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Agroscope

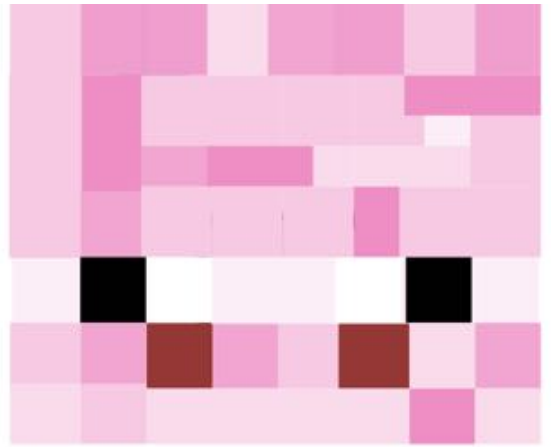
Heritability of nitrogen and phosphorus efficiency in pigs

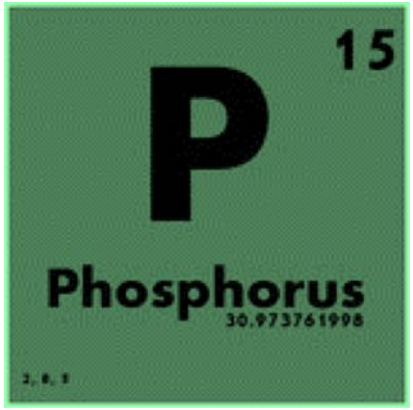
Claudia Kasper

SABRE-TP Workshop 05.06.2019

Overview

- excess of **nitrogen** and **phosphorus**
  - eutrophication (*local*)
  - import (*global*)
- **breeding sustainable pigs**
  - heritability
  - genetic correlations
- **preliminary results**
- **outlook** (work in progress)
  - larger dataset
  - genome-wide association study





Nitrogen and phosphorus

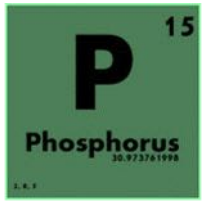
- agriculture: > 75% of global nitrogen and phosphorus emissions (Poore and Nemecek, 2018)
- intensification of stock: local effects of emissions from manure on sensitive ecosystems
- approx. 50% of nitrogen compounds in manure leak into the air as gaseous ammonia (Erisman, 2004)
- pig slurry: low nitrogen-phosphorus ratio - excess soil phosphorus (Wienhold 2005)

Nitrogen and phosphorus

- soybean imported from Brazil, Argentina or the USA
- deforestation, habitat loss, competition feed – food
- eviction of small farmers from arable land (Fearnside 2001)

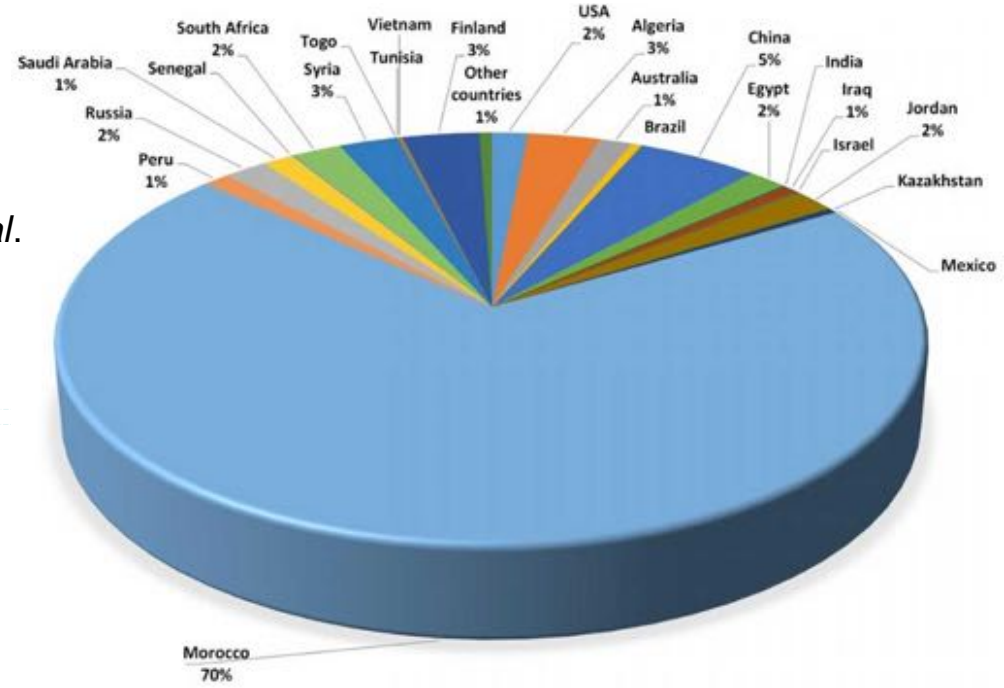
long-distance transport!

