# Microbiability of faecal nutrient digestibility in pigs

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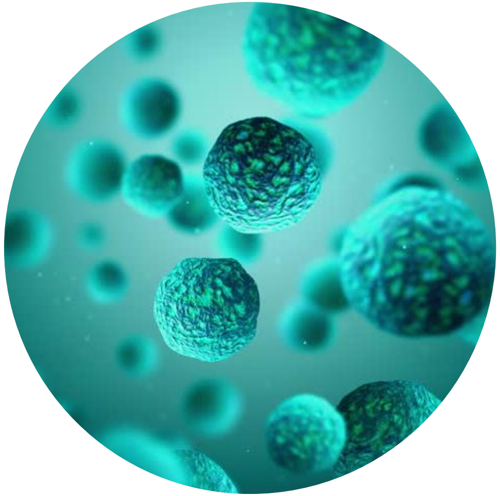
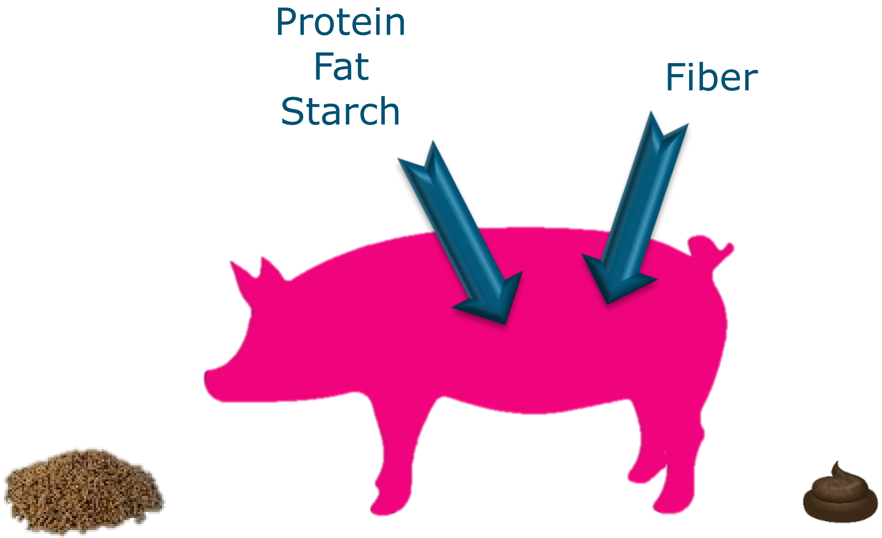


WAGENINGEN UNIVERSITY & RESEARCH
100years 1918 — 2018
Topigs Norsvin PROGRESS IN PIGS
Schothorst Feed Research
BREED4FOOD

# Introduction



Protein
Fat
Starch

Fiber

Faecal nutrient digestibility

=

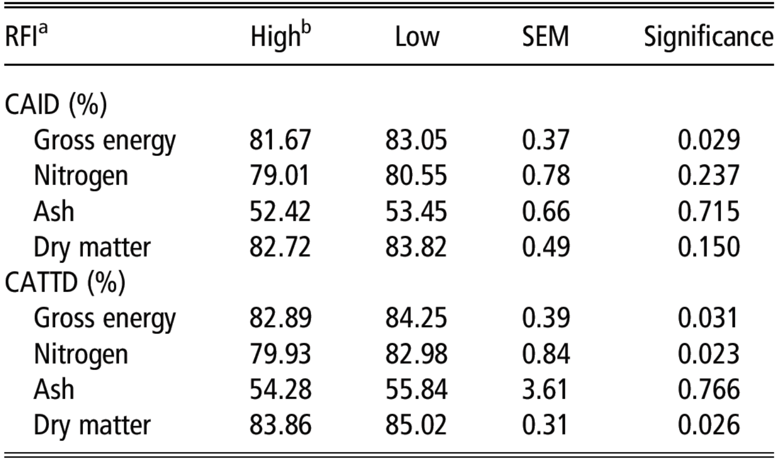
% of nutrients disappeared in the GIT

Higher

=

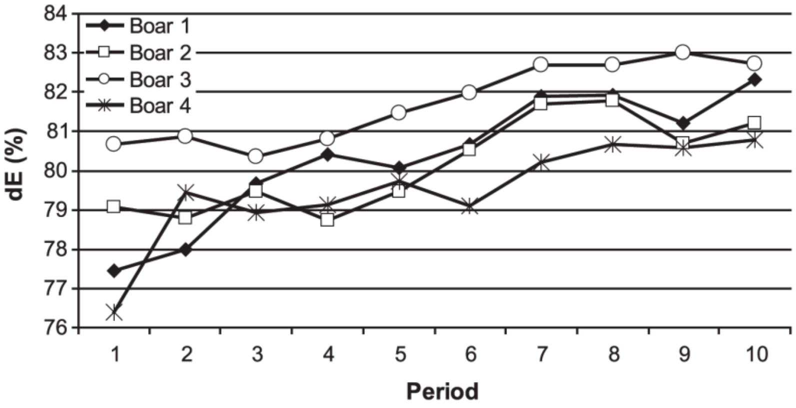
More nutrients for maintenance and growth

# Introduction



| RFI[a] | High[b] | Low | SEM | Significance |
|---|---|---|---|---|
| CAID (%) | | | | |
| Gross energy | 81.67 | 83.05 | 0.37 | 0.029 |
| Nitrogen | 79.01 | 80.55 | 0.78 | 0.237 |
| Ash | 52.42 | 53.45 | 0.66 | 0.715 |
| Dry matter | 82.72 | 83.82 | 0.49 | 0.150 |
| CATTD (%) | | | | |
| Gross energy | 82.89 | 84.25 | 0.39 | 0.031 |
| Nitrogen | 79.93 | 82.98 | 0.84 | 0.023 |
| Ash | 54.28 | 55.84 | 3.61 | 0.766 |
| Dry matter | 83.86 | 85.02 | 0.31 | 0.026 |

