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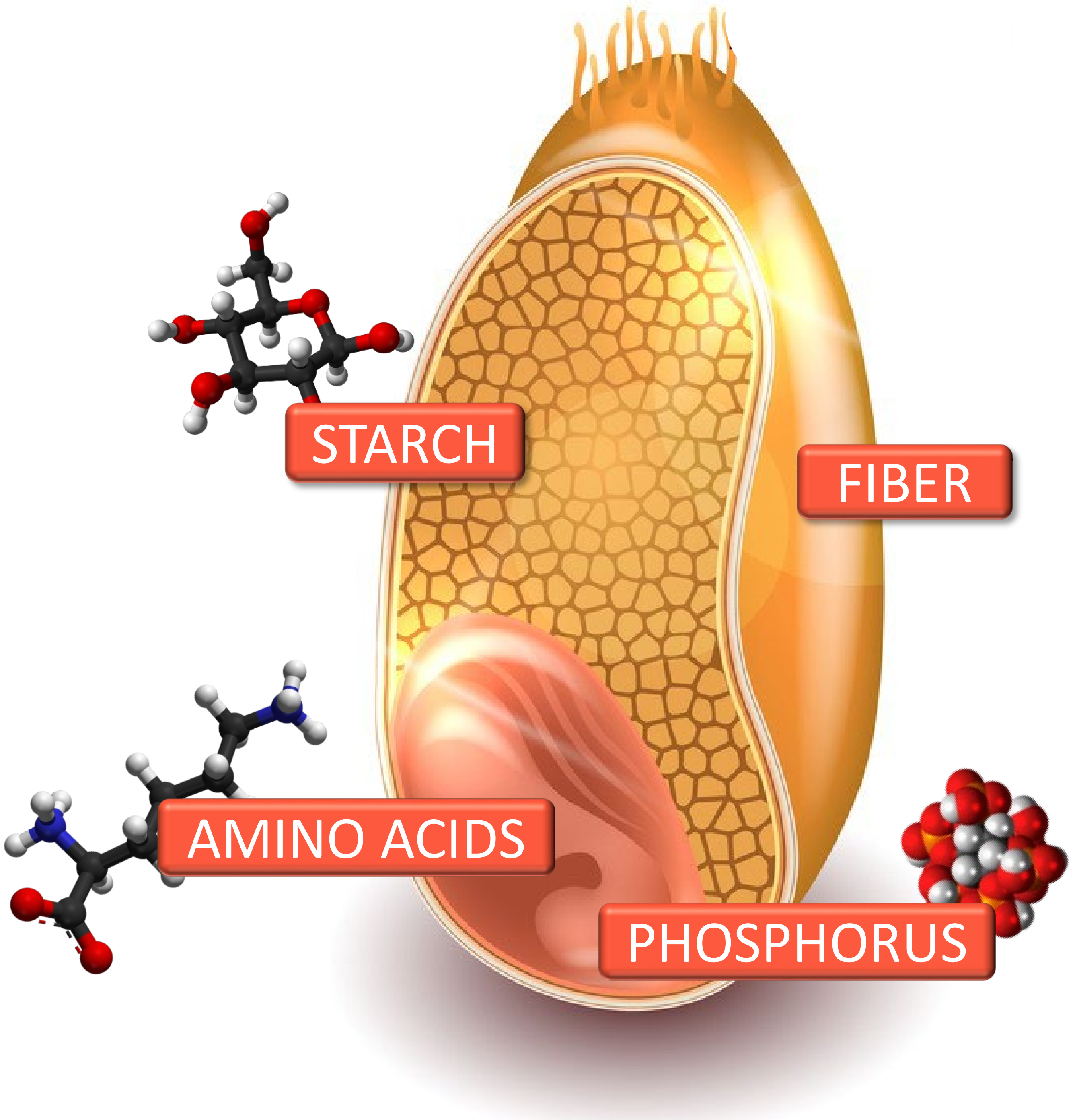
Nutritional Value of Hybrid Rye for Pigs

Molly McGhee

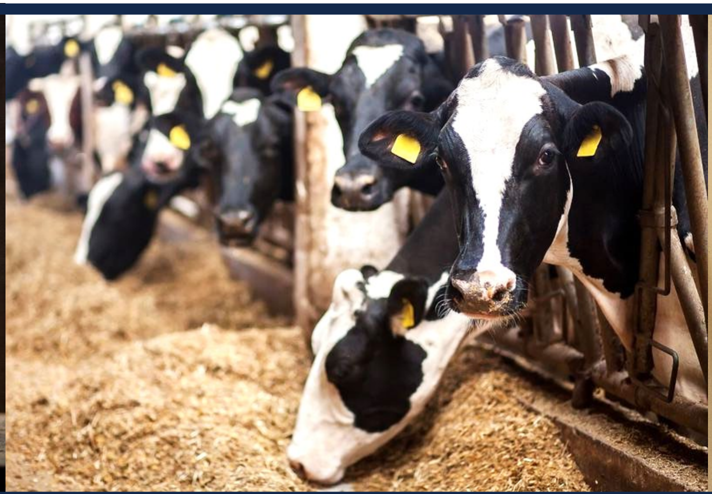
UNIVERSITY OF ILLINOIS

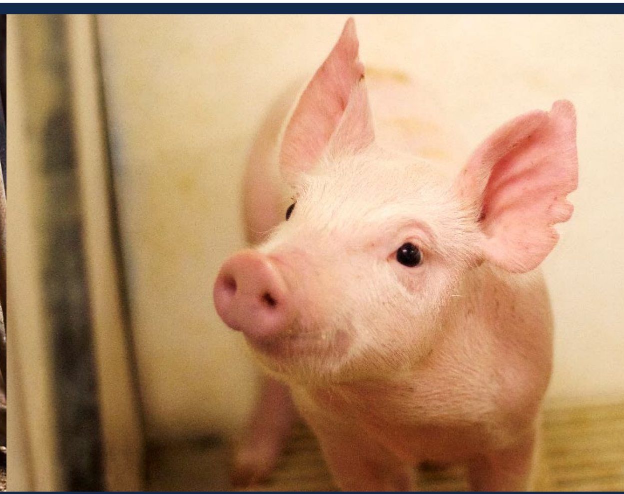
Outline

- BACKGROUND
- DIGESTIBLE NUTRIENTS
- PIG PERFORMANCE



Hybrid Rye



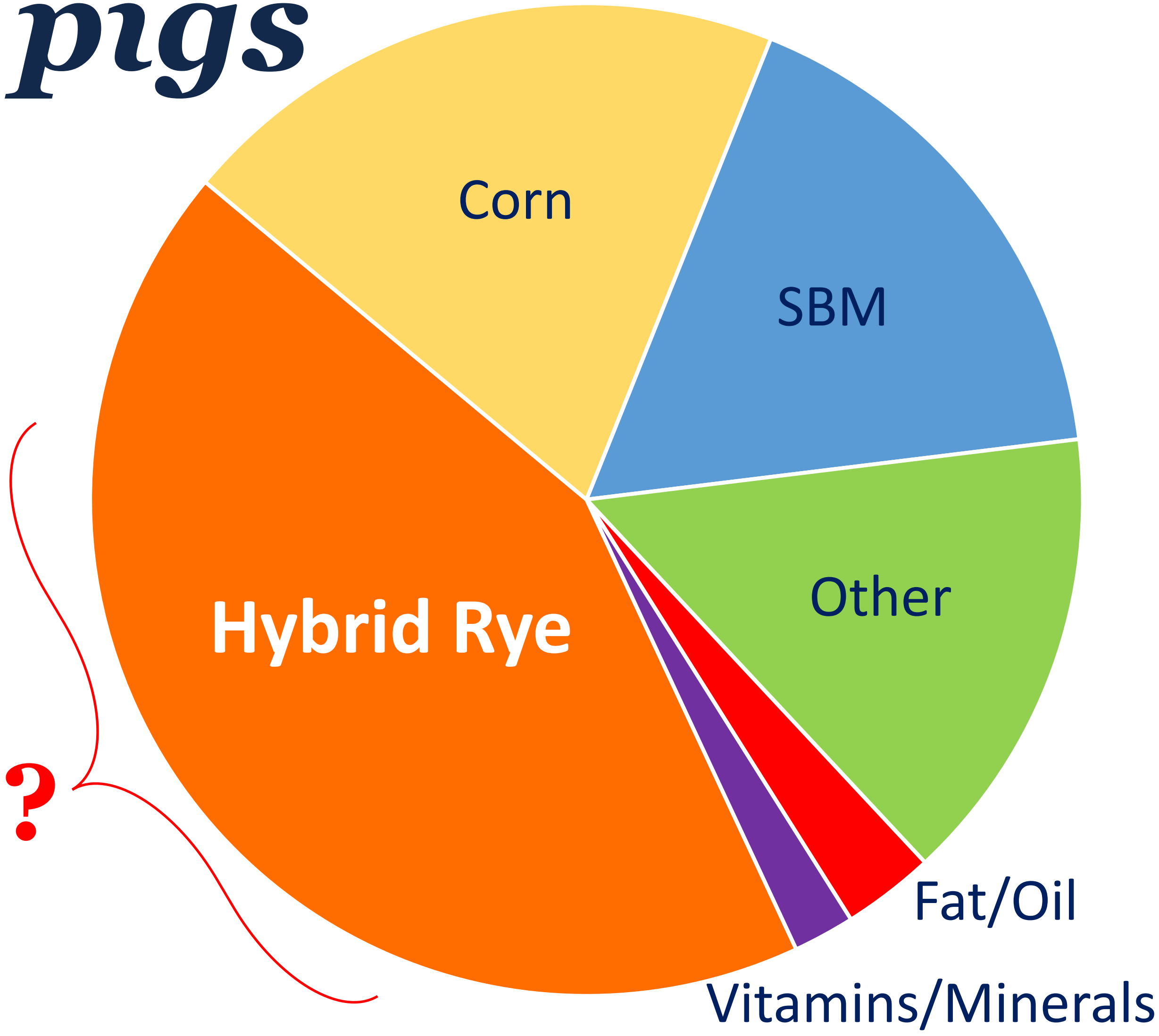


Hybrid Rye *for pigs*

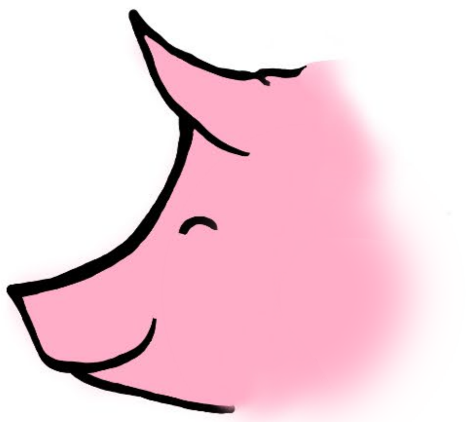
Objective of swine nutrition

"Provide each nutrient in both quantity and form that will precisely meet the pig's requirements for growth, reproduction, milk production, and if necessary, maintenance, at the least possible cost."

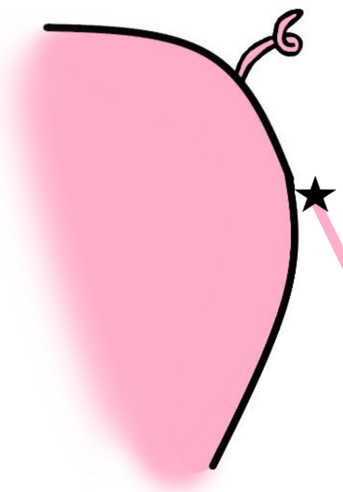
-Dr. Robert Easter



FEED INGESTION

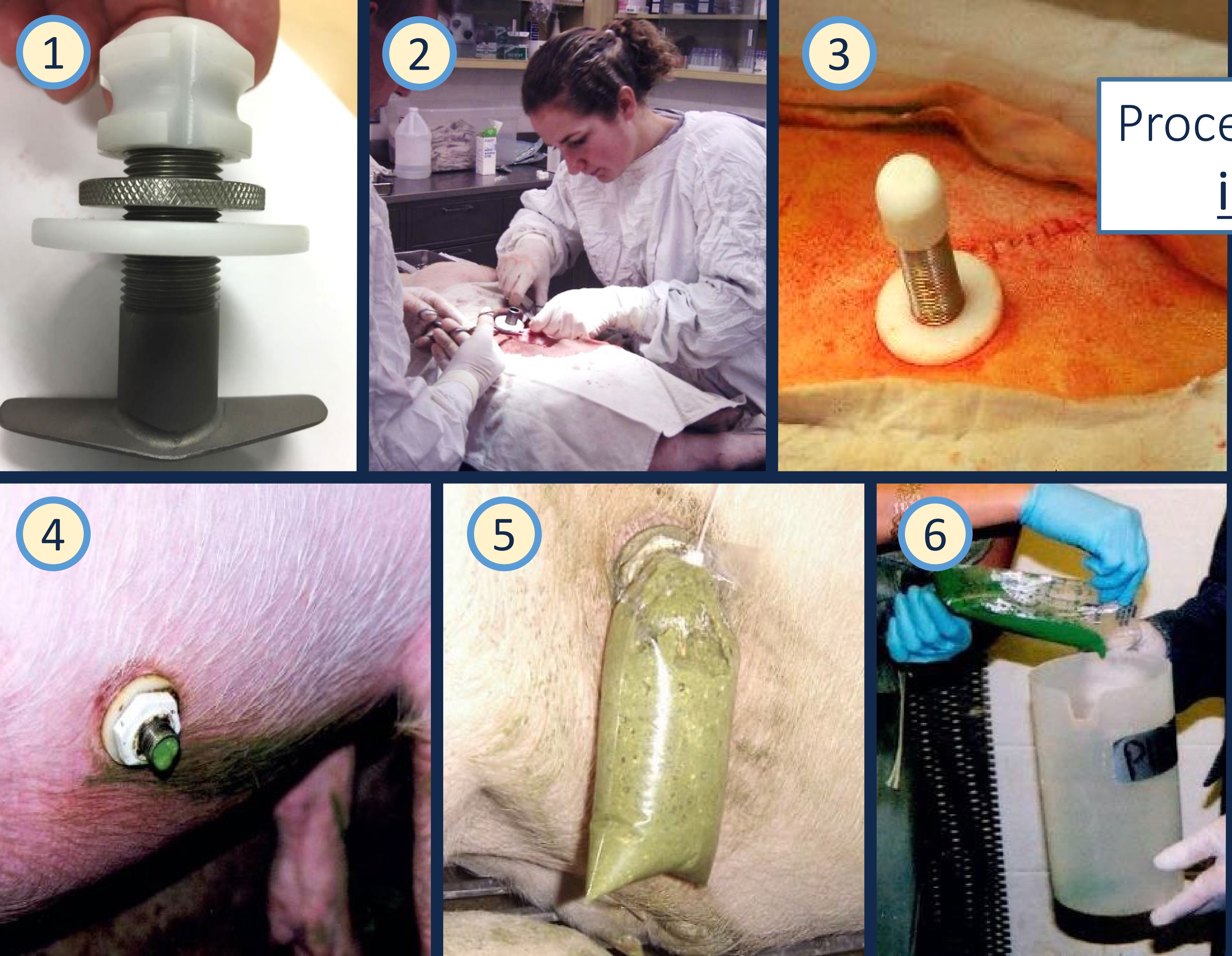


ILEAL OUTPUT =
ileal digestibility



FECAL OUTPUT=
total tract digestibility

Procedure for measuring <u>ileal digestibility</u>



Used for:

AMINO ACIDS

STARCH

Procedure for measuring <u>total tract digestibility</u>

Used for:

ENERGY
MINERALS
FIBER

day 1 — 5 — 10

ADAPTATION (day 1–5)

COLLECTION (day 5–10)

EXP. 1

Amino Acid Digestibility

Apparent and standardized ileal digestibility of AA and starch in hybrid rye, barley, wheat, and corn fed to growing pigs[1]

Molly L. McGhee and Hans. H. Stein[2]