Nitrogen and phosphorus



- mineral phosphorus non-renewable
- few active phosphorus mines left (mainly West Sahara and Morocco)
- potential consequences for food security (de Boer *et al*. 2019)
- heavy metal pollution and the destruction of ecosystems at the mining sites (Cordell & White 2011)

global problems



long-distance transport!

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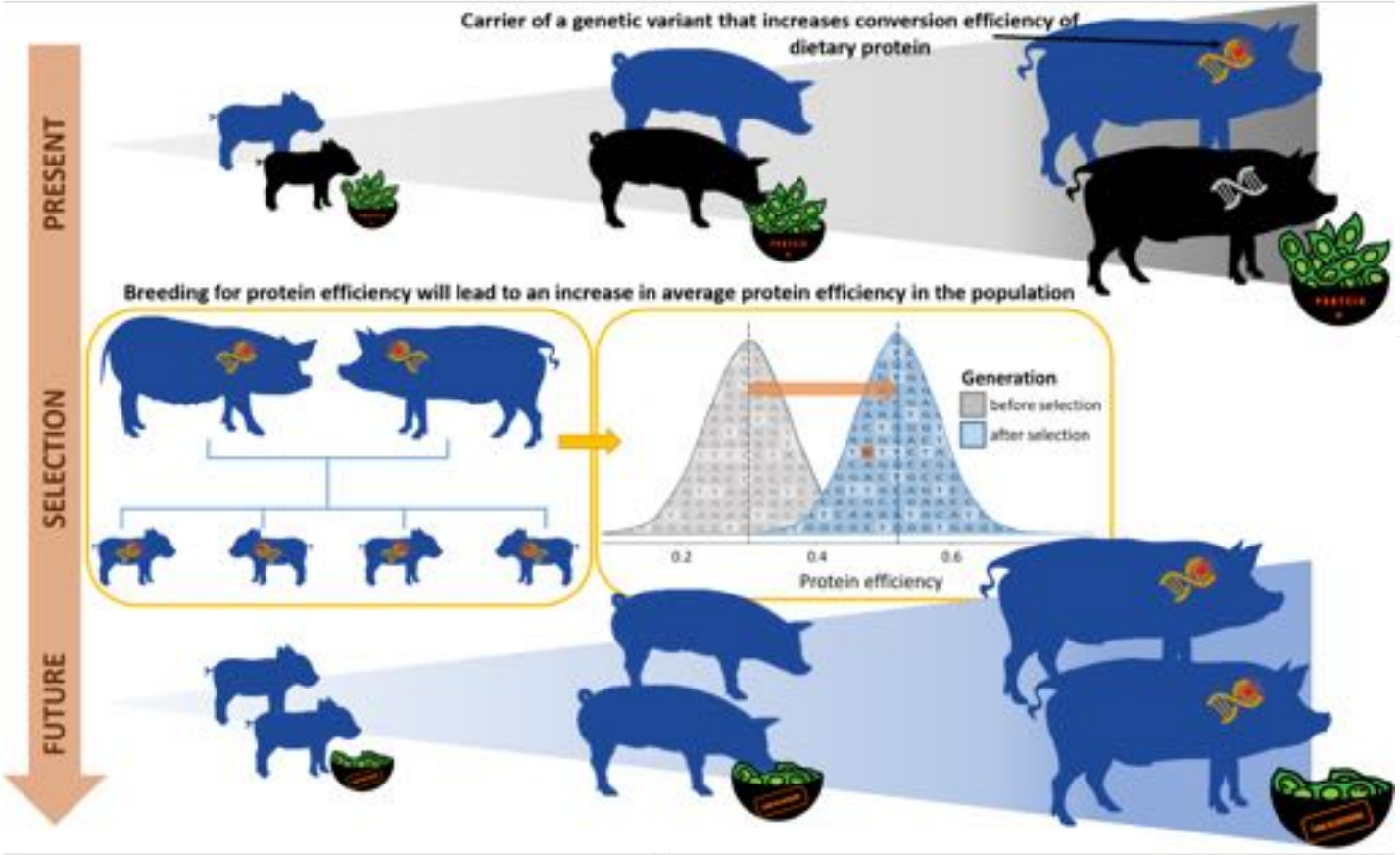
Breeding sustainable pigs

Pig production has a higher ecological and social impact than commonly believed!



