in the selection objective

Trait weights in the selection objective:



ALLIANCE RED
Innovation Durable en Génétique Porcine

Alternative breeding schemes

» Increase the **budget by 30%** compared to the reference breeding scheme

Alternative breeding schemes

» Increase the **budget by 30%** compared to the reference breeding scheme

Additional individuals phenotyped for digestive efficiency:

» Proxy of feed efficiency ($cor_g < -0,23$)
» Sample cost : 25 €
» Using the three DC measures separately or together
» Different scenarios constructed :

- +30%_DCE
- +30%_DCOM
- +30%_DCN
- +30%_3DC

25€/sample (+1,500 ♂)

15€/sample (+2,500 ♂)

- +30%_DCE
- +30%_DCOM
- +30%_DCN
- +30%_3DC

- +30%_DCE
- +30%_DCOM
- +30%_DCN
- +30%_3DC

12€/sample (+2,500 ♂)

ALLIANCE R&D Innovation Durable en Génétique Porcine

Alternative breeding schemes

» Increase the **budget by 30%** compared to the reference breeding scheme

Additional individuals phenotyped for digestive efficiency:

» Proxy of feed efficiency ($cor_g < -0,23$)
» Sample cost : 25 €
» Using the three DC measures separately or together
» Different scenarios constructed :

- +30%_DCE
- +30%_DCOM
- +30%_DCN
- +30%_3DC

25€/sample (+1,500 ♂)

- +30%_DCE
- +30%_DCOM
- +30%_DCN
- +30%_3DC

15€/sample (+2,500 ♂)

- +30%_DCE
- +30%_DCOM
- +30%_DCN
- +30%_3DC

12€/sample (+2,500 ♂)

Additional individuals phenotyped for feed efficiency:

» Sample cost : 50 €
» One scenario constructed :