Department of Animal Sciences, University of Illinois, Urbana, IL 61801

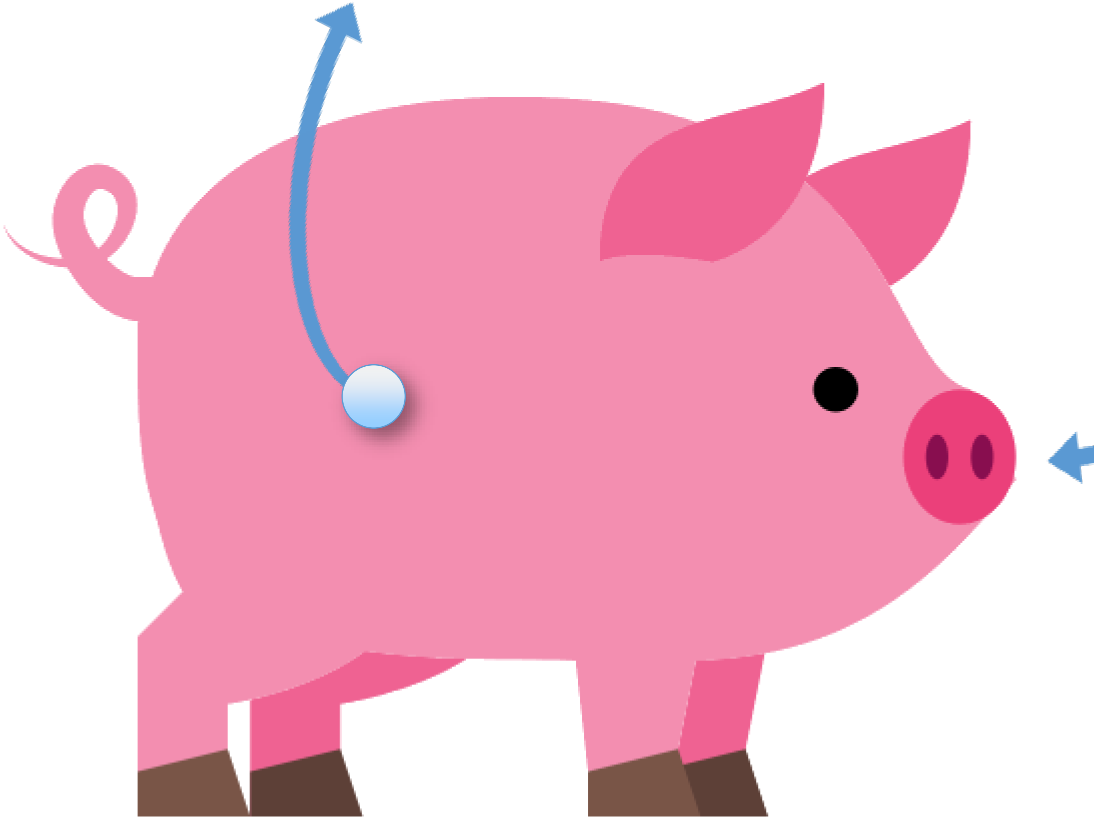
ABSTRACT: An experiment was conducted to determine the apparent ileal digestibility (**AID**) of AA and starch and the standardized ileal digestibility (**SID**) of AA in three varieties of hybrid rye and in one source of barley, wheat, and corn. Seven growing barrows (initial BW = 26.1 ± 2.4 kg) were randomly allotted to a 7 × 7 Latin square design with seven periods and seven experimental diets. Six diets included one of the grains as the sole source of AA, and an N-free diet was used to determine basal endogenous losses of CP and AA. In each period, ileal digesta were collected for 8 h on days 6 and 7 following a 5-d adaptation period. At the conclusion of the experiment, all ingredients, diets, and ileal digesta samples were analyzed for starch, CP, and AA. The AID of starch was greater ($P < 0.05$) in wheat and corn than in barley or hybrid rye, but all grains had AID values for starch that were above 95%. Wheat and barley contained more CP and indispensable AA than hybrid rye, but hybrid rye contained more indispensable AA compared with corn. The SID of CP and all indispensable AA was greater ($P < 0.05$) in barley, wheat, and corn than in the three varieties of rye. However, because of the greater concentration of AA in hybrid rye than in corn, the quantities of standardized ileal digestible CP and AA were not different between corn and hybrid rye. In conclusion, hybrid rye has greater concentrations of most AA than corn, but the digestibility of AA in rye is less than in other cereal grains. It is likely that the reason for the reduced SID of AA in rye is that rye contains more fructans and soluble dietary fiber than other cereal grains, which may increase viscosity and reduce the efficiency of endogenous peptidases.

Key words: AA digestibility, cereal grains, hybrid rye, pigs, starch digestibility

J. Anim. Sci. 2018.96:3319–3329

doi: 10.1093/jas/sky206

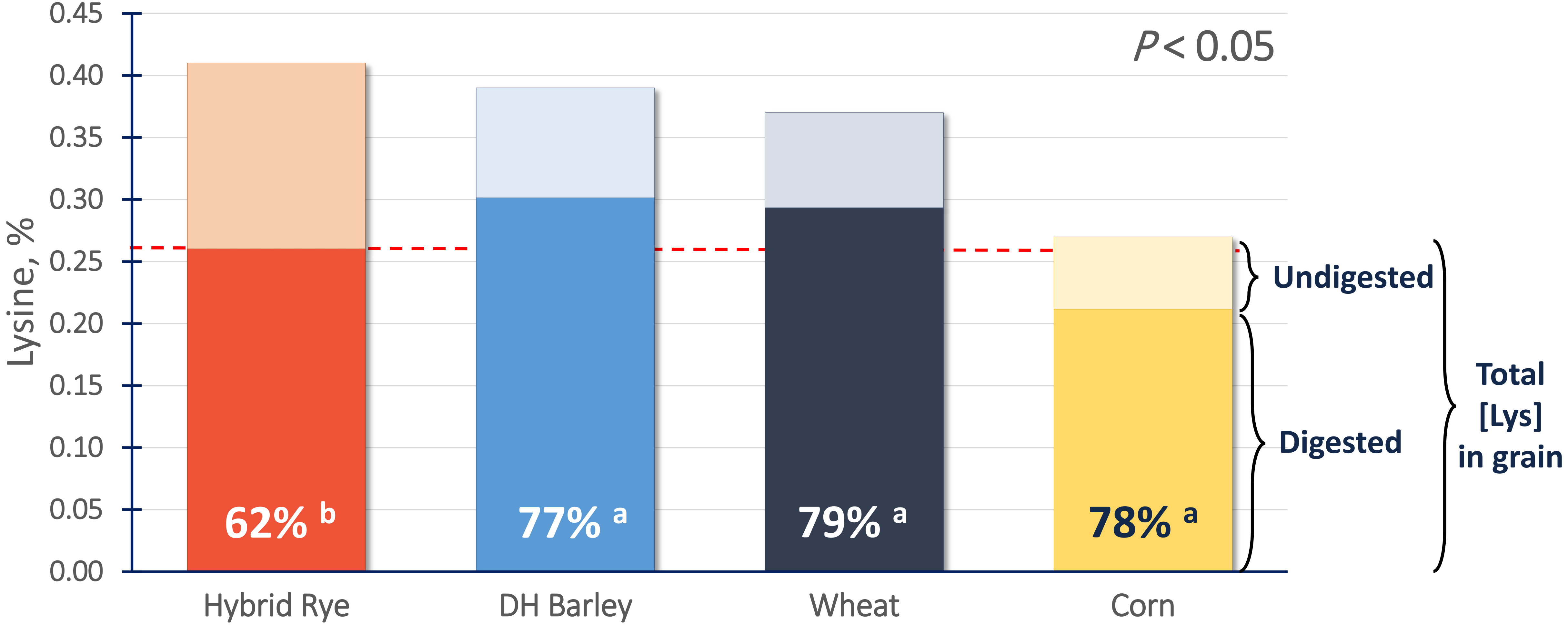
SID = 64%



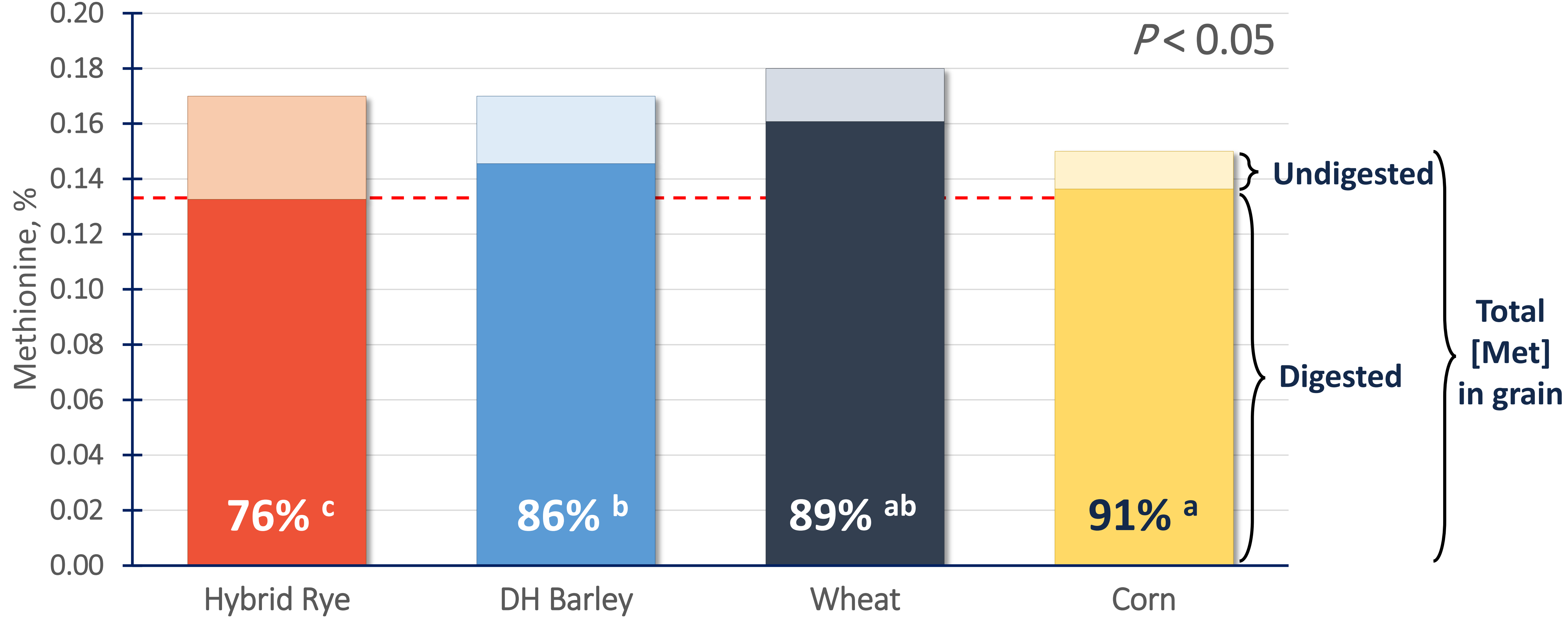
0.41% Lysine

0.26% *SID* Lysine

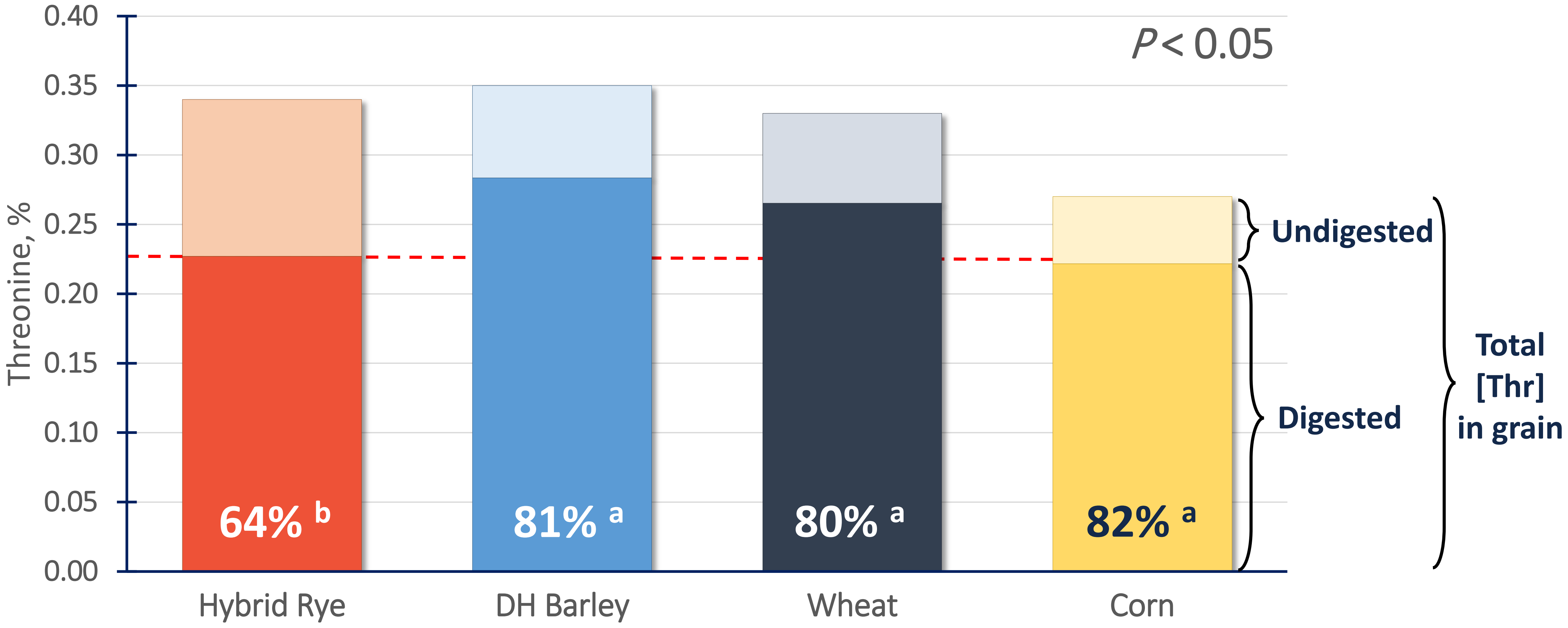
Digestible Lysine (SID)



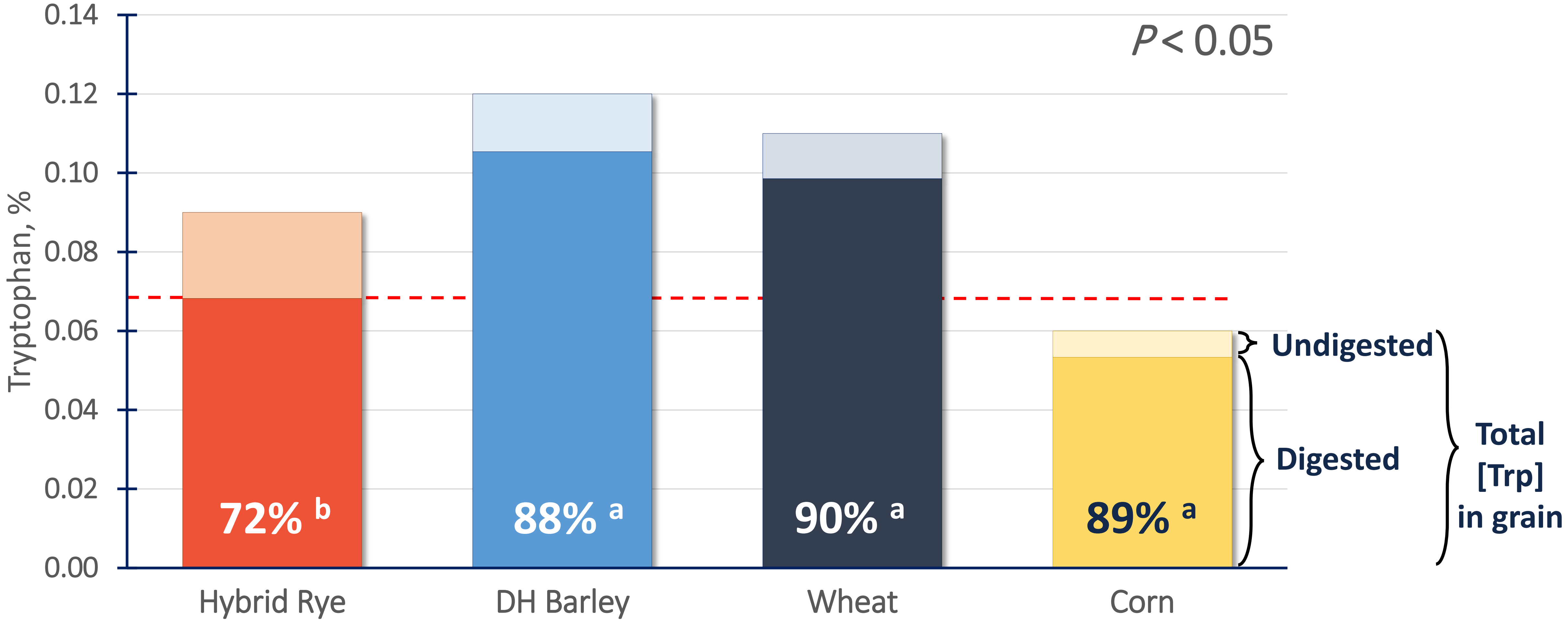
Digestible Methionine (SID)



Digestible Threonine (SID)



Digestible Tryptophan (SID)



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Exp. 1 Conclusions

AA digestibility: Hybrid rye < Other grains

Antinutritive factors (insoluble fiber), viscosity

Quantities of digestible AA: Hybrid rye ≈ corn

Similar diet formulations for corn & rye

EXP. 2

Phosphorus Digestibility

Effects of microbial phytase on standardized total tract digestibility of phosphorus in hybrid rye, barley, wheat, corn, and sorghum fed to growing pigs[1]