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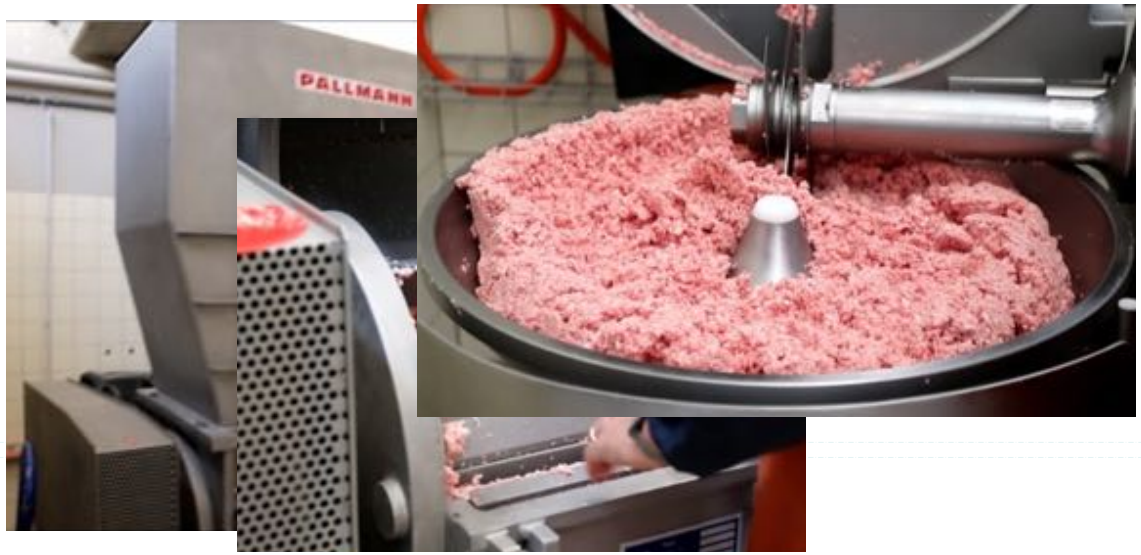
Breeding sustainable pigs

labour-intensive phenotyping

- What is known?
  - Pigs: h^2 of N estimated! ion = 0.29 ± 0.06 to 0.40 ± 0.06 (Saintilan *et al.* 2013)
  - Chicken: h^2 of N = 0.29 ± 0.02 and P excretion = 0.22 ± 0.04 (de Verdal *et al.* 2011)
- Genetic correlations
  - Chicken: r_G N and P = 0.74 (± 0.06) (de Verdal *et al.* 2011)
- Genetic markers
  - Pigs: 23 QTLs ident estimated! cretion at different growth phases (Shirali *et al.* 2013)

Pilot analysis

- PhD thesis **Isabel Ruiz-Ascacibar**
- feeding experiments with standard diet (control) and protein-reduced treatment (80% of control)
- phenotypic variation in protein efficiency (not explained by diet)
- wet-chemistry analyses of pigs and feed - high accuracy phenotype!



Lyophilisation; milling 1mm; residual water, ash and mineral analysis (ICP-MS)