(Vigors *et al.*, 2016)



(Noblet *et al.*, 2013)

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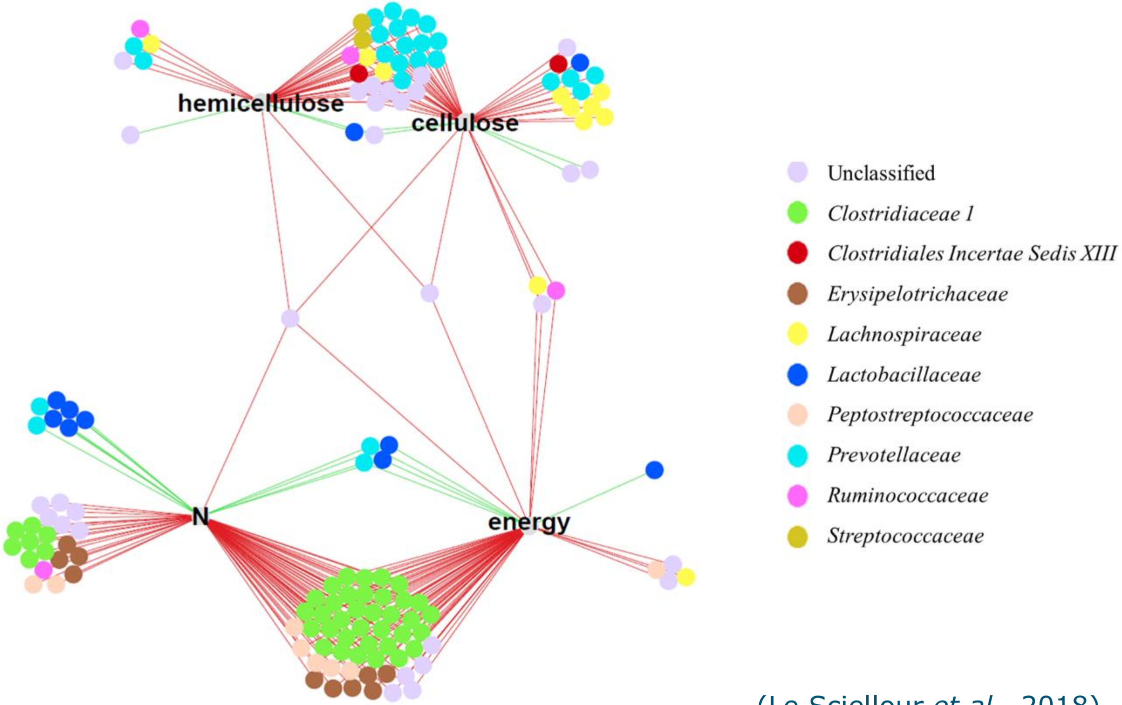


(Le Sciellour *et al.*, 2018)

# Aim

- Use faecal microbial relationships to predict nutrient digestibility

# Materials and Methods

**CS**

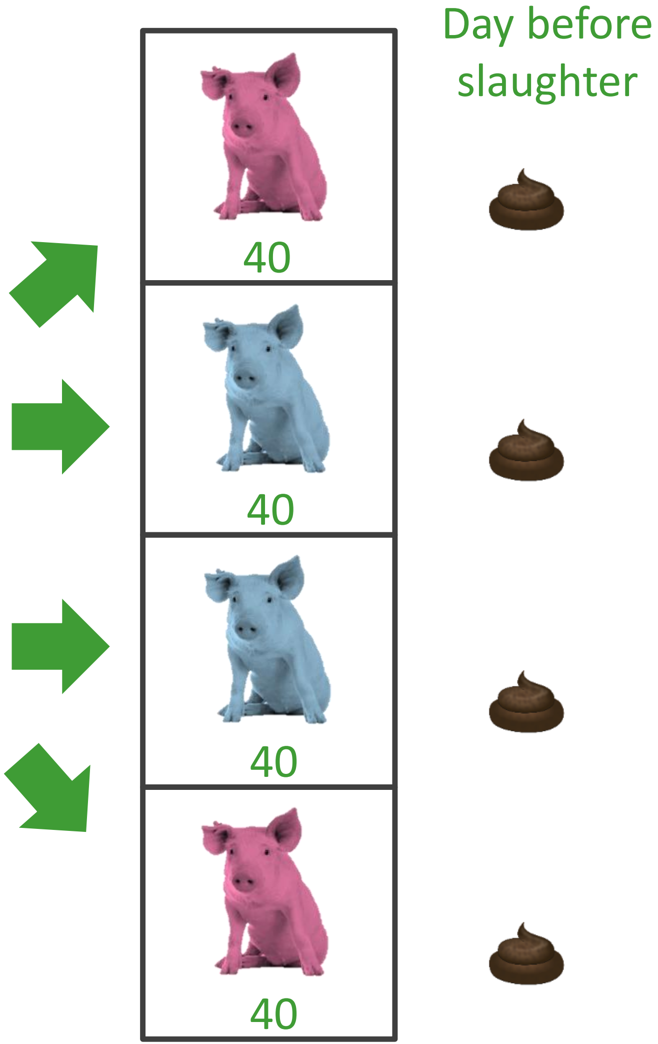
~ 85 % Corn/Soybean meal

~ 10% By products

**WB**

~ 50 % Wheat/Barley

~ 45 % By products



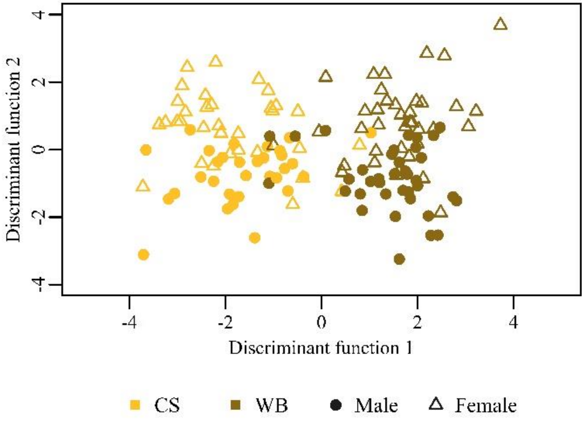
# Materials and Methods (I)