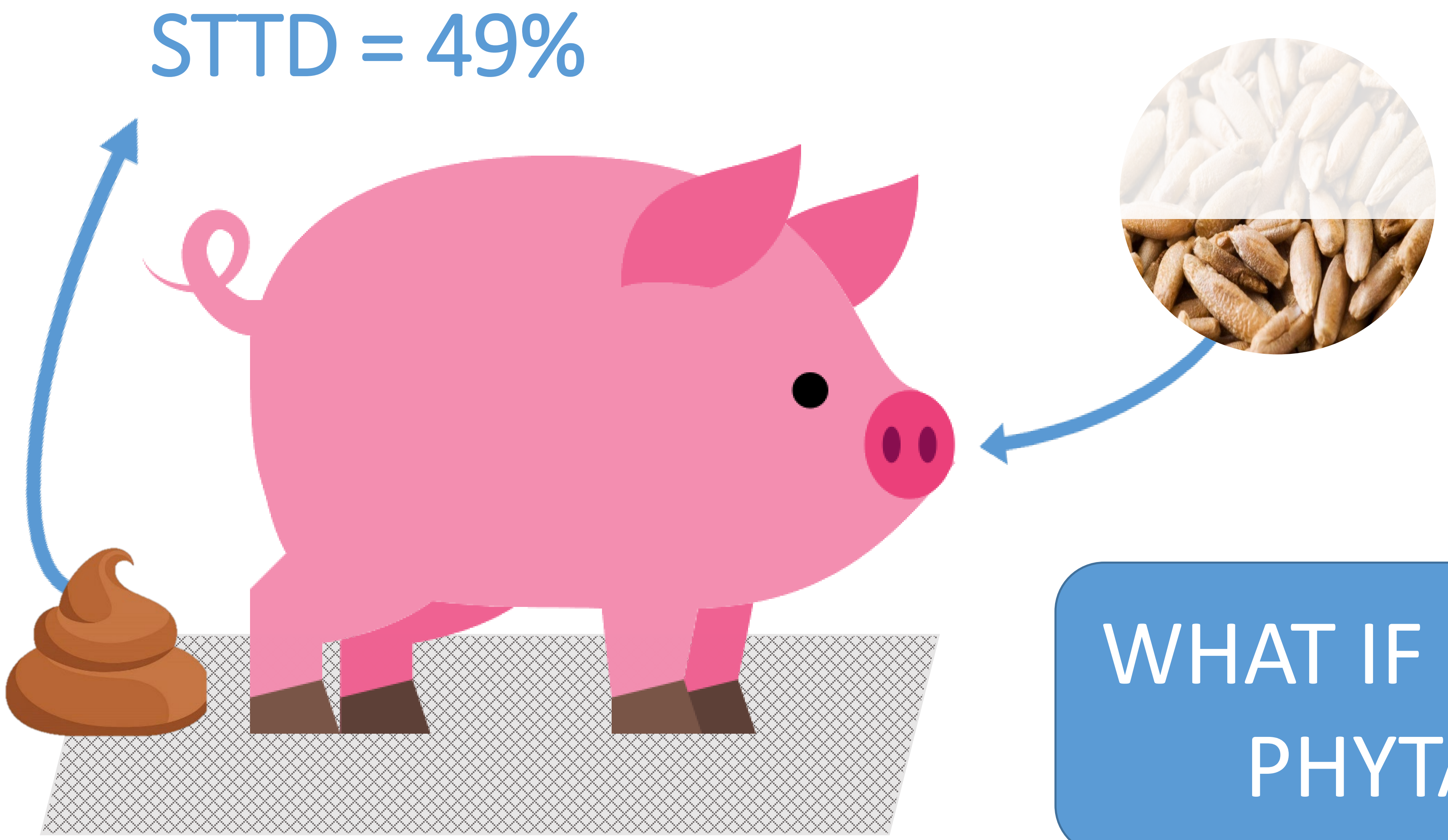
Molly L. McGhee and Hans H. Stein[2]

Department of Animal Sciences, University of Illinois, Urbana, IL 61801

ABSTRACT: An experiment was conducted to determine the apparent total tract digestibility (ATTD) and the standardized total tract digestibility (STTD) of P in three varieties of hybrid rye and in one source of barley, wheat, corn, and sorghum. The STTD of P in each cereal grain was determined both without and with addition of microbial phytase. In total, 112 growing barrows (13.7 ± 1.3 kg initial BW) were allotted to a randomized complete block design with four blocks of 28 pigs. Pigs were randomly allotted to 14 diets with two replicate pigs per diet in each block, resulting in a total of eight replicate pigs per diet for the four blocks. Each diet contained one of the cereal grains as the sole source of P. There were two diets with each cereal grain with one diet containing no microbial phytase and the other diet containing 1,000 units of microbial phytase per kilogram of diet. In each period, fecal output was collected for 5 d following a 5-d adaptation period according to the marker-to-marker procedure. Among the diets that did not include microbial phytase, one hybrid of rye had greater ($P < 0.05$) STTD of P than wheat, corn, and sorghum, which is likely a result of the greater intrinsic phytase activity in rye than in the other cereal grains. Without microbial phytase, there was no difference in the STTD of P in the three hybrids of rye and barley. Among the diets containing microbial phytase, there was no difference in STTD of P among the three hybrids of rye, barley, and corn. The STTD of P in the three hybrids of rye with microbial phytase was 61.9%, 70.8%, and 63.0%, respectively. Overall, microbial phytase improved ($P < 0.05$) the STTD of P in all cereal grains, although the magnitude of the increase in STTD of P differed among the grains.

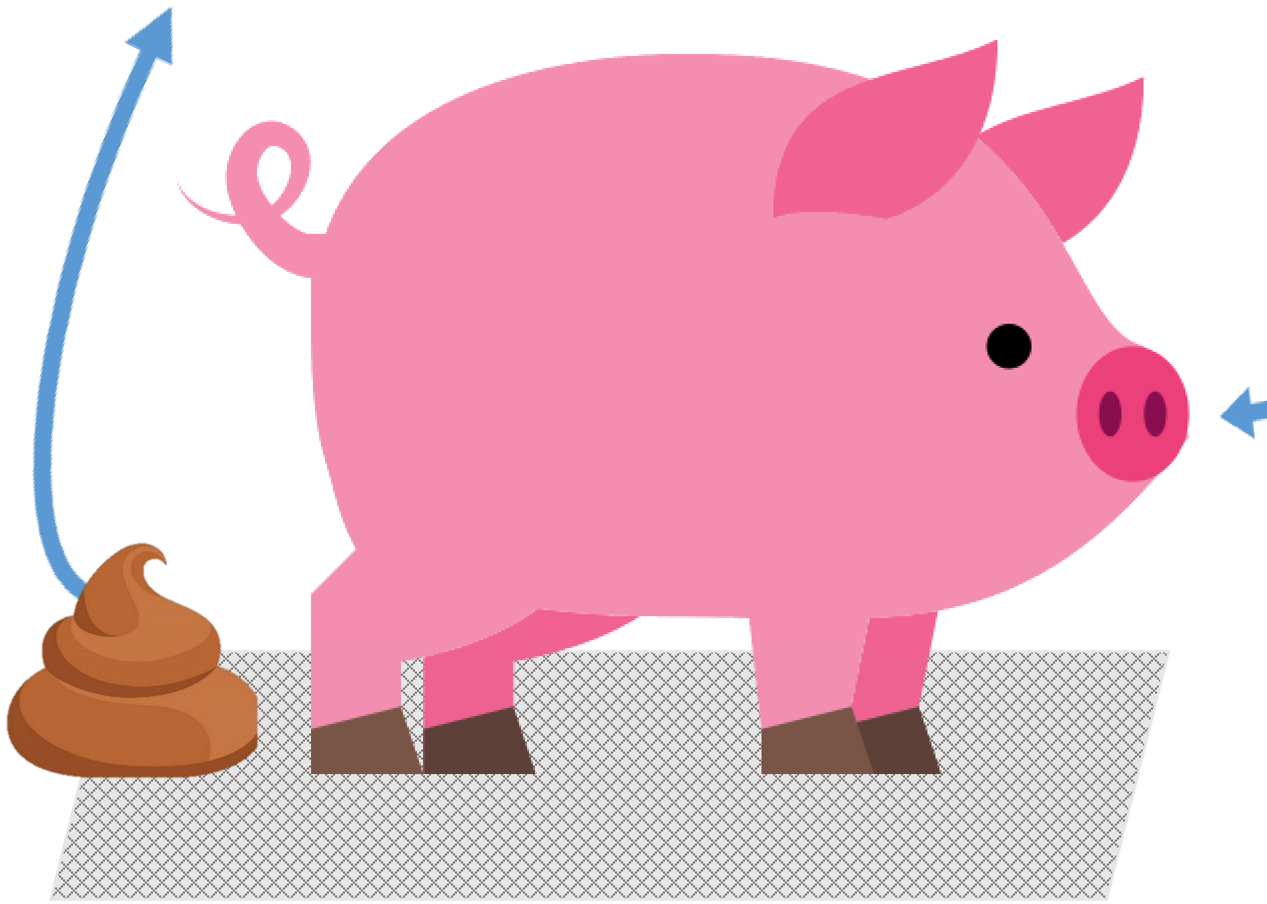
Key words: calcium, cereal grains, digestibility, hybrid rye, phosphorus, pigs

Transl. Anim. Sci. 2019.XX:0-0
doi: 10.1093/tas/txz088



WHAT IF WE ADD PHYTASE?

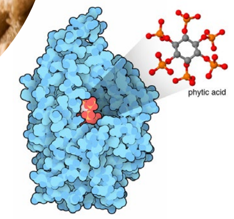
STTD = ~~49%~~ 63%



0.29% Phosphorus

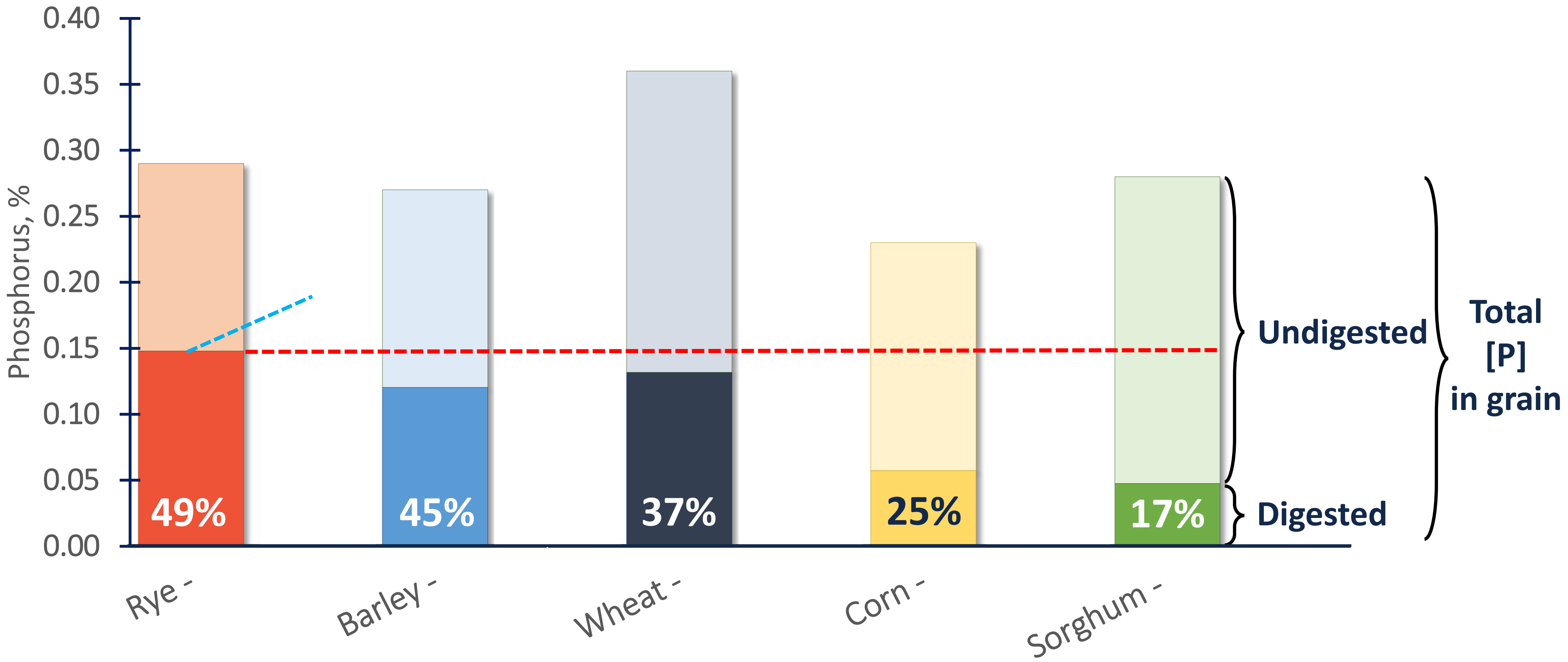
0.18% *STTD P*

\+

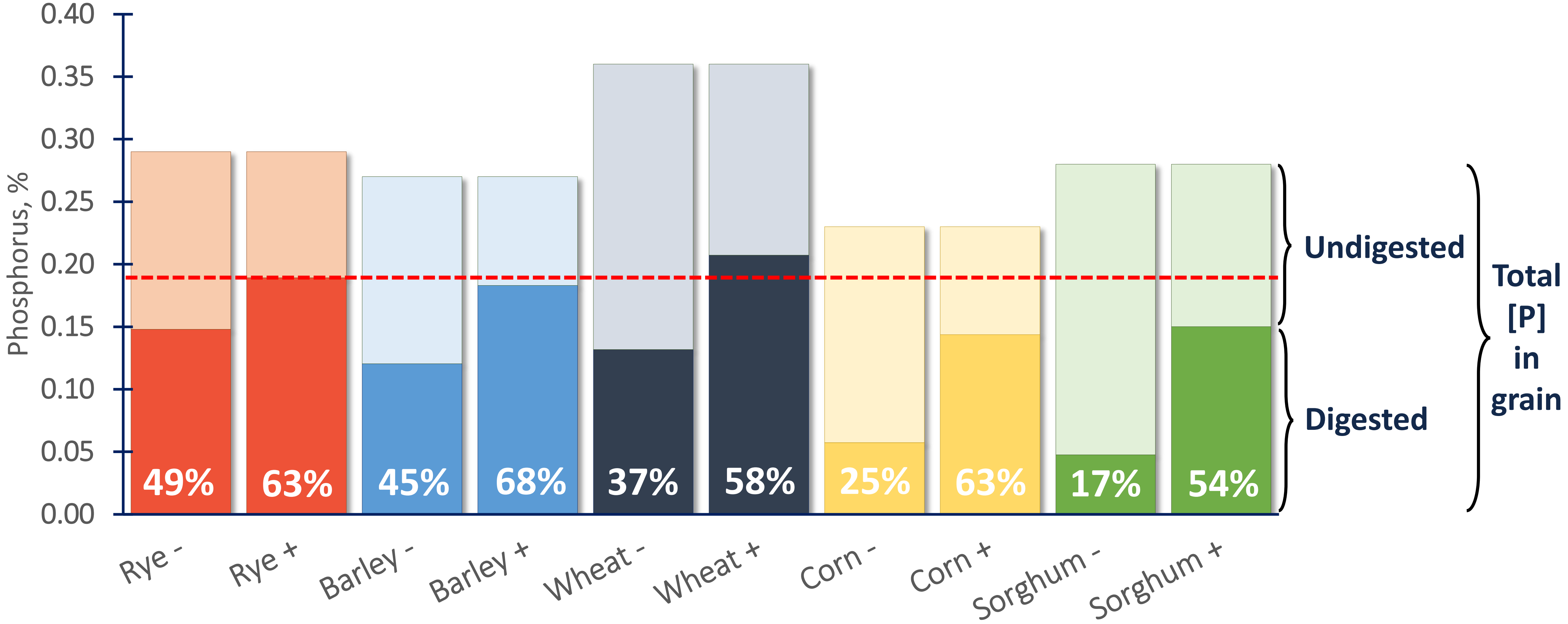


WHAT IF WE ADD PHYTASE?

Digestible Phosphorus (STTD)



Digestible Phosphorus (STTD)



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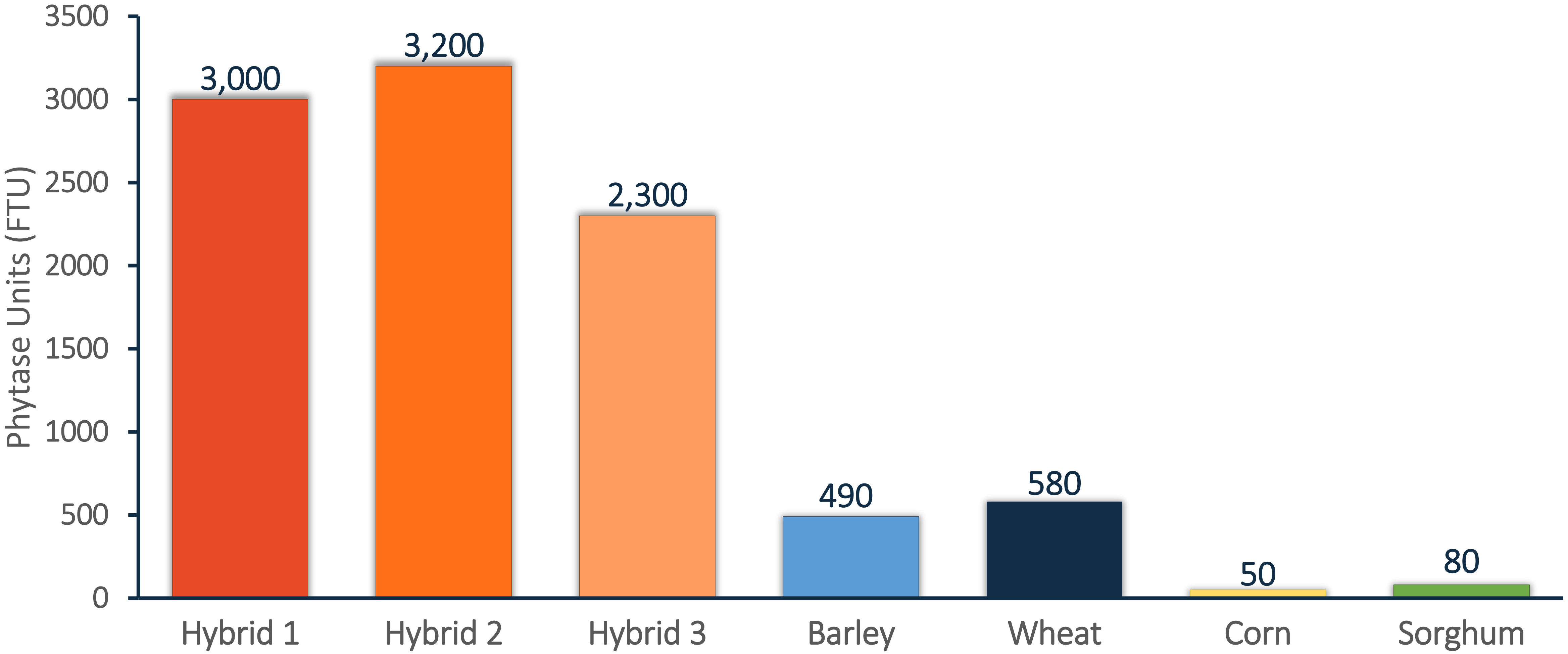
Intrinsic phytase



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Exp. 2 Conclusions

Hybrid rye contains large amounts of **intrinsic phytase**.