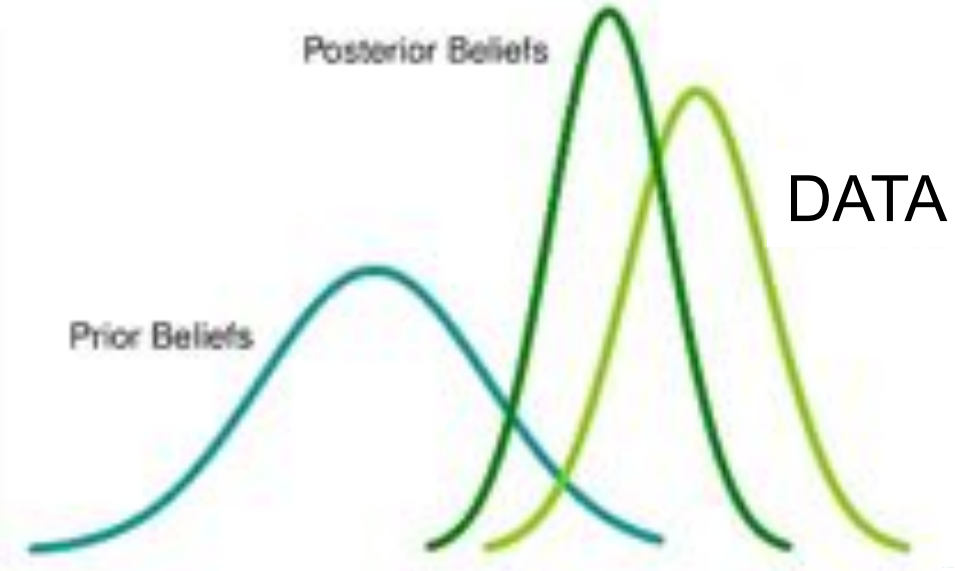
N and P content in the empty body were calculated

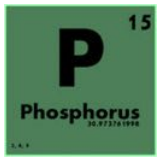
Pilot analysis

- Swiss Large White (N=294)
- not optimal design for quantitative genetic studies (N_{sires}=17)
- pilot analysis to obtain prior information
  - plan large-scale breeding experiment for quantitative genetics and GWAS
  - **prior** for subsequent statistical analyses

Pilot analysis

- Animal model (LMM)
- Bayesian analysis
  - performance
  - appealing philosophy
  - uninformative prior (all values $V_A > 0$ equally likely)





Preliminary results

Empty body

Carcass

h^2

0.40 (0.07, 0.84)

0.32 (0.08, 0.74)

CE^2

0.002

(2.4 × 10^{-4}, 0.13)

0.002

(2.5 × 10^{-4}, 0.12)