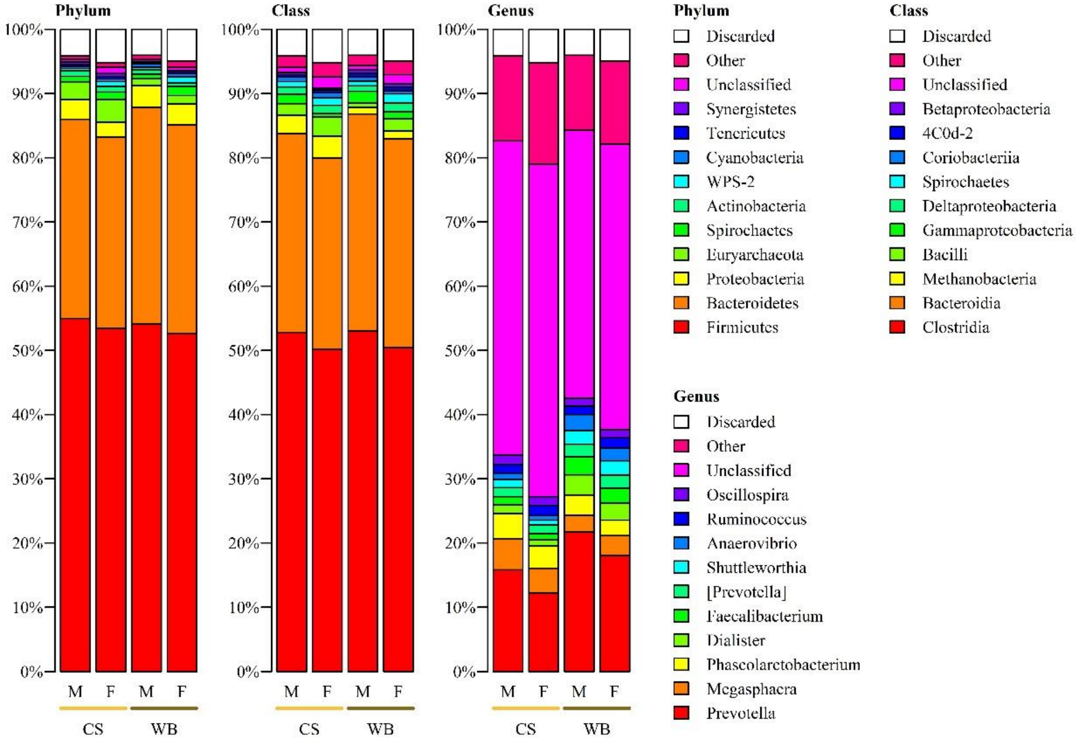
- Illumina MiSeq V3-V4 16S RNA sequencing
    - Cluster sequences into OTU
    - OTU filtering: mean relative abundance > 0.001 and present in > 5% of the animals
    - DAPC for diet, sex, and litter effects
- Chemical analysis for nutrient digestibility
    - Dry matter, ash, organic matter, crude protein, crude fat, crude fibre and non-starch polysaccharides

# Results & Discussion (I)

| Index | Diet | | Sex | | P-value | | |
|---|---|---|---|---|---|---|---|
| | CS | WB | M | F | Diet | Sex | Litter |
| Shannon | 5.99 | 5.84 | 5.82 | 6.01 | * | ** | *** |
| Chao | 19925 | 19098 | 18587 | 20436 | NS | NS | *** |