Therefore, P digestibility is relatively high to begin with.

Microbial phytase **increased** P digestibility in **all grains**.

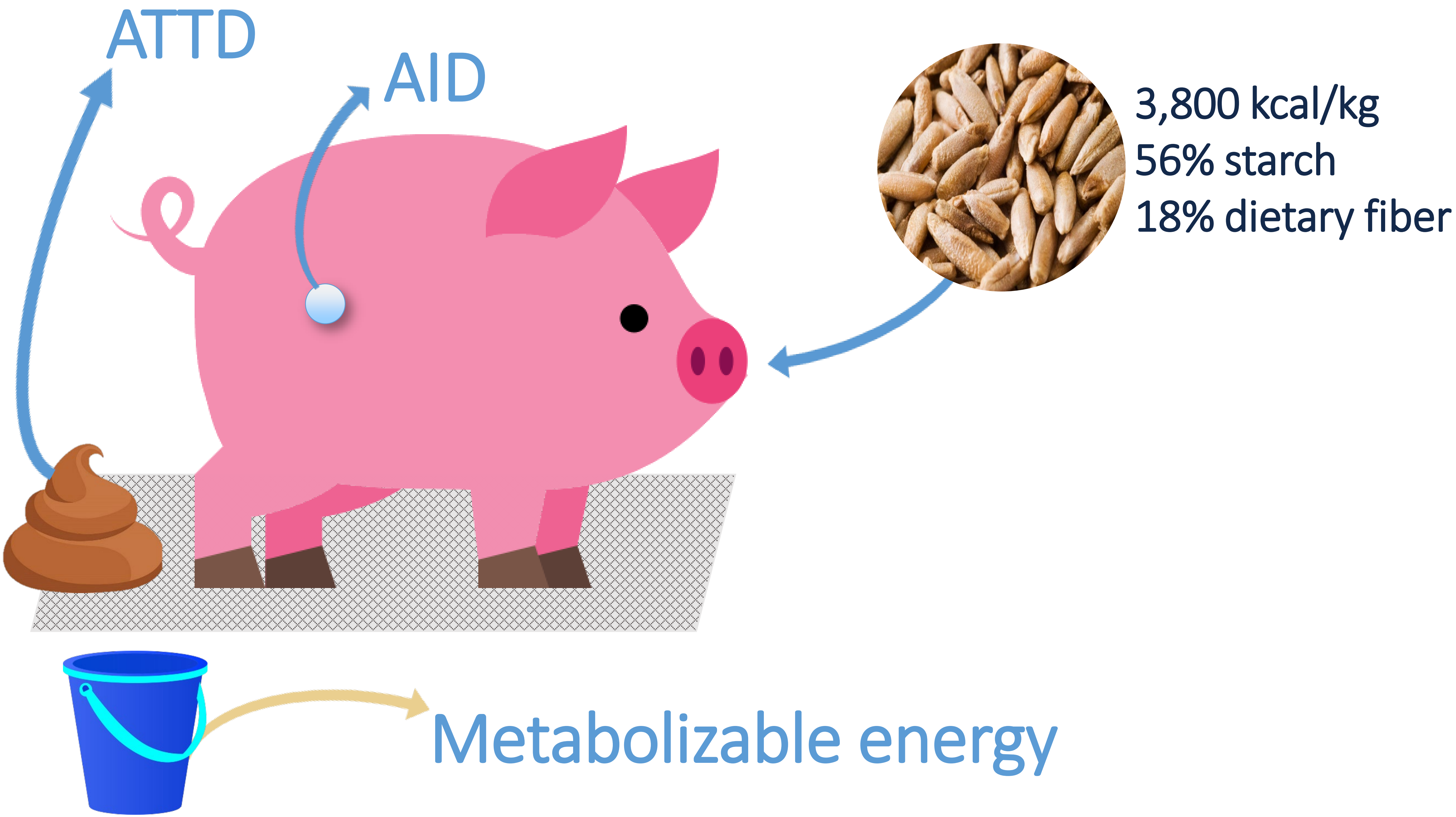
In rye, the increase was significant, but less pronounced.

Conc. of **digestible P** in hybrid rye greater than in other grains

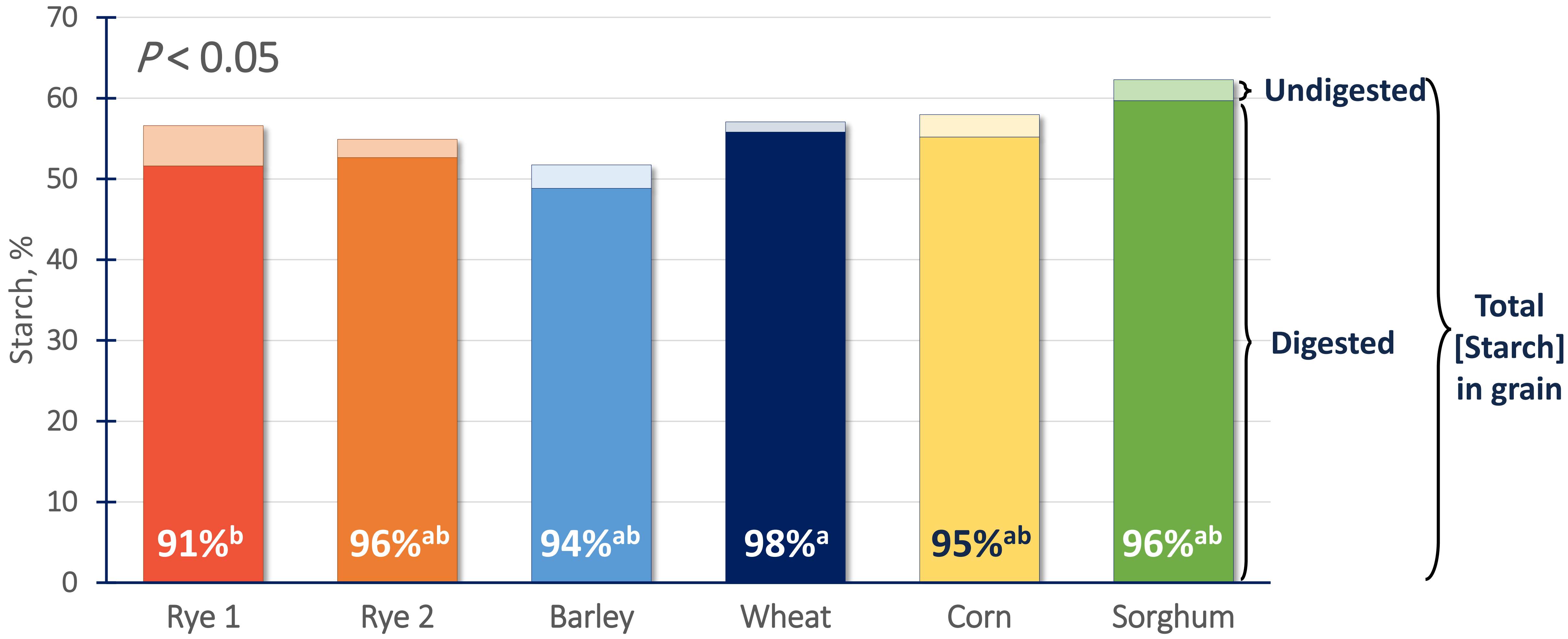
Less inorganic P needed in diets, less P excreted in feces

EXP. 3

Carbohydrate and Energy Digestibility

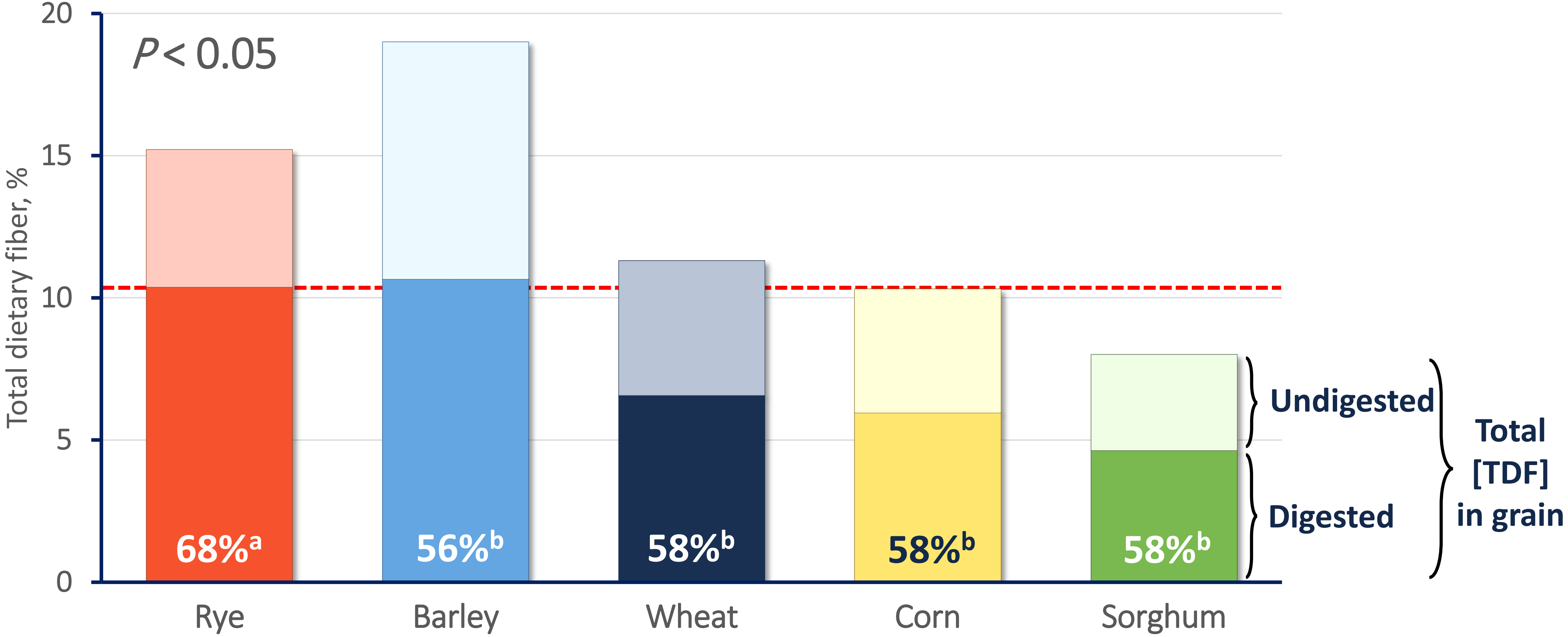

ATTD
AID
3,800 kcal/kg
56% starch
18% dietary fiber
Metabolizable energy

Starch (AID)

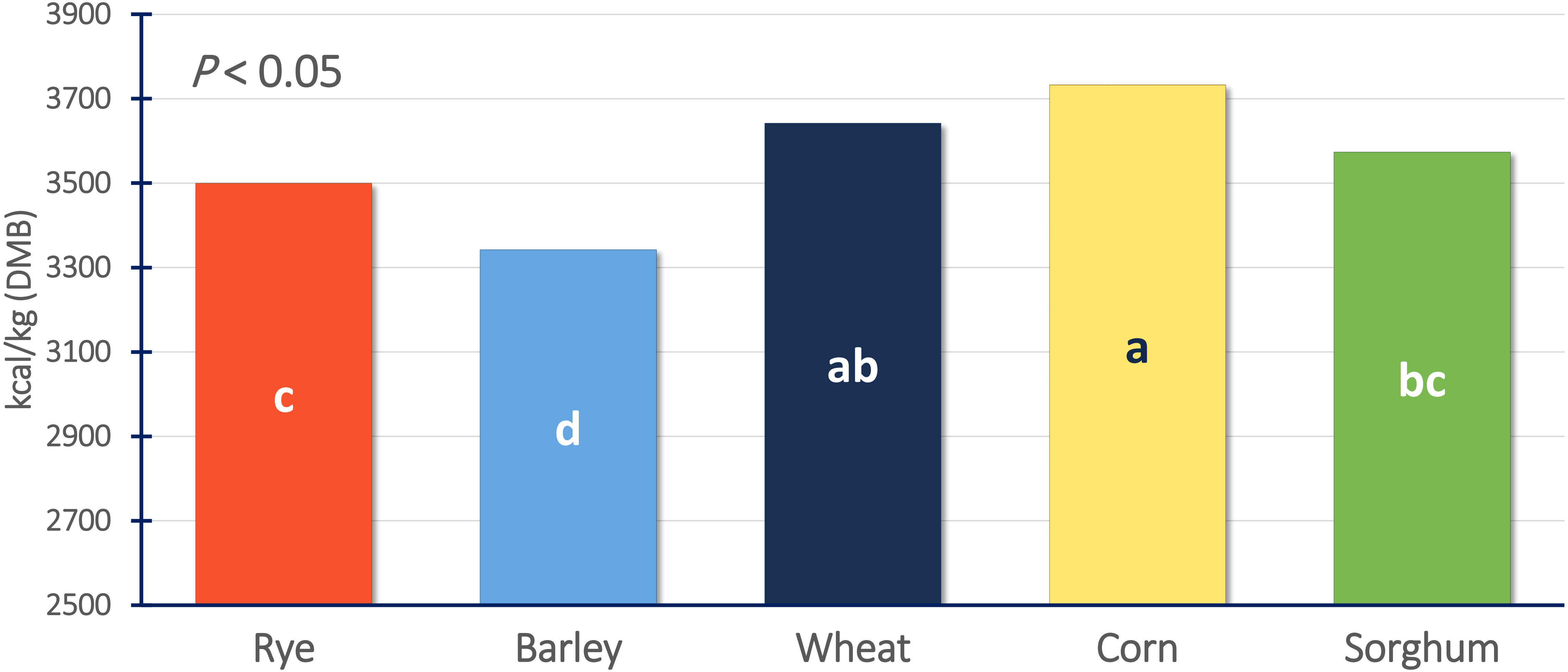


P < 0.05
Starch, %
70
60
50
40
30
20
10
0
91%b
96%ab
94%ab
98%a
95%ab
96%ab
Rye 1
Rye 2
Barley
Wheat
Corn
Sorghum
Undigested
Digested
Total [Starch] in grain

Total dietary fiber (ATTD)



Metabolizable energy, kcal/kg DMB



Exp. 3 Conclusions

Starch digestibility >90% in all cereal grains

Rye digestibility may differ among sources

Fermentation of rye fiber is **more** efficient than other grains

Contributes energy to pig via SCFA, may improve gut health!

Metabolizable energy in hybrid rye ≅ sorghum > barley

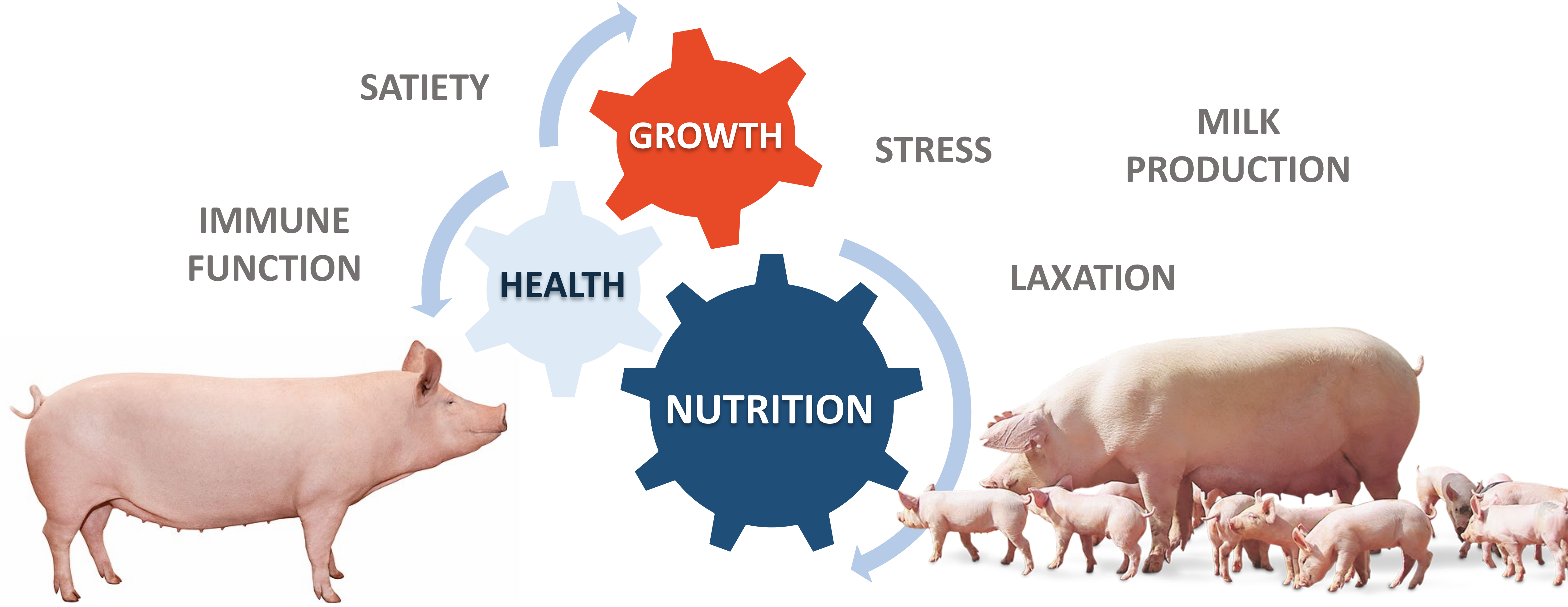
(Less than corn and wheat)