res^2

0.00 0.25 0.50 0.75 1.00

0.00 0.25 0.50 0.75 1.00

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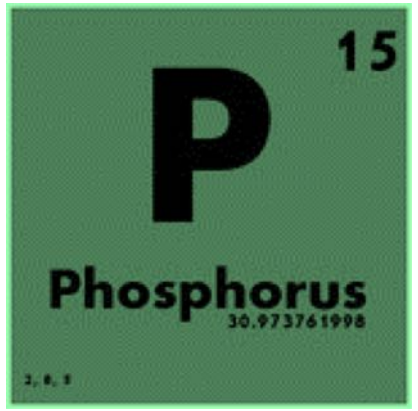
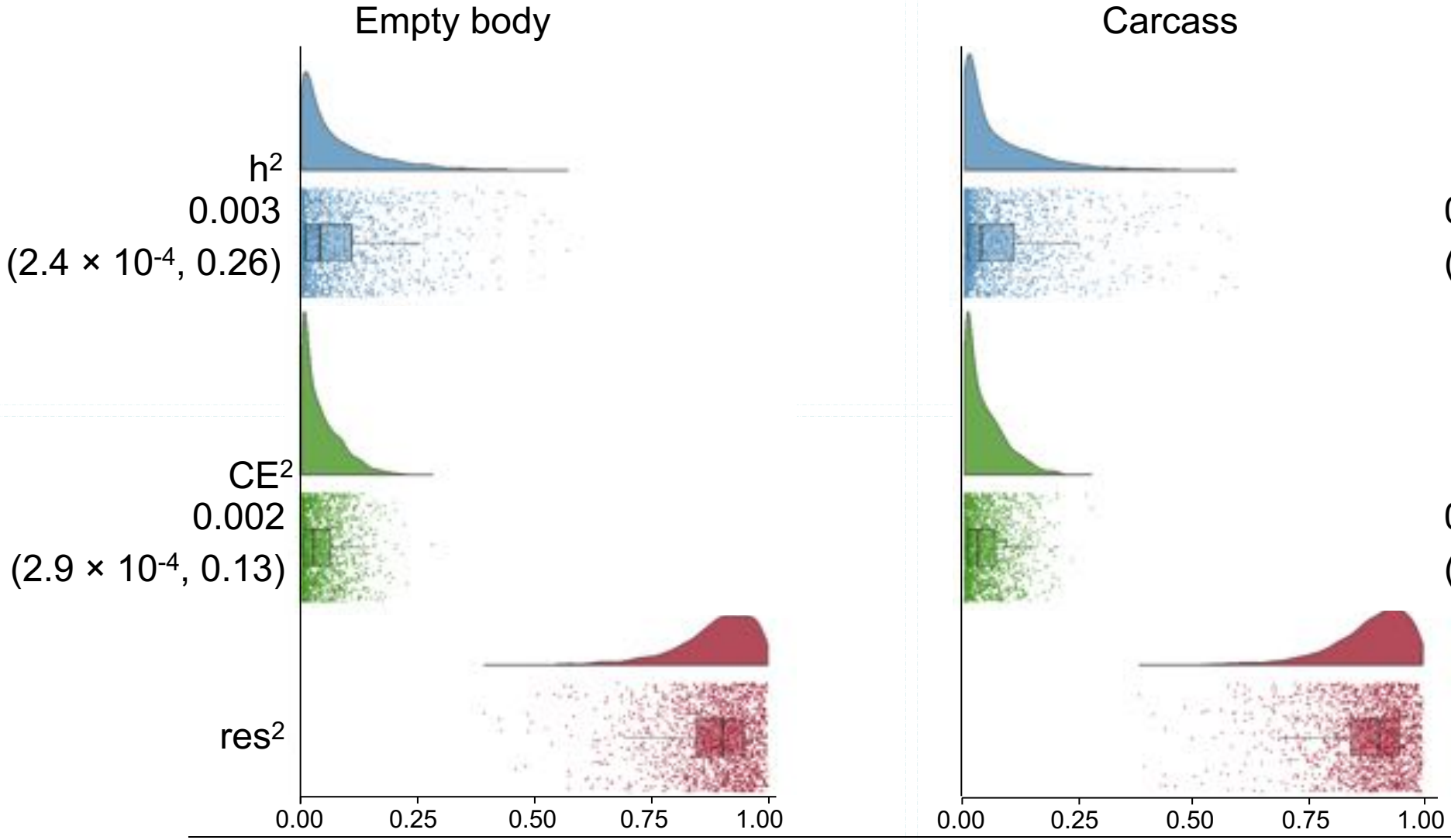
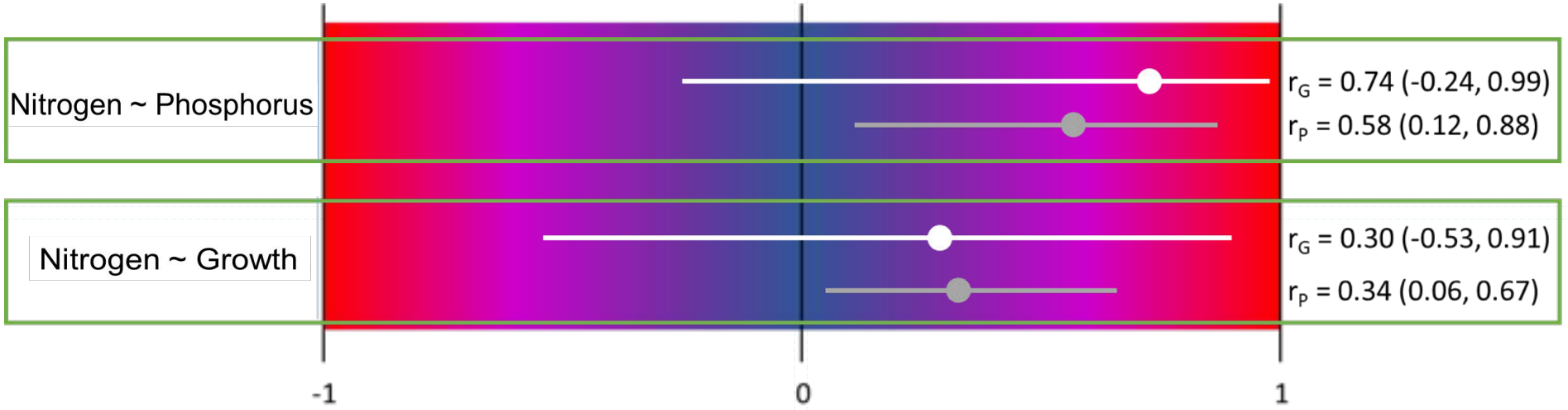
Preliminary results