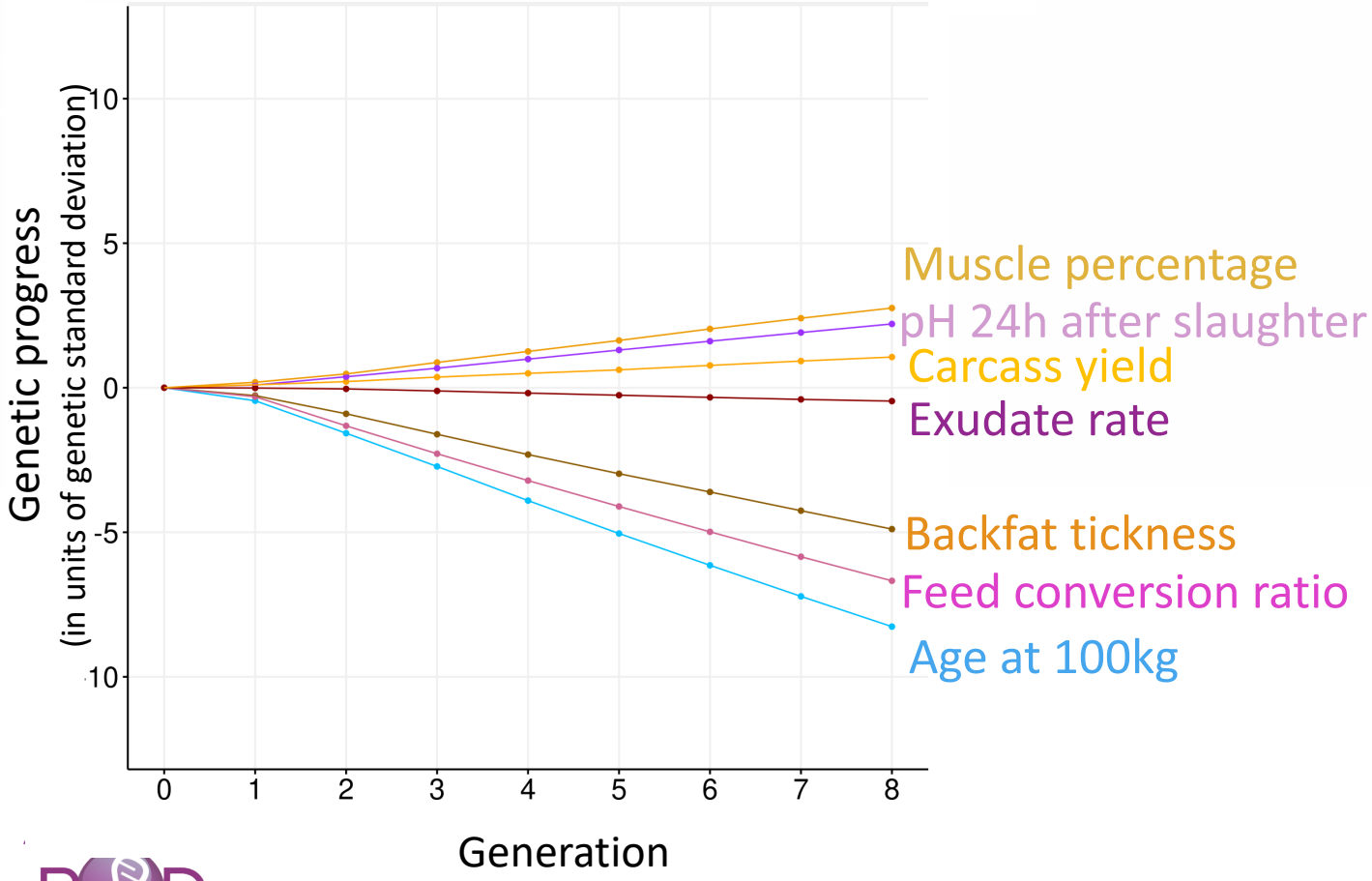
- +30%_FCR

50€/sample (+ 750 ♂)

ALLIANCE R&D Innovation Durable en Génétique Porcine

Estimated genetic progress for traits in the reference breeding scheme

Evolution of ΔG of traits included in the index over 8 generations:



Estimated annual genetic progress for feed efficiency:

Trait	ΔGy*
Feed conversion ratio	-0.71

* in units of genetic standard deviation

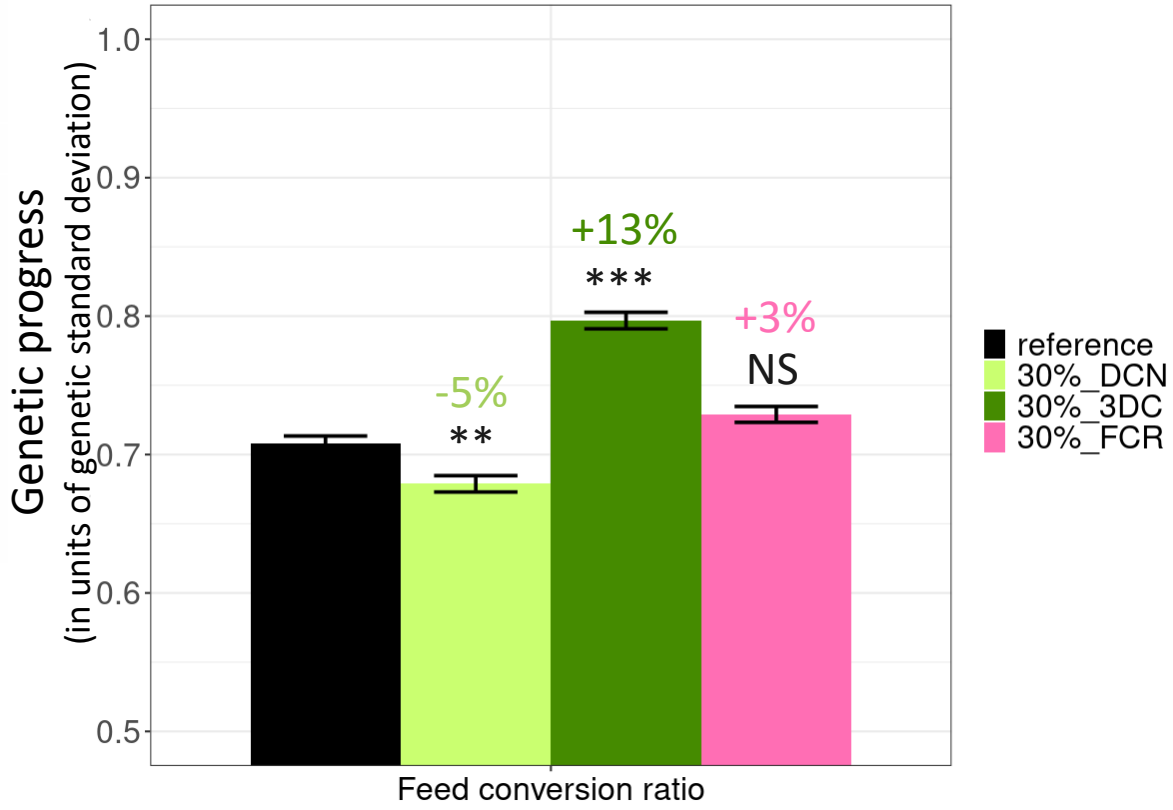
Impact of an additional 30% phenotyping budget on the genetic gain of FCR