EXP. 4

Sow performance

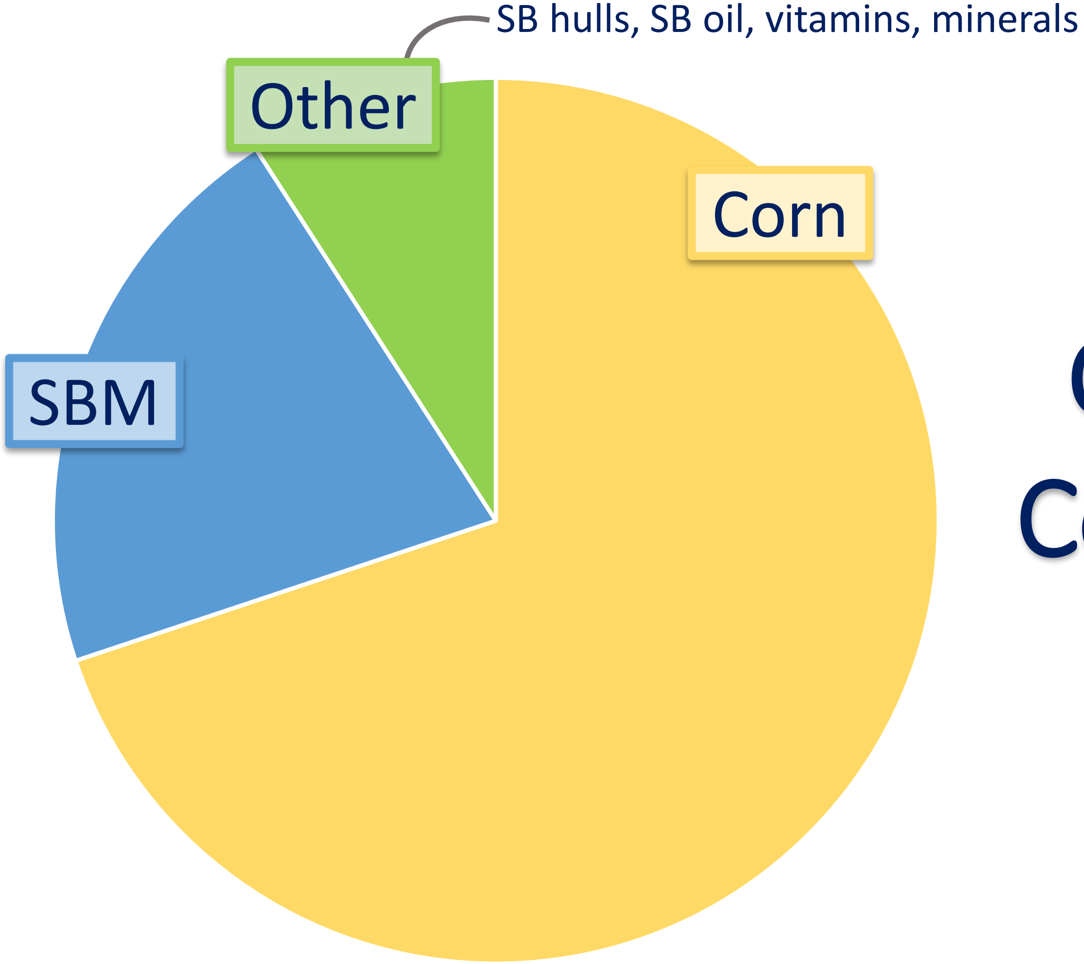
OCTOBER 2018 – AUGUST 2019

Hybrid rye for sows



Sow dietary treatments

FORMULATED FOR GESTATION + LACTATION



Control:
Corn/SBM

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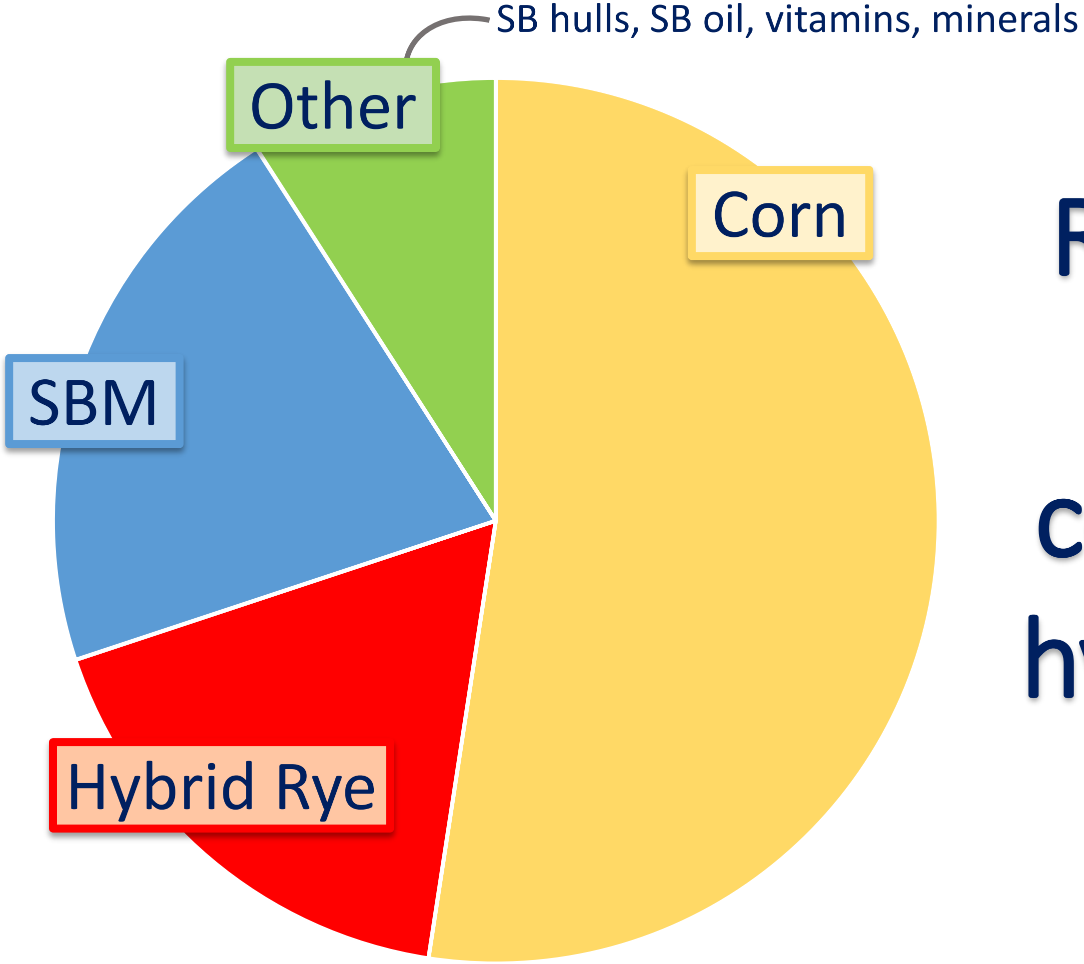
Sow dietary treatments

FORMULATED FOR GESTATION + LACTATION



Replaces **<u>25%</u>** of corn with hybrid rye

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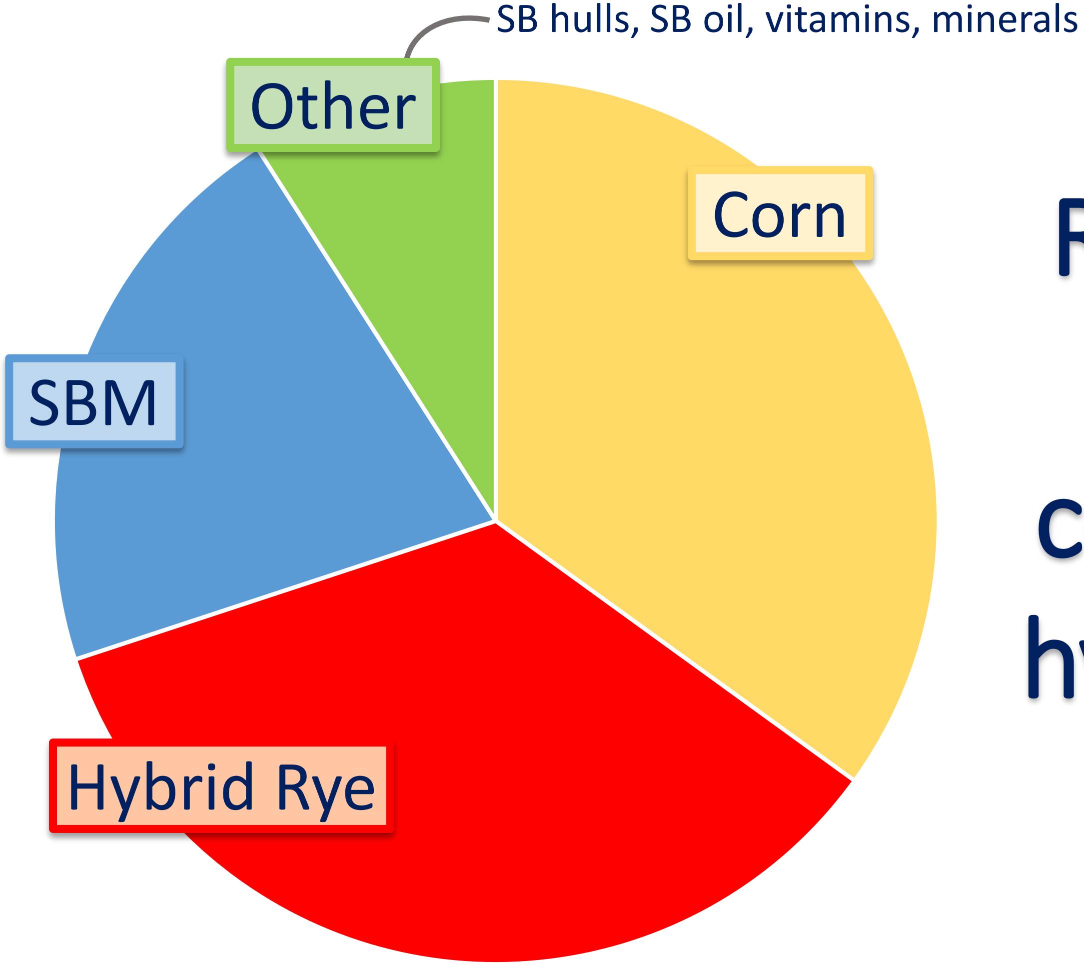
Sow dietary treatments

FORMULATED FOR GESTATION + LACTATION



Replaces **50%** of corn with hybrid rye

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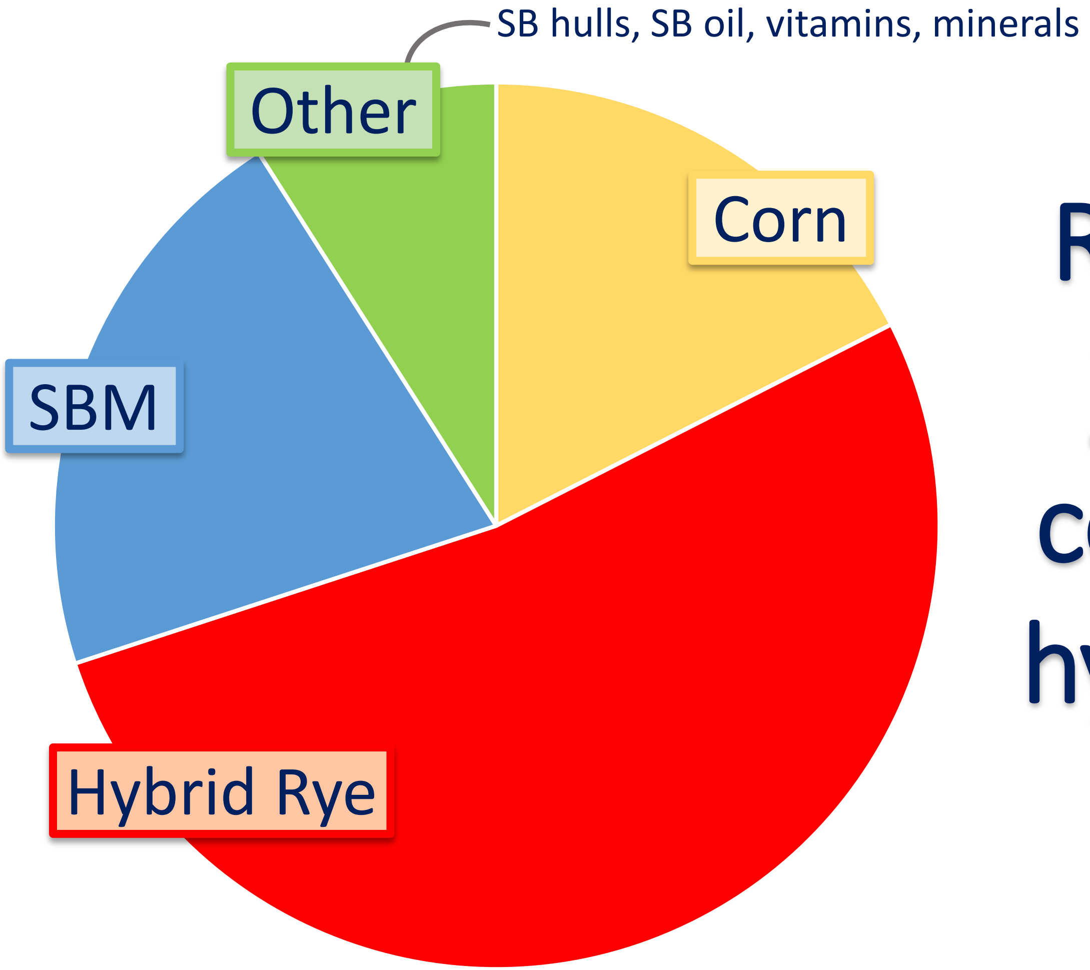
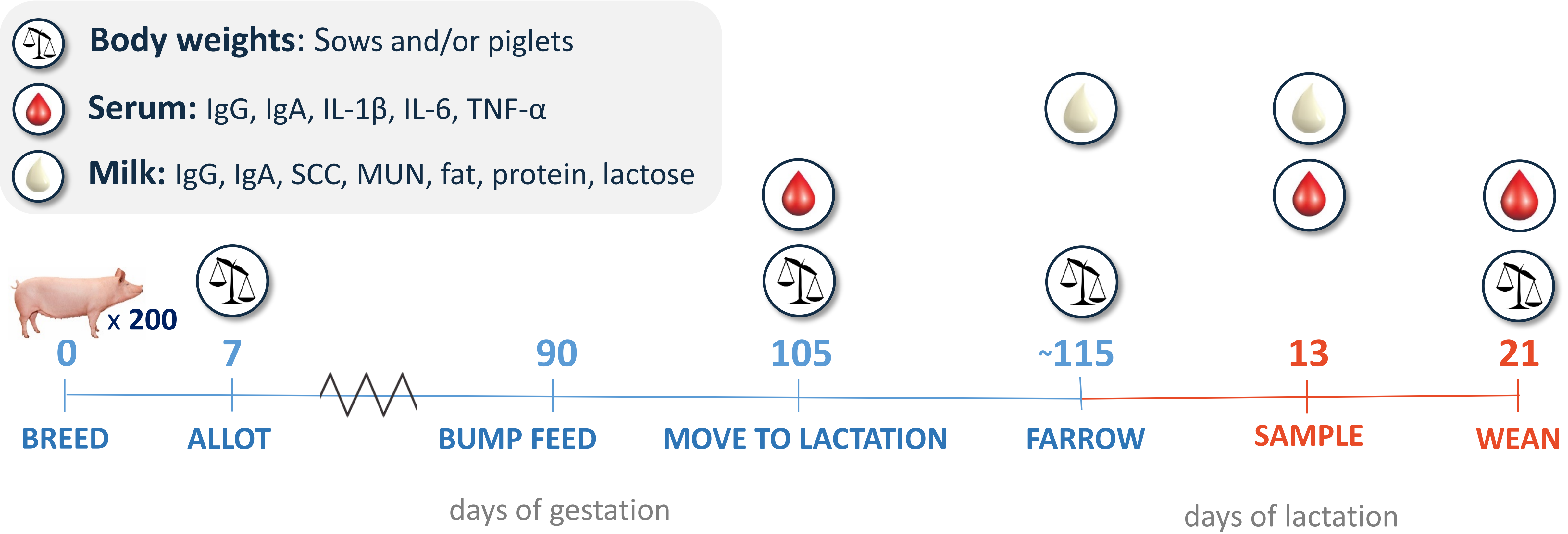
Sow dietary treatments