Preliminary results

- Genetic and phenotypic correlations



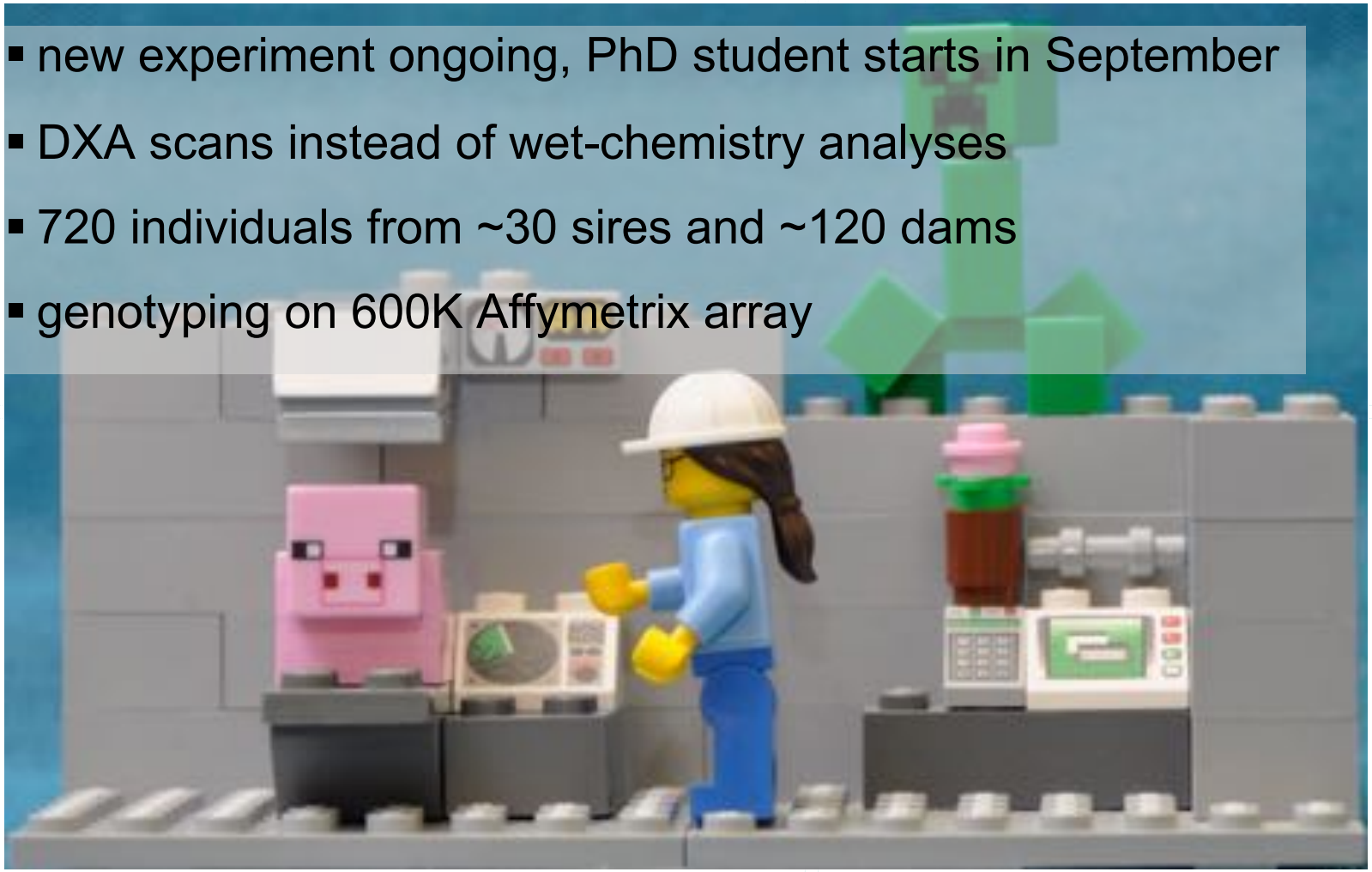
Summary

- promising heritability of nitrogen efficiency
- heritability of phosphorus efficiency low
- positive genetic correlation between nitrogen and phosphorus efficiency
- potentially low negative genetic correlation between growth and nitrogen efficiency

precision and accuracy low

Outlook

- new experiment ongoing, PhD student starts in September
- DXA scans instead of wet-chemistry analyses
- 720 individuals from ~30 sires and ~120 dams
- genotyping on 600K Affymetrix array



Thank you!

Isabel Ruiz-Ascacibar

Peter Stoll

Giuseppe Bee