# Results & Discussion (I)



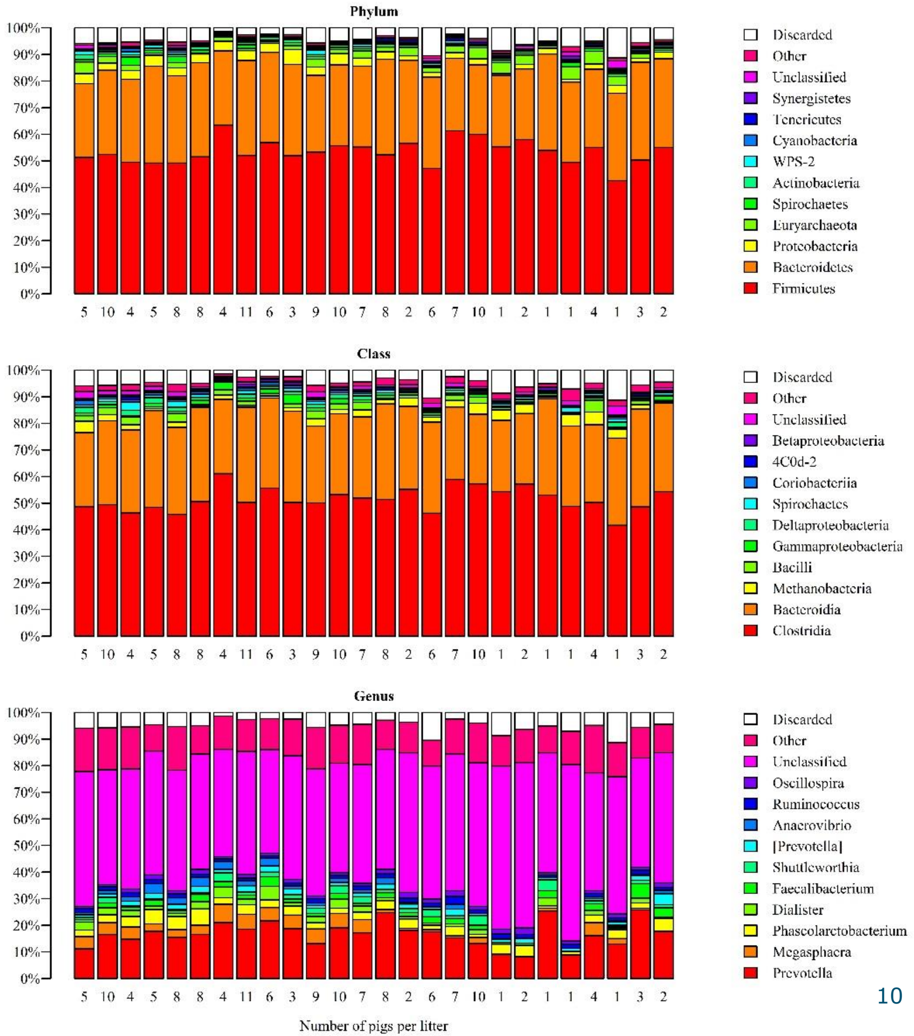


# Results & Discussion (I)

The DAPC analysis could distinguish

5 litters
from the other
21 litters

based on the faecal microbial composition



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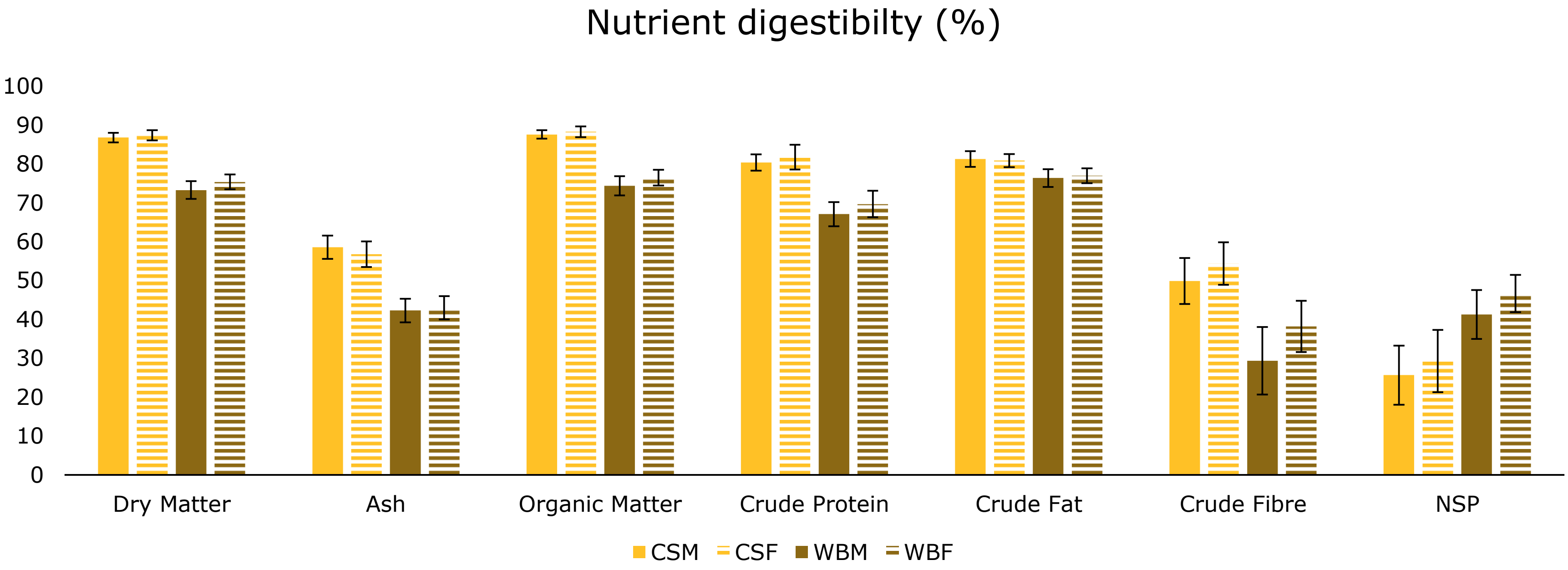