FORMULATED FOR GESTATION + LACTATION

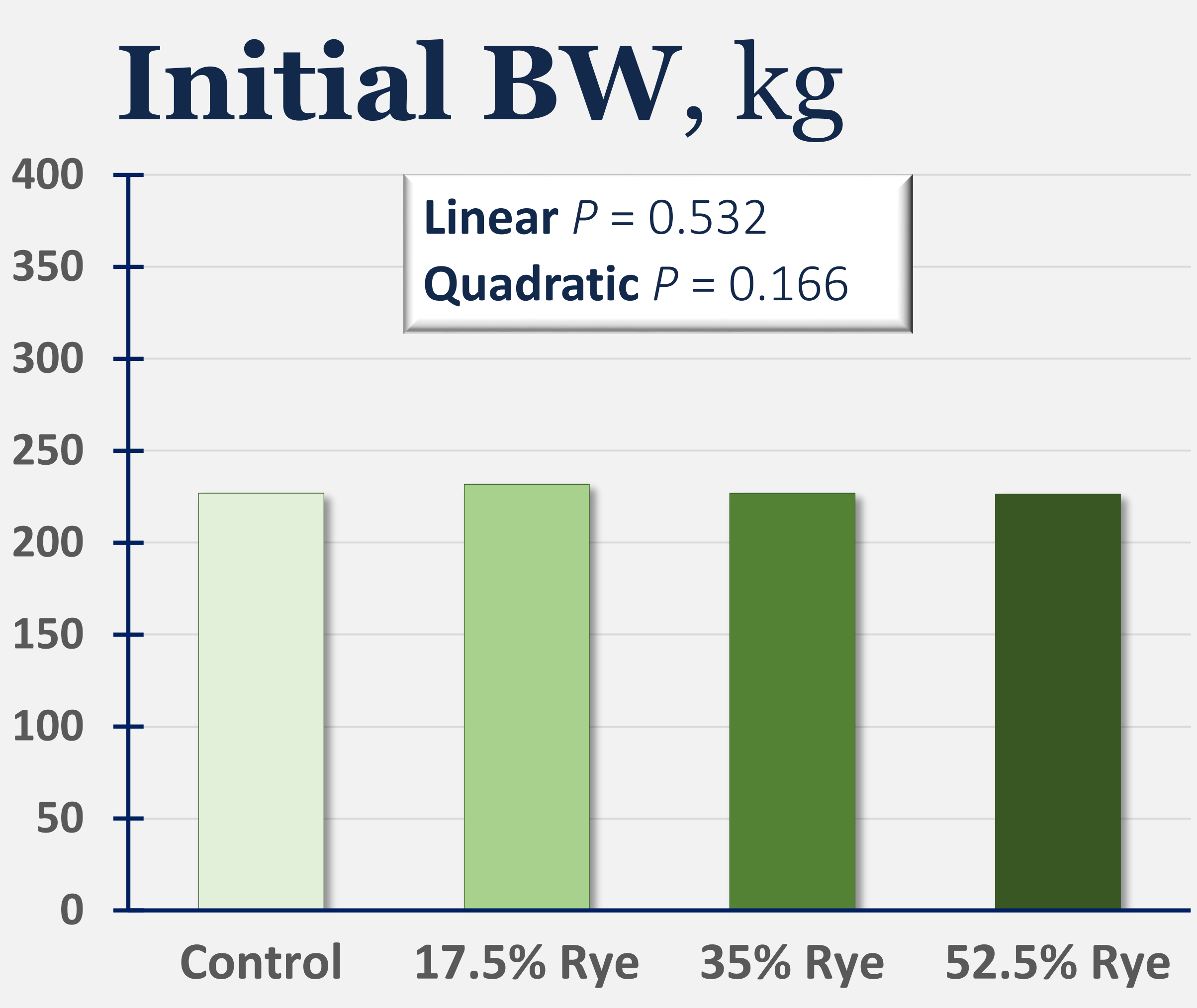


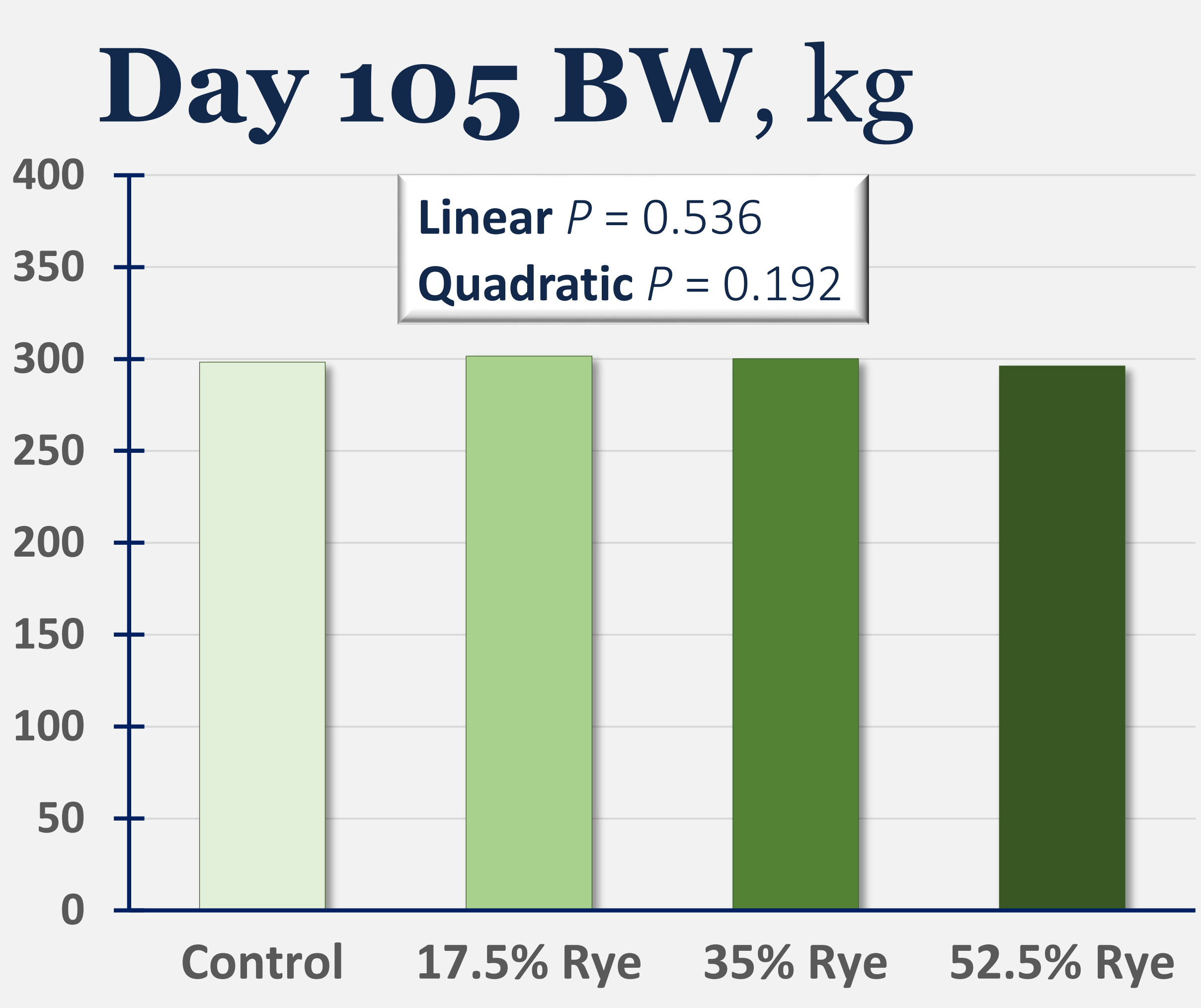
Replaces **75%** of corn with hybrid rye

Methods

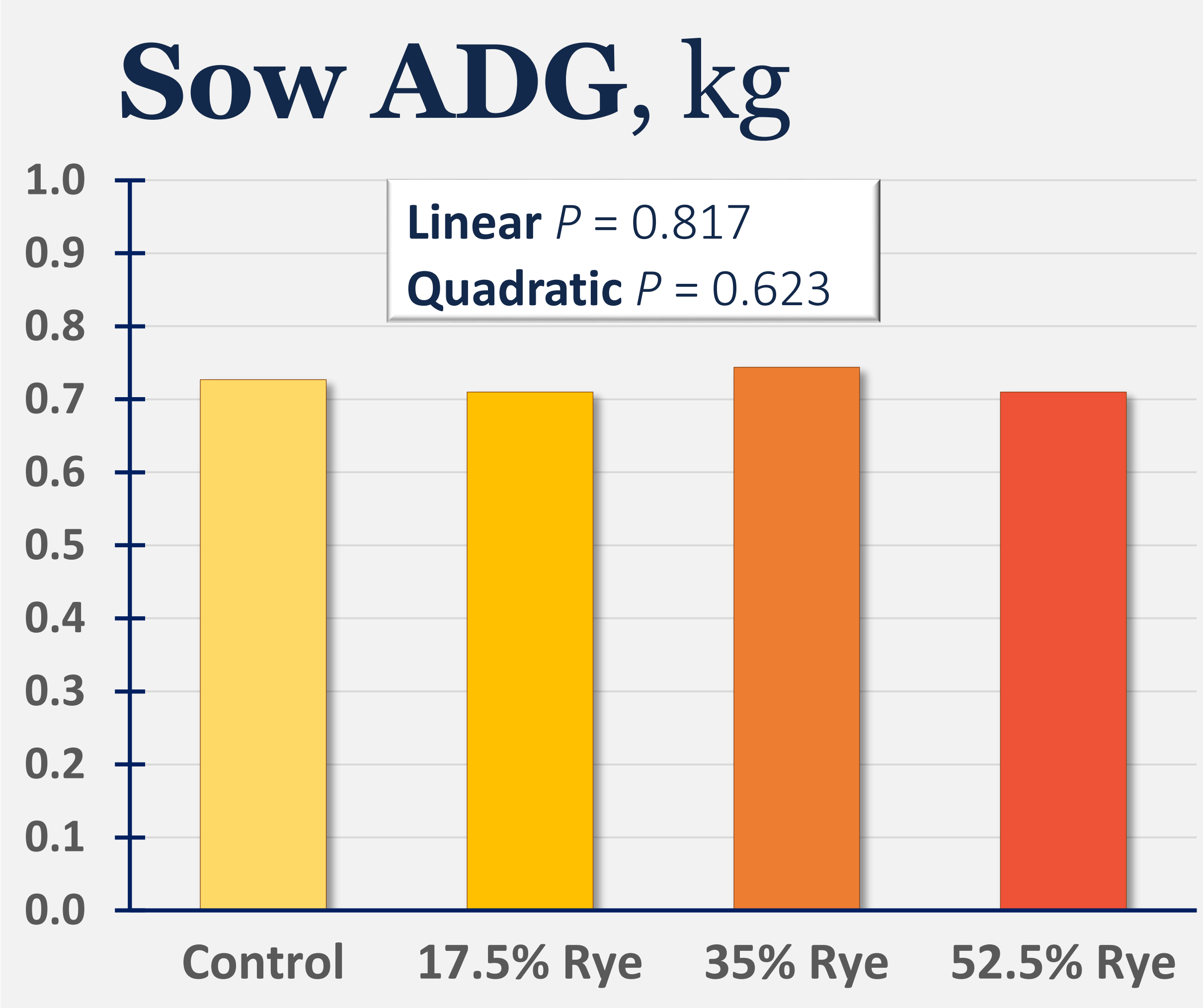

Body weights: Sows and/or piglets
Serum: IgG, IgA, IL-1β, IL-6, TNF-α
Milk: IgG, IgA, SCC, MUN, fat, protein, lactose
x 200
0
7
90
105
~115
13
21
BREED
ALLOT
BUMP FEED
MOVE TO LACTATION
FARROW
SAMPLE
WEAN
days of gestation
days of lactation