» Price of digestibility sample: 25 €

» No positive impact with DCN, DCE and DCOM separately

» A significant positive effect on annual genetic progress of FCR with the three DC considered jointly

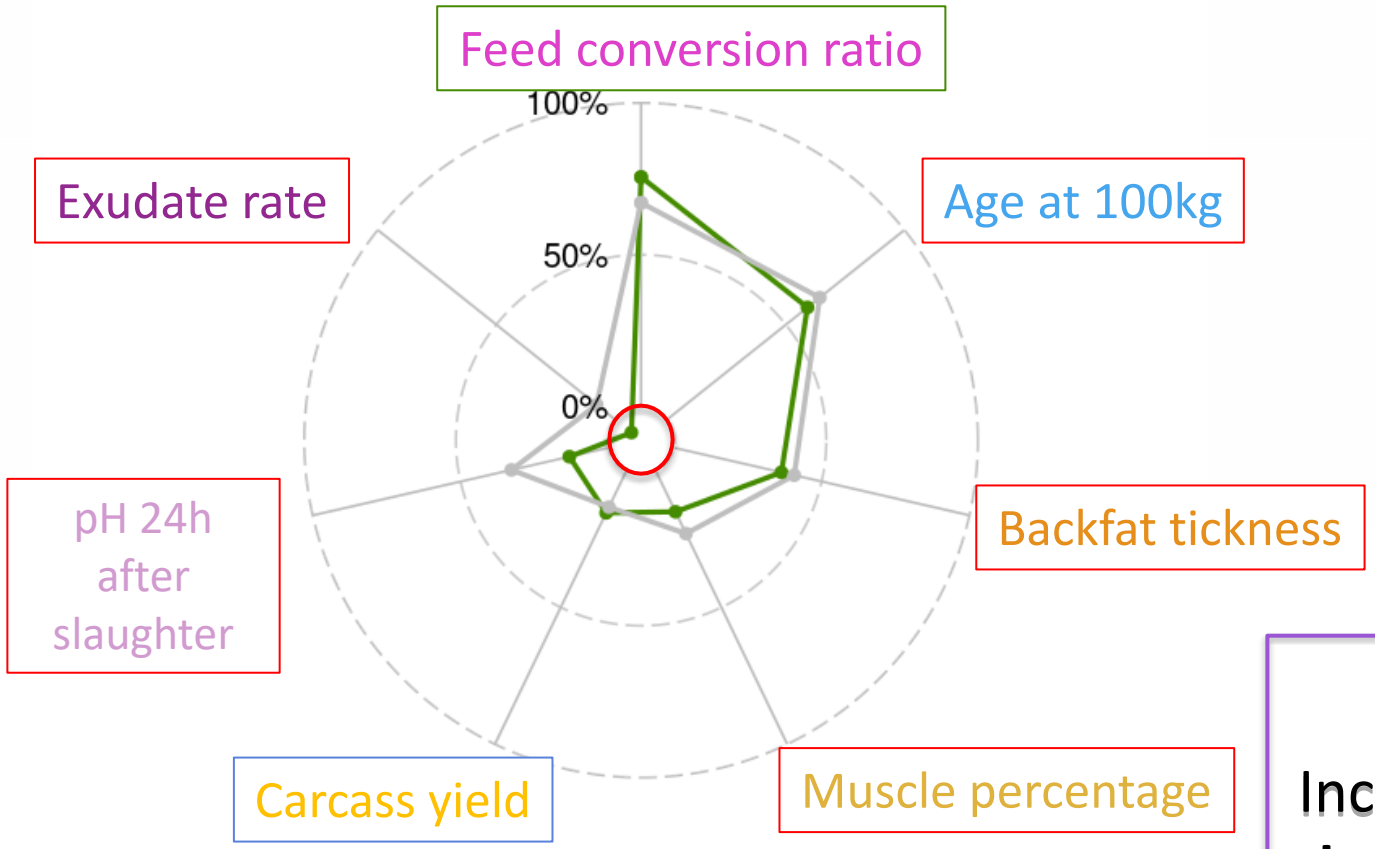
Best scenario =
Increase by **13% the** genetic gain **for FCR**