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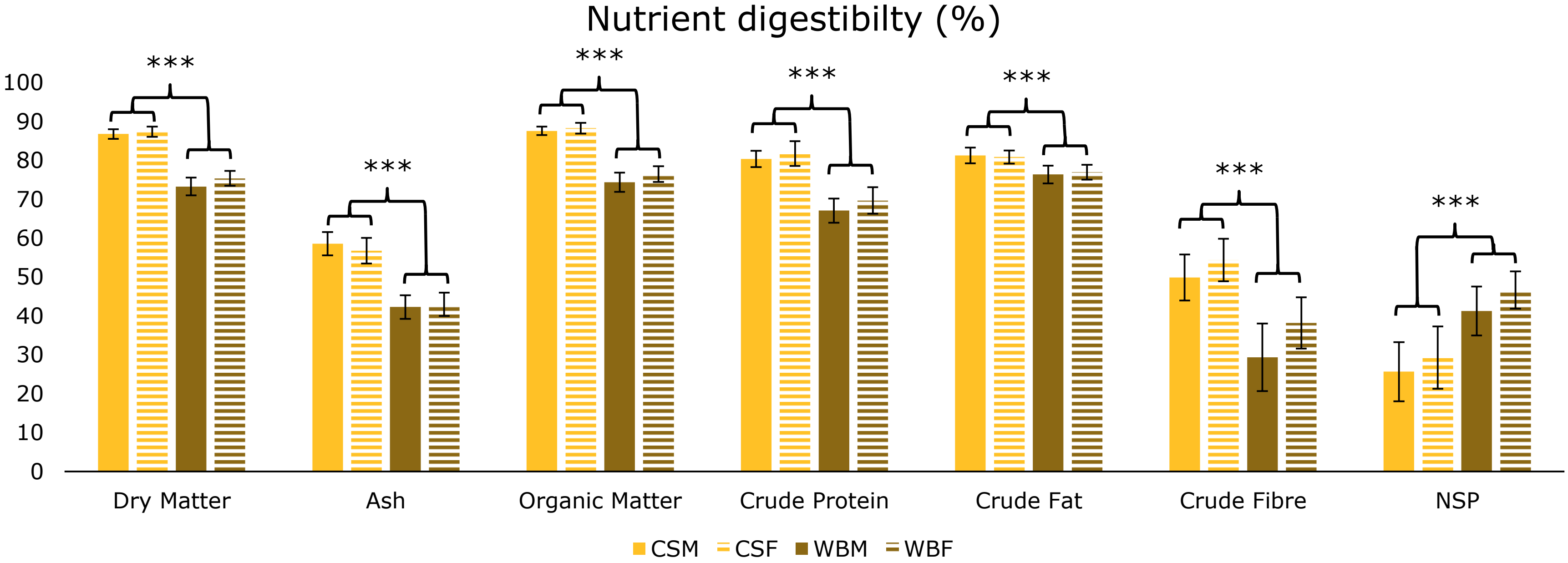

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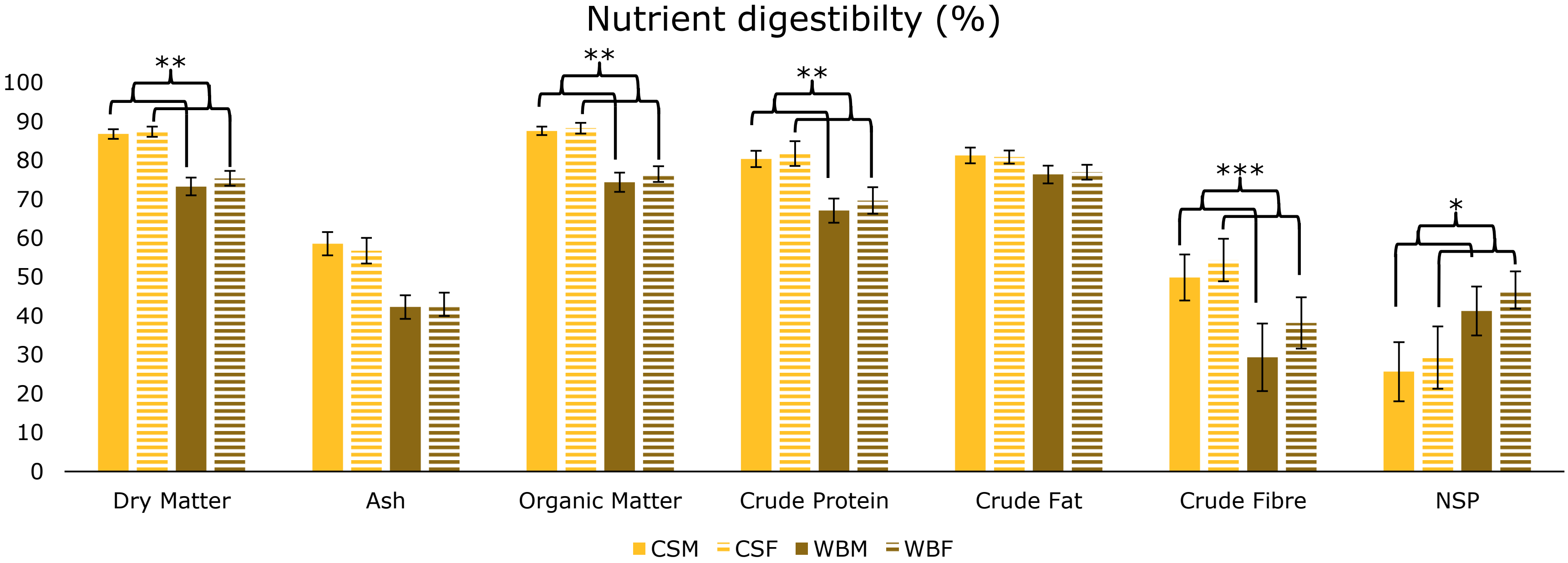

# Materials and Methods (II)

**Microbiability**

**The fraction of the phenotypic variance explained by the microbial variance (Difford et al., 2016).**

**In formula:**

$$m^2 = \sigma^2_m / (\sigma^2_m + \sigma^2_e)$$

# Materials and Methods (II)

- Model: $\mathbf{y} = \mathbf{Xb} + \mathbf{Zm} + \mathbf{Uc} + \mathbf{e}$

    - $\mathbf{y}$ = vector of phenotypes
    - $\mathbf{Xb}$ = fixed effects (sex, diet & pen)
    - $\mathbf{Zm}$ **=** random effects of OTU ~ $N(0,\mathbf{M}\boldsymbol{\sigma}^2_{\mathbf{m}})$
    - $\mathbf{Uc}$ = random effects of common litter (foster dam) ~ $N(0,\mathbf{I}\boldsymbol{\sigma}^2_{\mathbf{c}})$
    - $\mathbf{e}$ = vector of residuals ~ $N(0, \mathbf{I}\boldsymbol{\sigma}^2_{\mathbf{e}})$