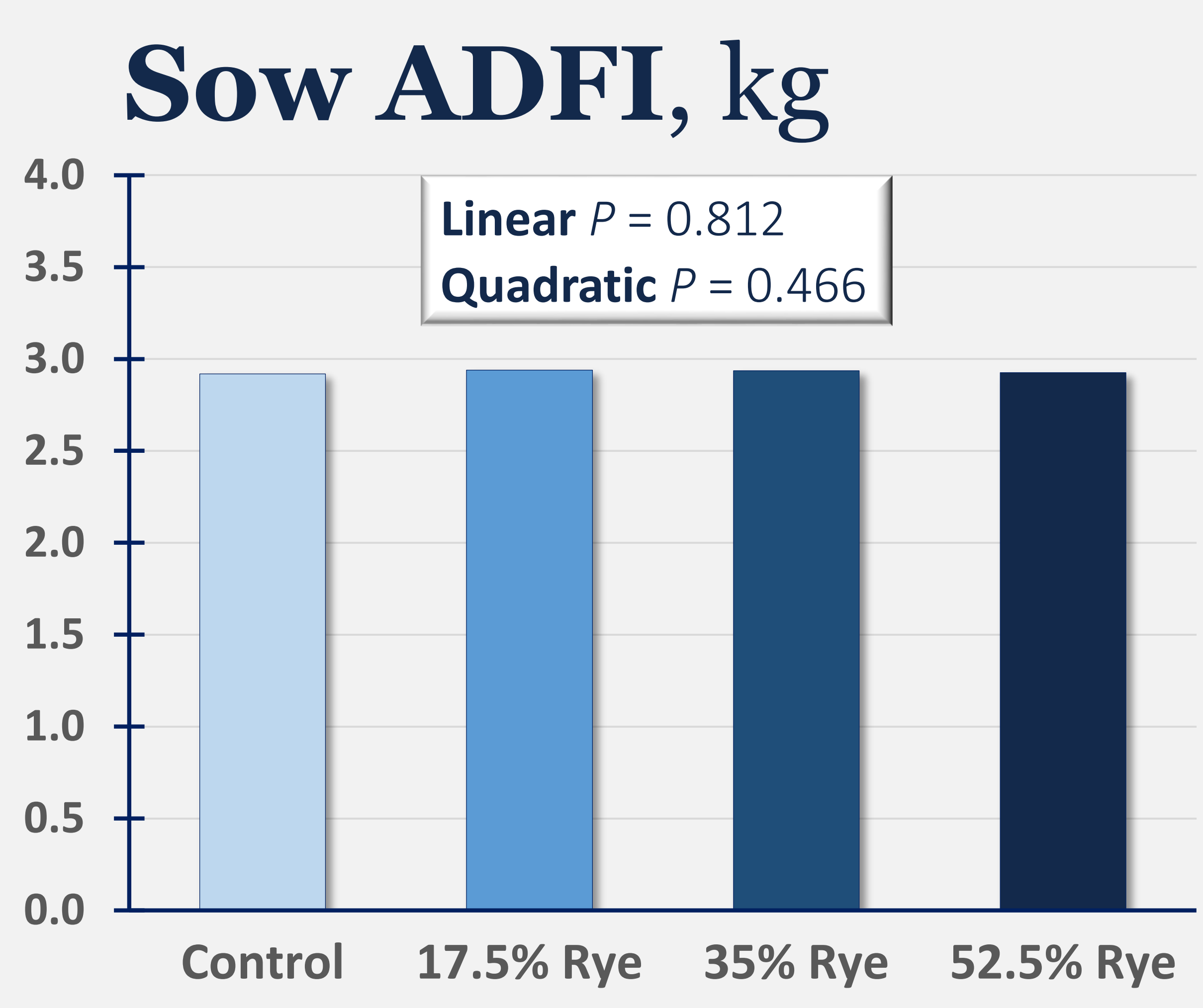
GESTATION DATA





GESTATION DATA





Results: Gestation

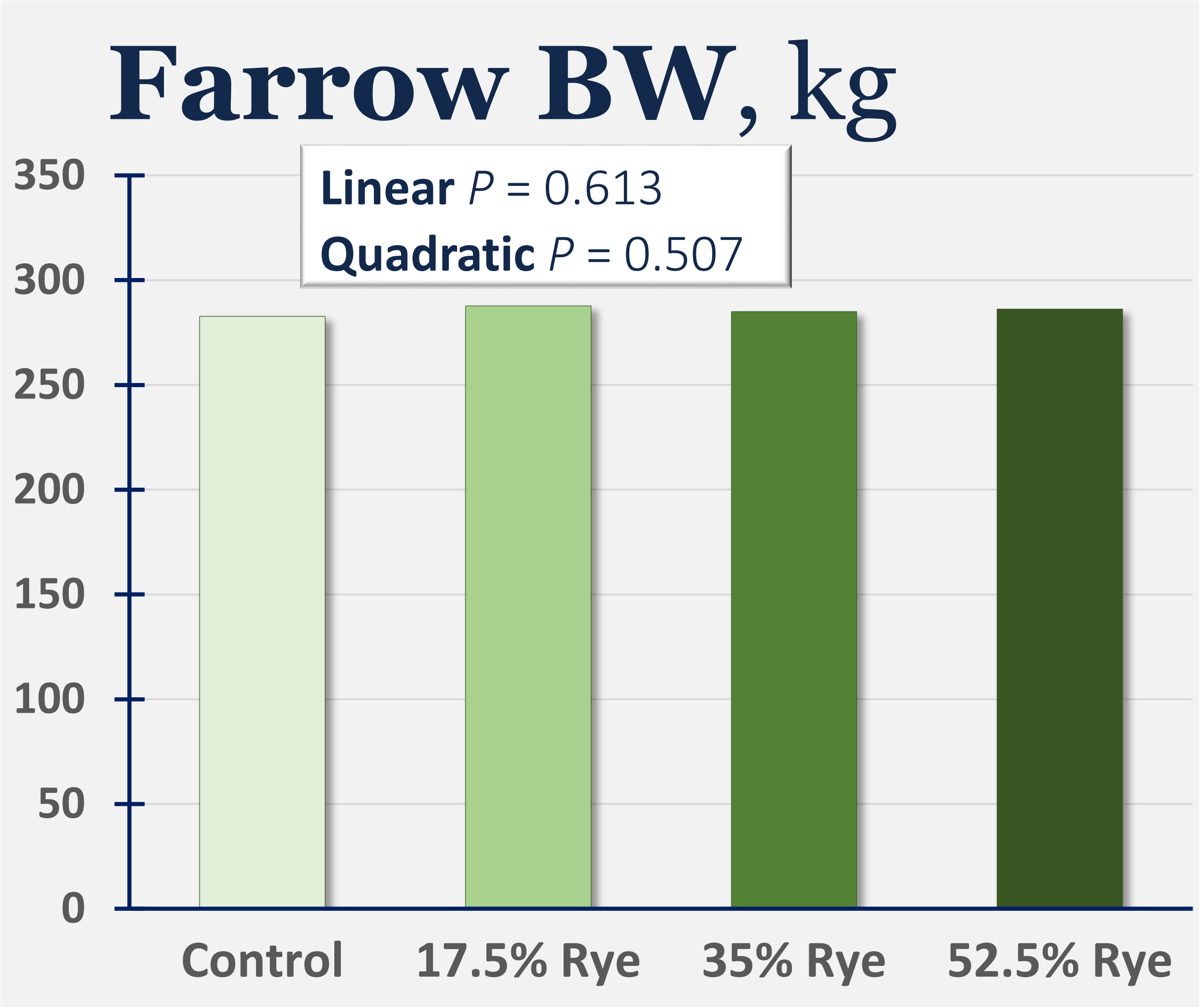
$P > 0.05$

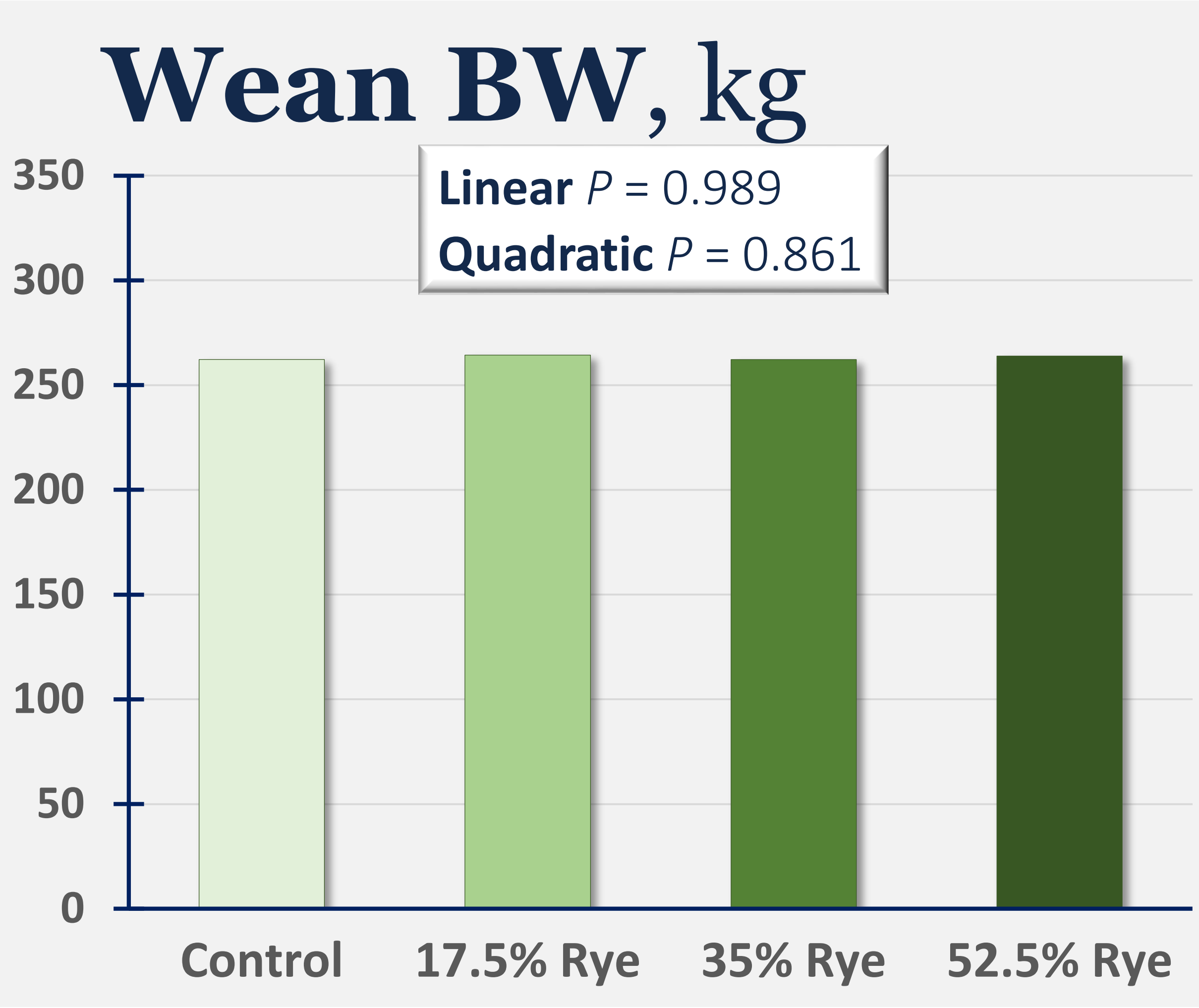
- INITIAL BODY WEIGHT, kg
- DAY 105 BODY WEIGHT, kg
- AVERAGE DAILY GAIN, kg
- AVERAGE DAILY FEED INTAKE, kg

Hybrid rye **inclusion rate of 52.5%** appears to have little to no effect on gestation performance.

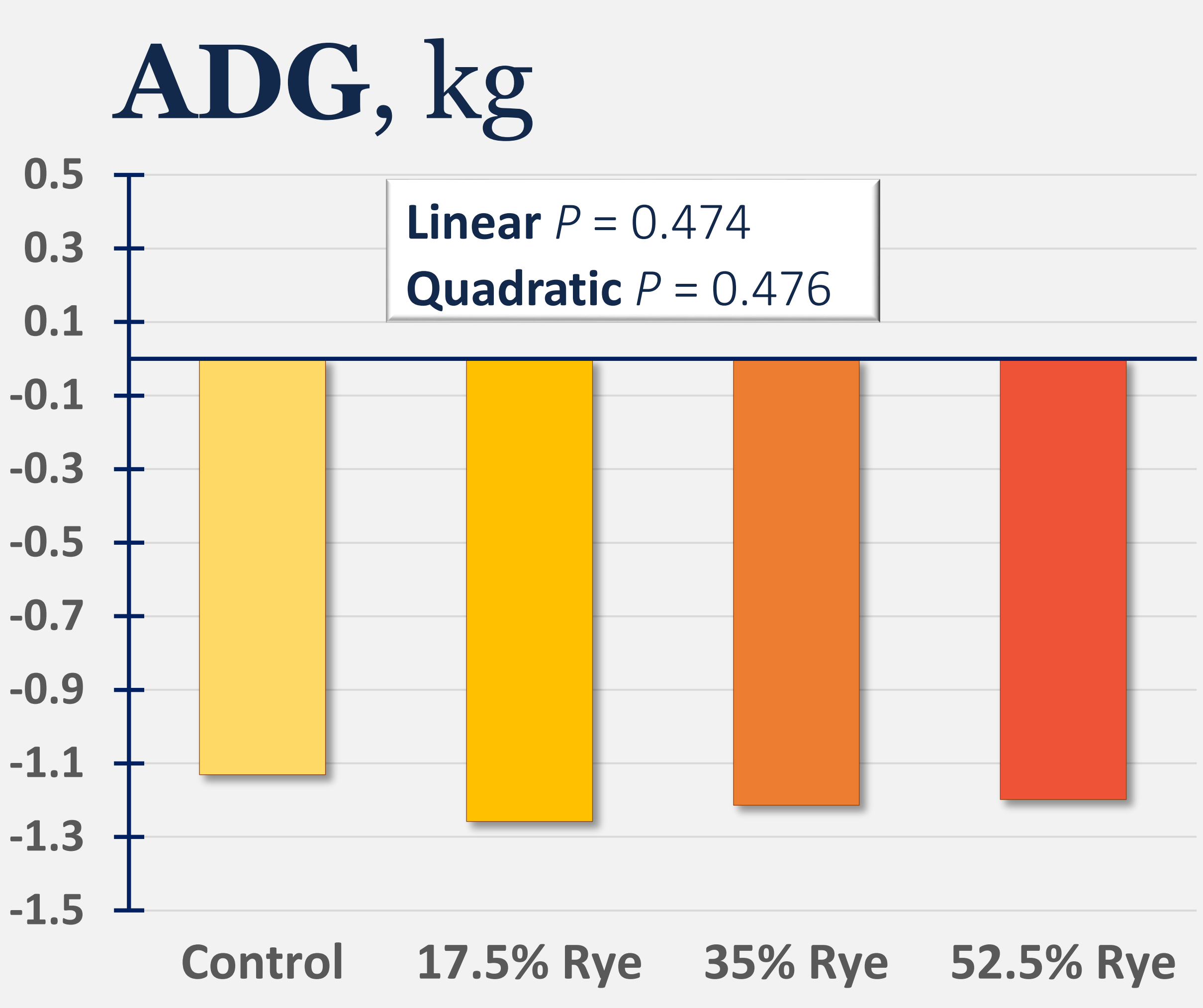
If no ergot is present, **it is predicted that 70%** hybrid rye in gestation diets would also be safe.

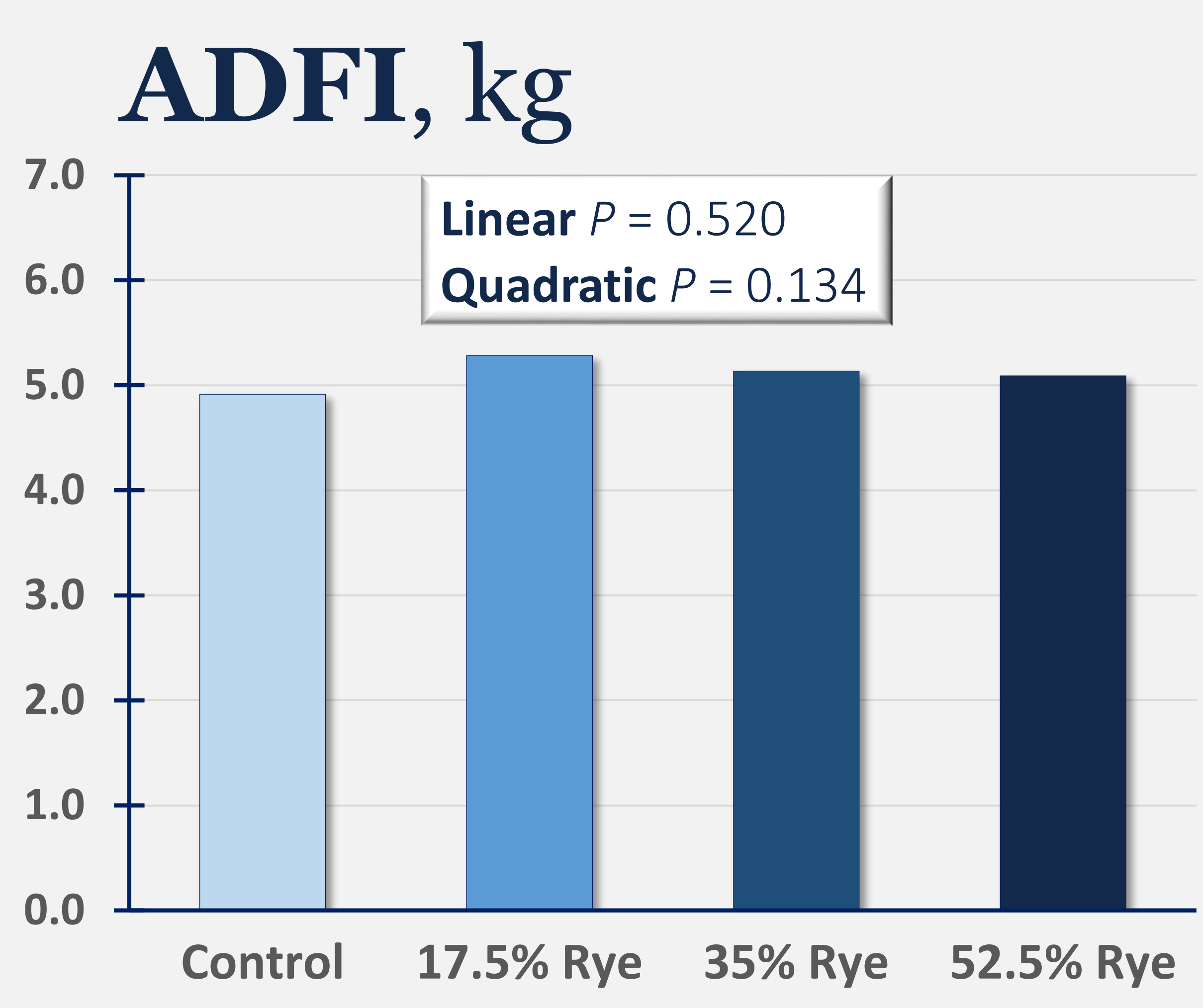
SOW LACTATION DATA





SOW LACTATION DATA





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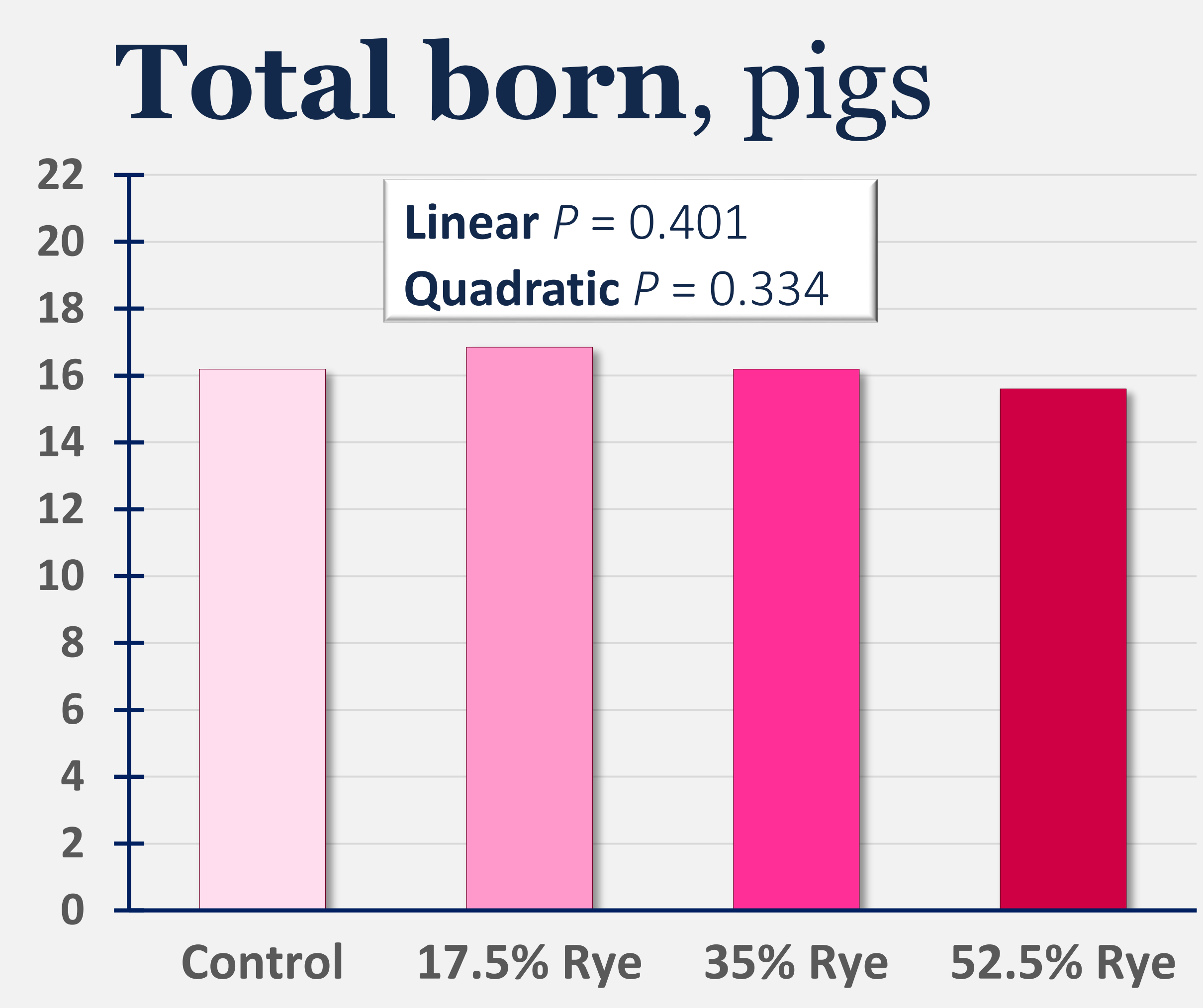
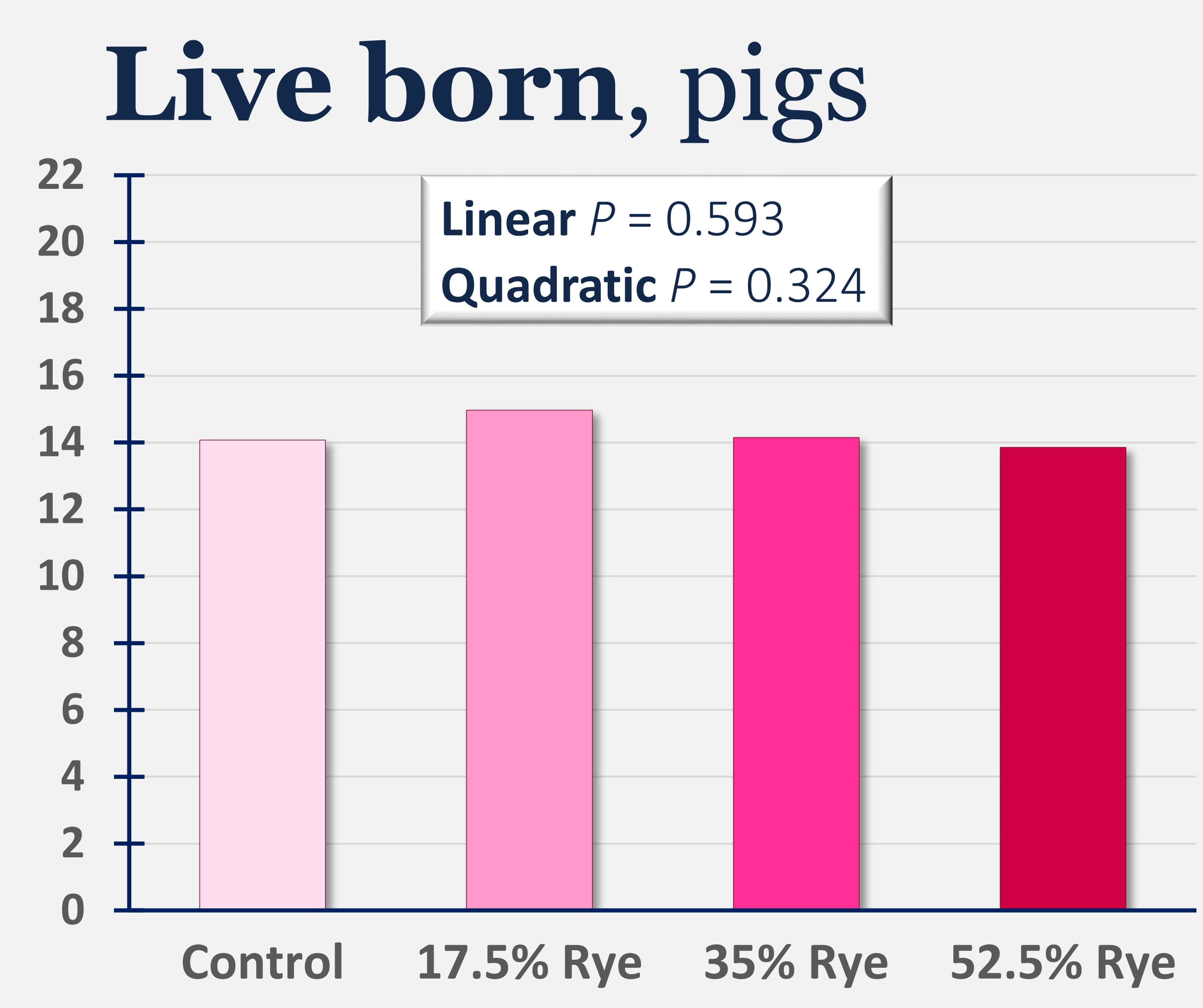
PIGLET DATA