*Mean comparison pairwise t-test between the alternative scenario and the reference scenario: ***: P < 0.001; **: P < 0.01; NS: not significant*

ALLIANCE R&D Innovation Durable en Génétique Porcine

Impact of an additional 30% phenotyping budget on the genetic gain of other traits



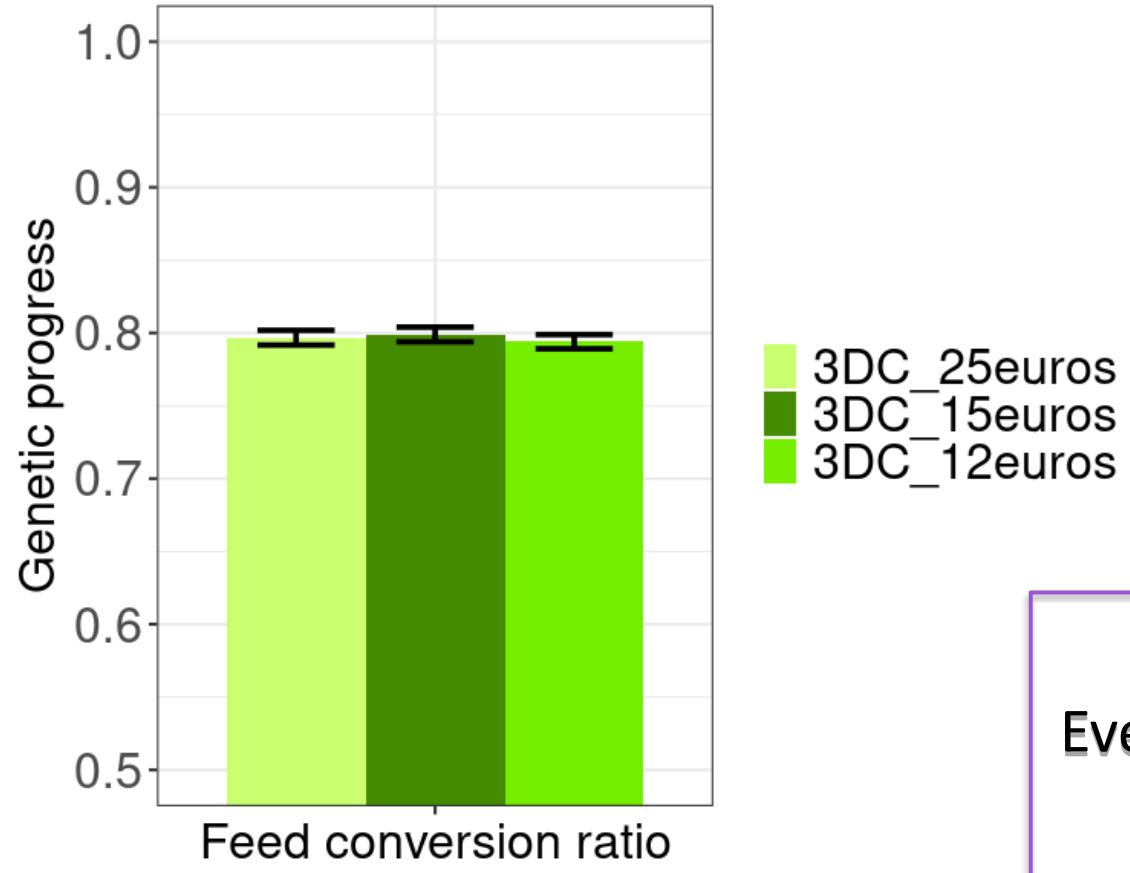
» Comparison of the reference breeding scheme (in grey) and the scenario +30%_3DC