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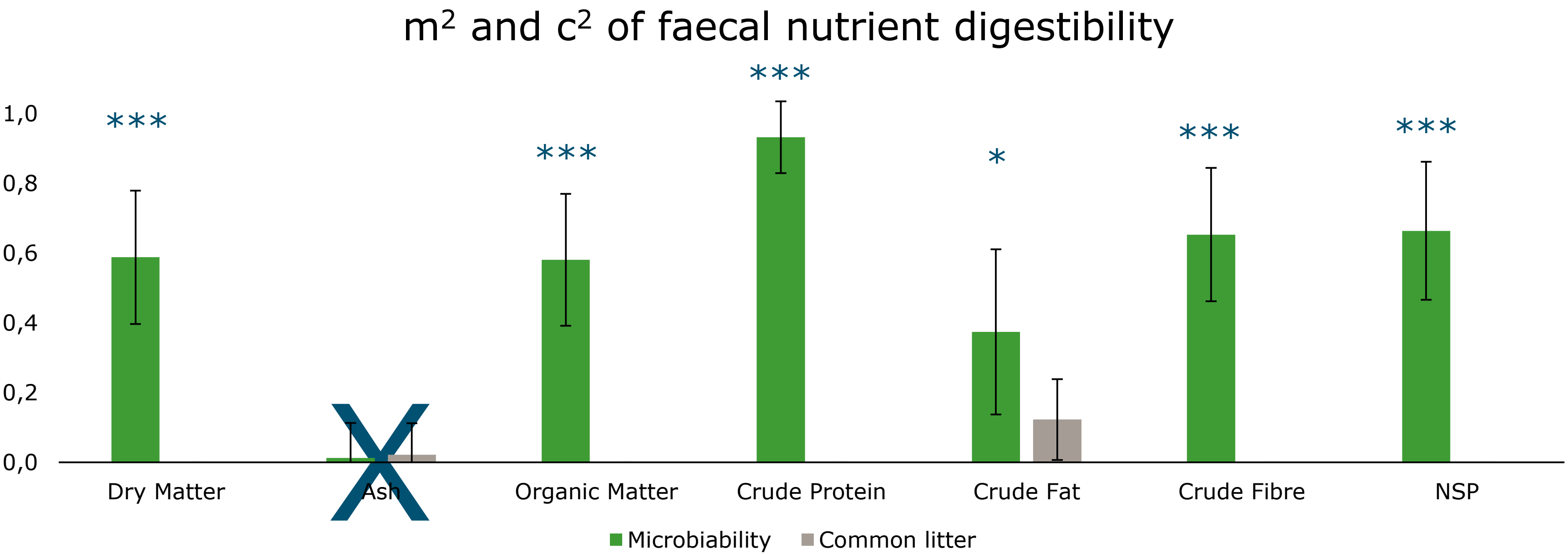

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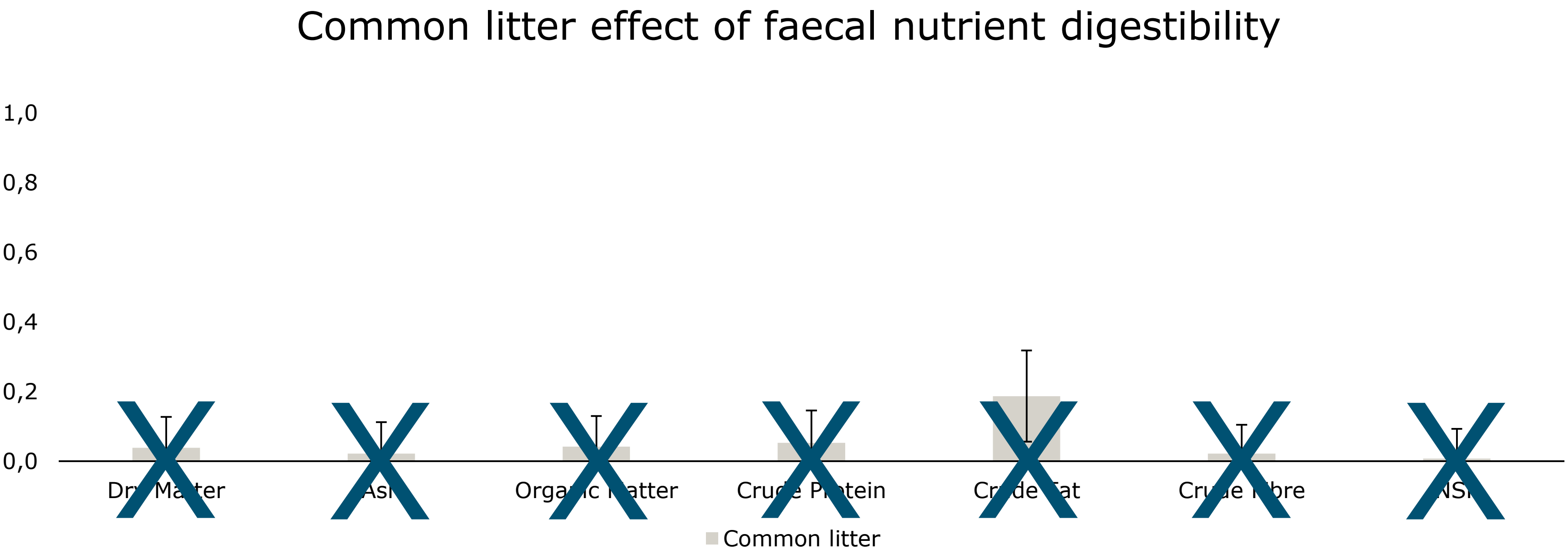
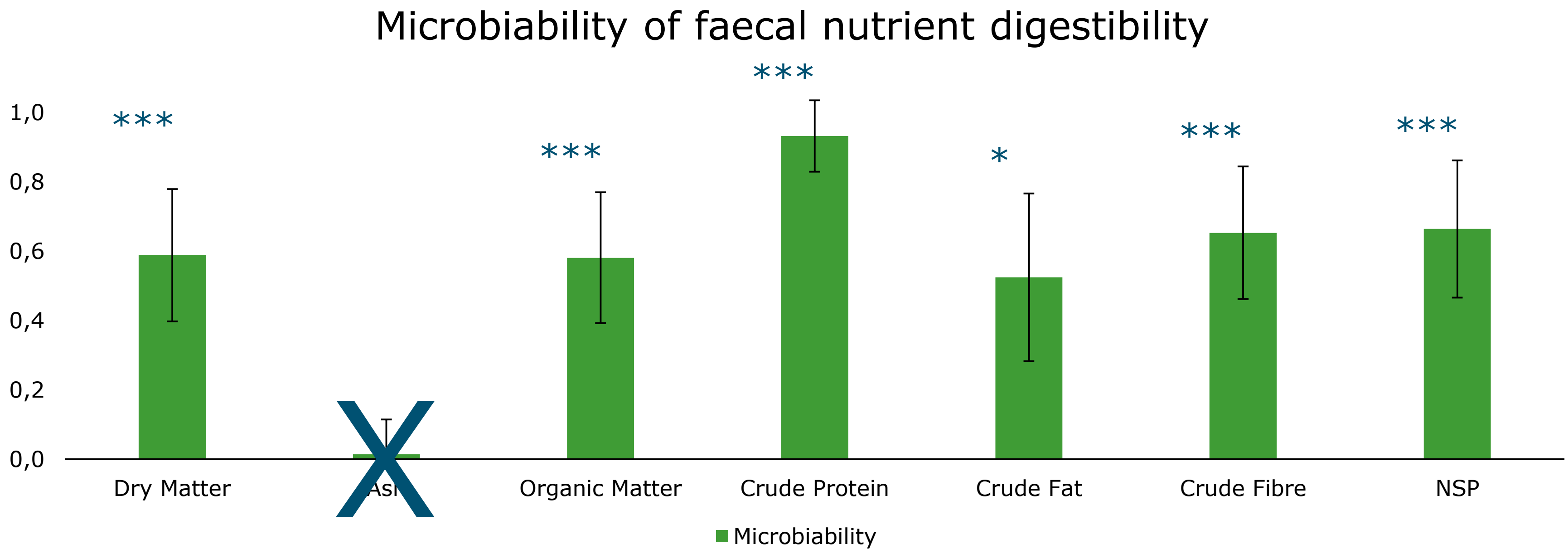