» Decrease of genetic gain of all traits, except carcass yield in comparison to the reference scenario

Best scenario =
Increase by **13% the** genetic gain **for FCR, but negative impact on the other traits**

In grey : reference breeding scheme scenario
In green : +30%_3DC scenario

Impact of the cost of measuring digestibility on annual genetic progress of FCR



» No significant impact of phenotyping more individuals on the three DC on ΔG_Y of FCR

» Assumption: Most families are represented and there is no additional interest in phenotyping more individuals.

Even if the cost **of digestibility measures decreases**: **not necessary to phenotype more individuals**

ALLIANCE R&D Innovation Durable en Génétique Porcine

Conclusion and perspectives

Summary

- **Phenotyping supplementary individuals for the three DC: improves genetic gain on FCR**
- But negative impact on genetic progress of other traits: growth traits, carcass composition traits (except carcass yield) and meat quality traits
- Not necessary to phenotype more individuals

What's next?

- **Find the best strategy**:
  - What type of animals to phenotype: females? males? Genetic connection?
  - Can we change the weights of the traits in the index to maintain the genetic progress of the other traits and still increase it on the FCR?

ALLIANCE R&D Innovation Durable en Génétique Porcine

Thank you for your attention !

ALLIANCE R&D Innovation Durable en Génétique Porcine

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

INRAE

ifip — Institut du porc

AXIOM l'évidence génétique

Nucléus L'innovation pour l'excellence

CHOICE Caring for life

ALLIANCE R&D Innovation Durable en Génétique Porcine

Appendix

Selection objective

$$H = -1.5 \times \text{Age\_100kg} - 4 \times \text{Backfat} + 5 \times \text{Muscle\%} - 225 \times \text{FCR} + 8 \times \text{Carcass\_y} - 250 \times \text{pH24} - 4.7 \times \text{Exsudate\_rate}$$