Common litter effect of faecal nutrient digestibility

# Results & Discussion (II)



# Results & Discussion (III)

| OTU | Phylum | Class | Family | Genera | Contribution to $m^2$ of CP |
|---|---|---|---|---|---|
| OTU843086 | Bacteroidetes | Bacteroidia | [Paraprevotellaceae] | [Prevotella] | 1.08 |
| OTU130147 | Bacteroidetes | Bacteroidia | [Paraprevotellaceae] | [Prevotella] | 0.94 |
| OTU781124 | Bacteroidetes | Bacteroidia | [Paraprevotellaceae] | [Prevotella] | 0.85 |
| OTU753291 | Bacteroidetes | Bacteroidia | [Paraprevotellaceae] | [Prevotella] | 0.52 |
| OTU424454 | Bacteroidetes | Bacteroidia | [Paraprevotellaceae] | [Prevotella] | 0.49 |

Greengenes core set 13_8

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- Model: $\mathbf{y} = \mathbf{Xb} + \mathbf{Zm} + \xcancel{\mathbf{Uc}} + \mathbf{e}$
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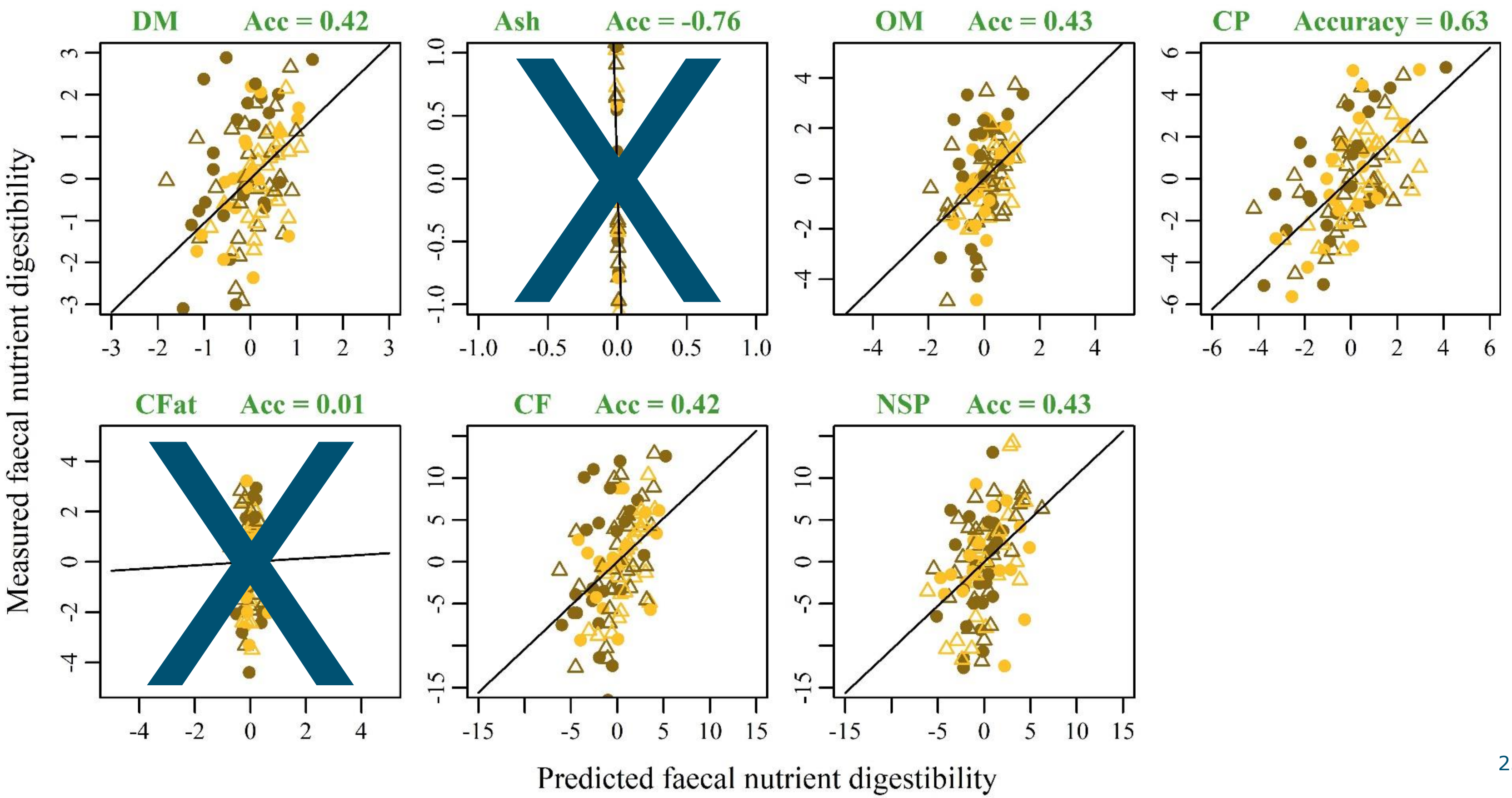
Subsequently a leave-one out analysis was performed to test for predictive capacity

# Results & Discussion (III)

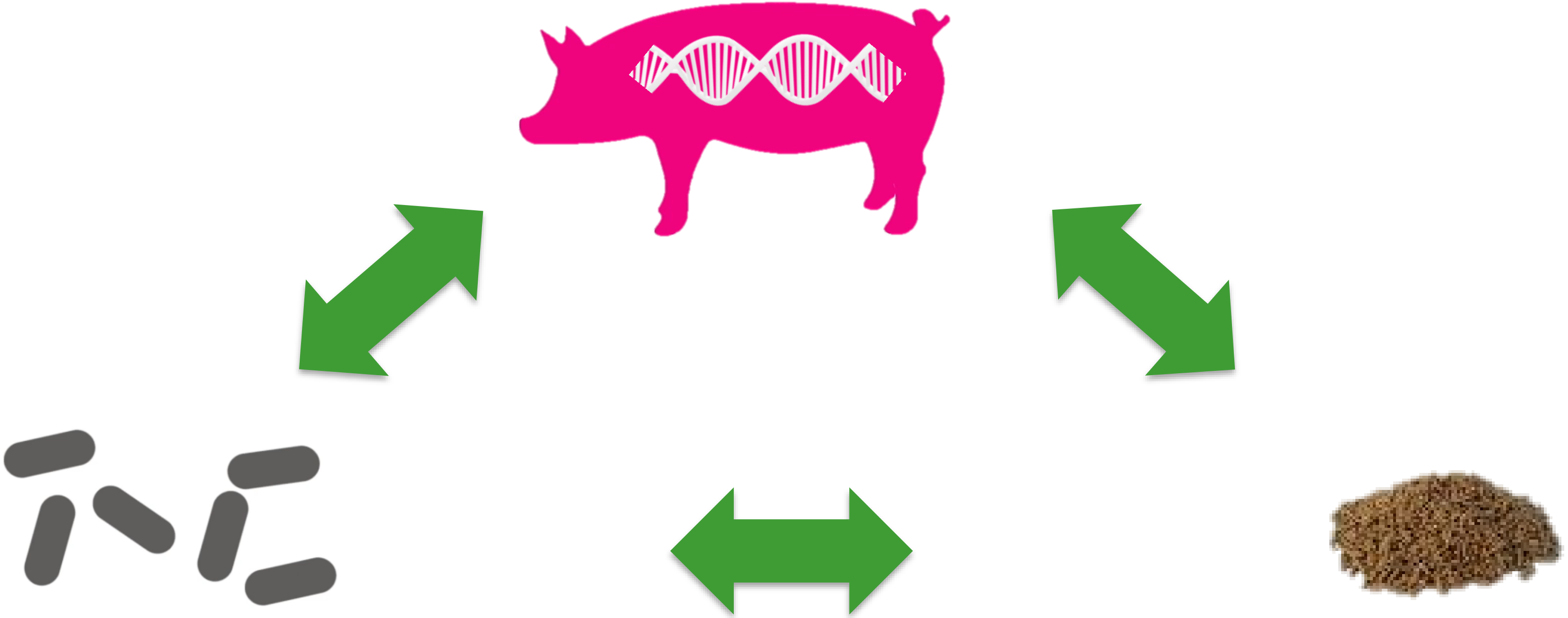


# Conclusion

- Prediction of faecal digestibility using metagenomic profiles:
  - Possible for DM, OM, CP, CF, and NSP
  - Accuracies too low for nutrition studies; BUT promising to rank animals

- No effect of common litter on faecal digestibility of nutrients

# Future



# Acknowledgement

Animal Breeding
& Genomics

Animal nutrition

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Topigs Norsvin
PROGRESS IN PIGS

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# Take home message

Faecal digestibility of DM, OM, CP, CF, and NSP can be predicted based on metagenomics

The predictions can subsequently be used as phenotypes in genetic or genomic selection