ALLIANCE R&D Innovation Durable en Génétique Porcine

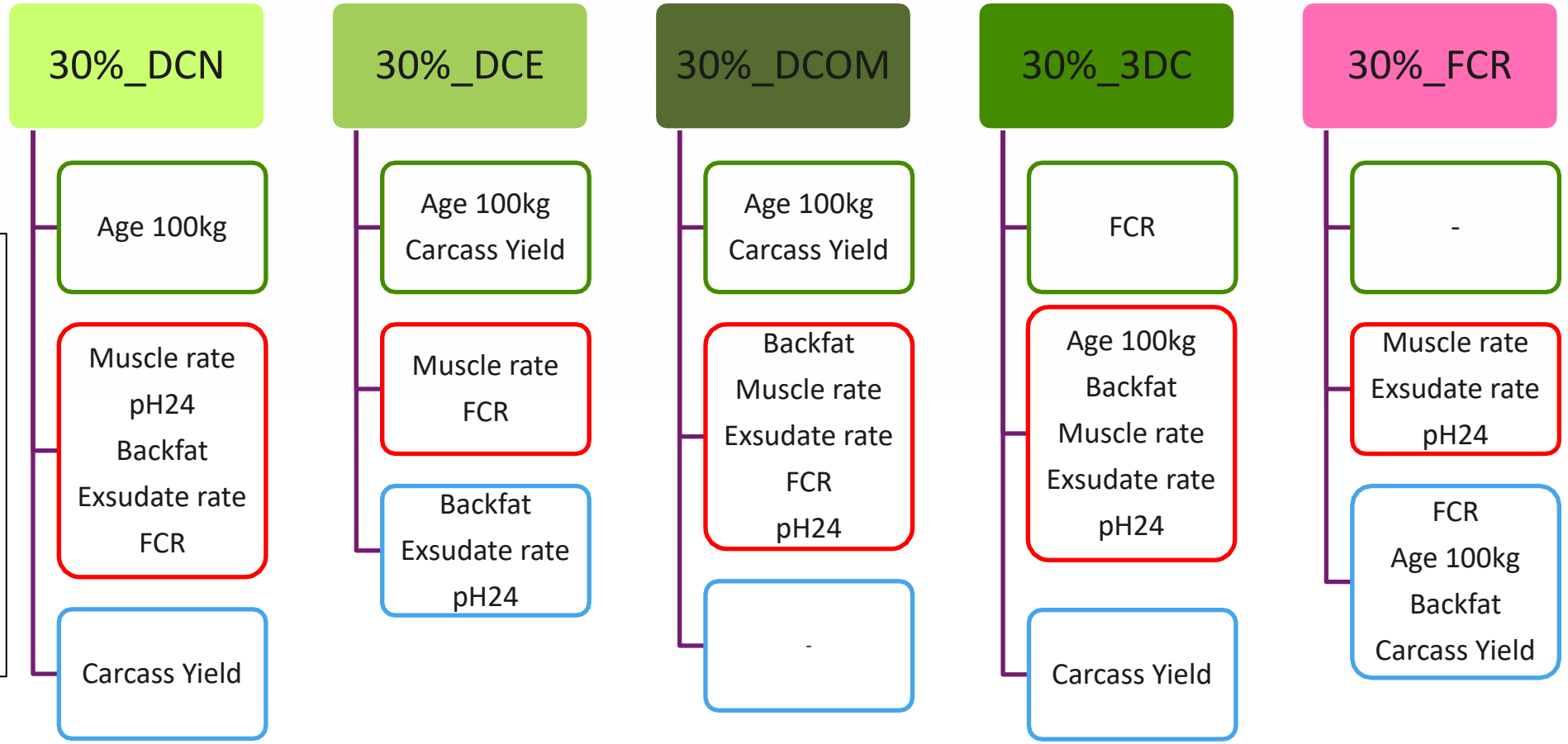
Annual genetic progress of all traits in all scenarios

Trait	Reference scheme	+30%_DCN	+30%_DCE	+30%_DCOM	+30%_3DC	+30%_FCR
Age 100kg	-0.87 [a]	-0.91 [b]	-0.94 [c]	-0.91 [b]	-0.80 [d]	-0.87 [a]
FCR	-0.71 [a]	-0.67 [b]	-0.57 [c]	-0.68 [b]	-0.80 [d]	-0.73 [a]
Backfat	-0.51 [a]	-0.49 [b]	-0.52 [a]	-0.44 [c]	-0.46 [c]	-0.52 [a]
Carcass yiel	0.11 [a]	0.13 [b]	0.18 [c]	0.17 [c]	0.12 [a.b]	0.12 [a]
Muscle %	0.29 [a]	0.17 [b]	0.22 [c]	0.18 [b]	0.19 [b]	0.18 [b]
pH24	0.23 [a]	0.19 [b]	0.21 [a.b]	0.20 [b]	0.09 [c]	0.15 [d]
Exsudate rate	-0.05 [a]	-0.02 [b]	-0.03 [b]	-0.01 [b]	0.05 [c]	0.02 [d]
DCE	0.30 [a]	0.33 [b]	0.25 [c]	0.23 [c]	0.31 [b]	0.33 [b]
DCN	0.30 [a]	0.32 [b]	0.24 [c]	0.23 [c]	0.32 [b]	0.33 [b]
DCOM	0.35 [a]	0.38 [b]	0.31 [c]	0.29 [c]	0.35a	0.38 [b]

ALLIANCE R&D Innovation Durable en Génétique Porcine

Impact of an additional 30% phenotyping budget on the annual genetic progress of other traits in comparison to the reference scenario

Green = favorable impact on genetic progress
Red = unfavorable impact on genetic progress
Blue = no significant impact on genetic progress



ALLIANCE RED
Innovation Durable en Génétique Porcine