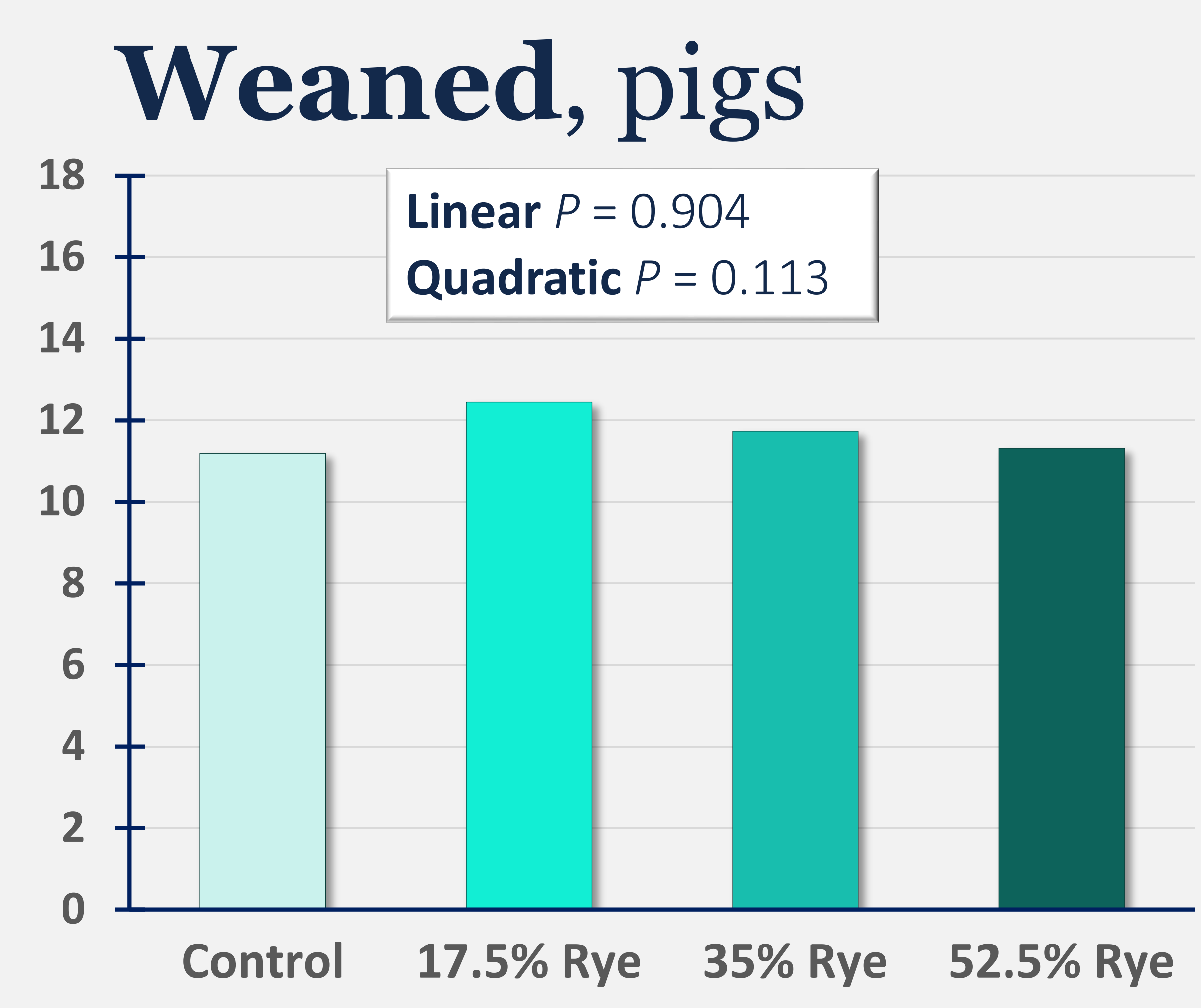


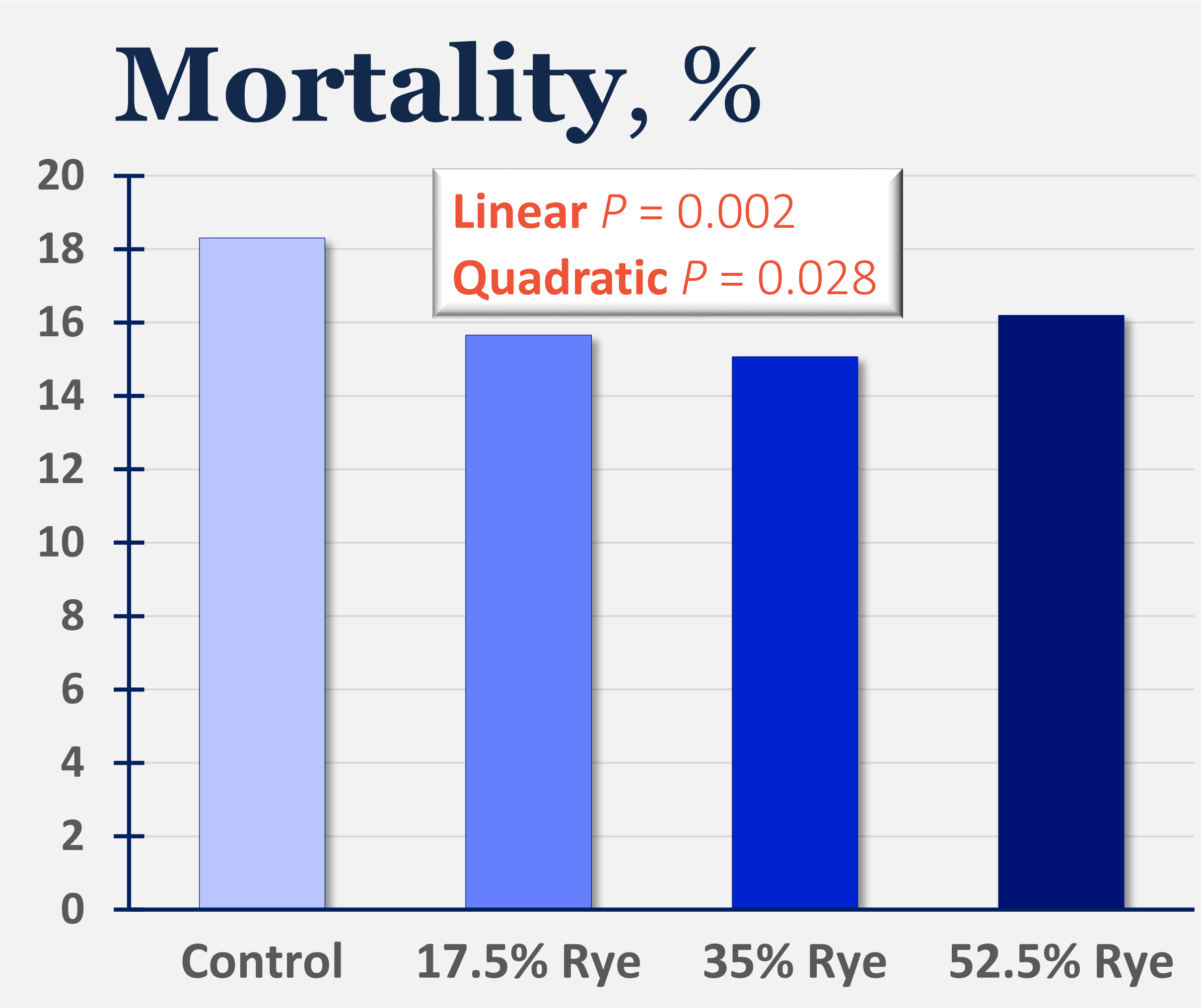
Total born, pigs
Linear P = 0.401
Quadratic P = 0.334
22
20
18
16
14
12
10
8
6
4
2
0
Control
17.5% Rye
35% Rye
52.5% Rye



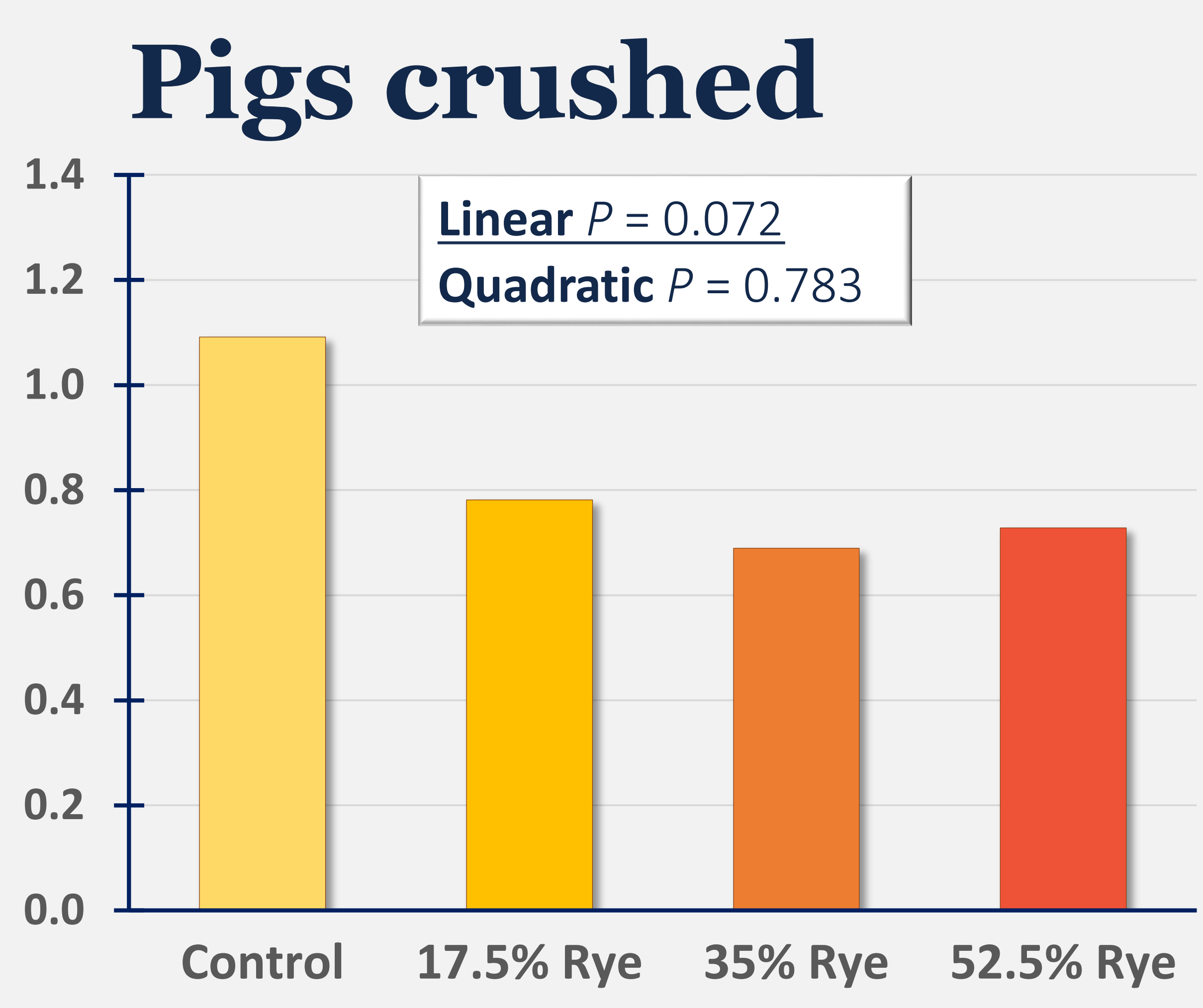
Live born, pigs
Linear P = 0.593
Quadratic P = 0.324
22
20
18
16
14
12
10
8
6
4
2
0
Control
17.5% Rye
35% Rye
52.5% Rye

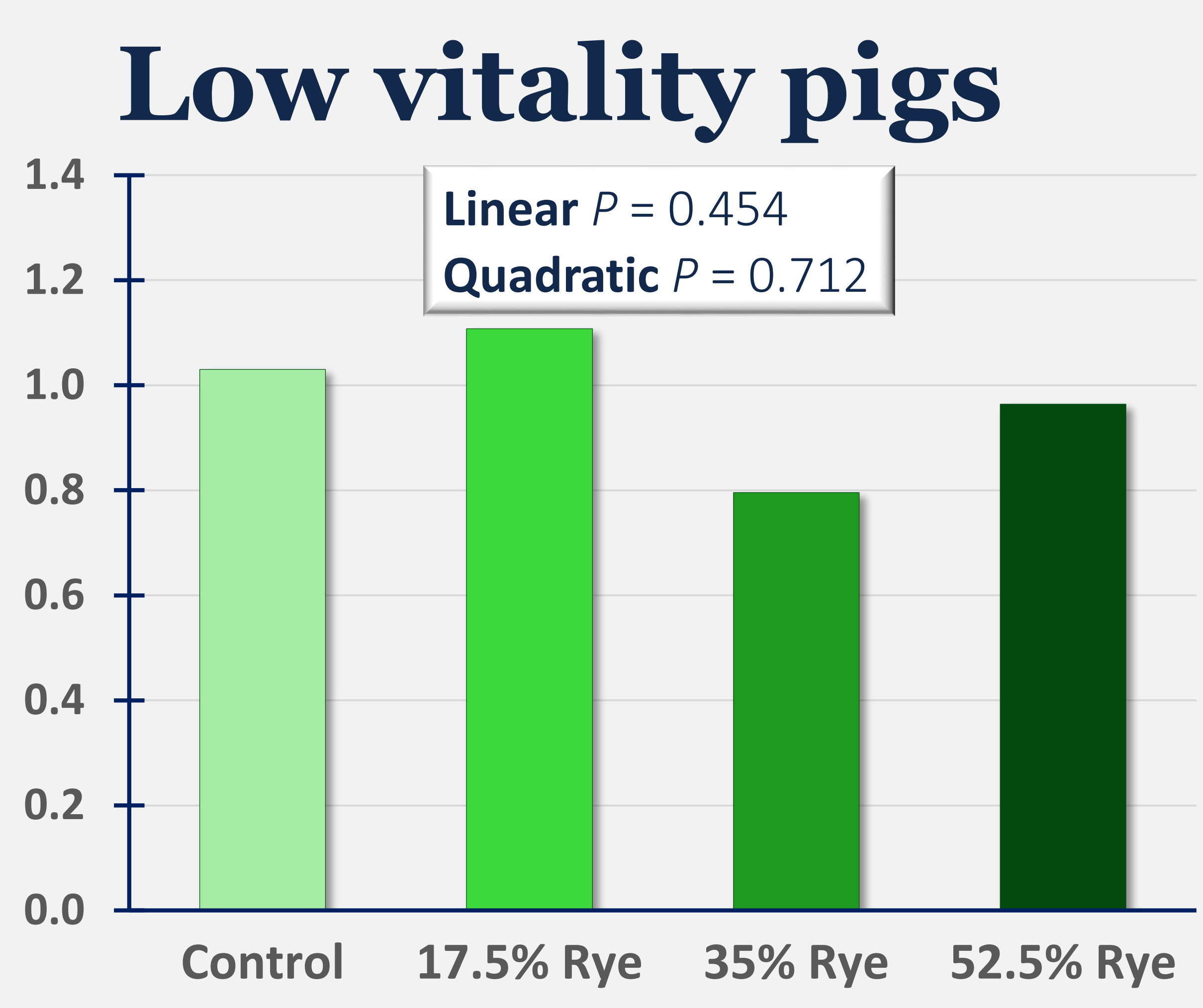
PIGLET DATA


Weaned, pigs
18
16
14
12
10
8
6
4
2
0
Linear P = 0.904
Quadratic P = 0.113
Control
17.5% Rye
35% Rye
52.5% Rye

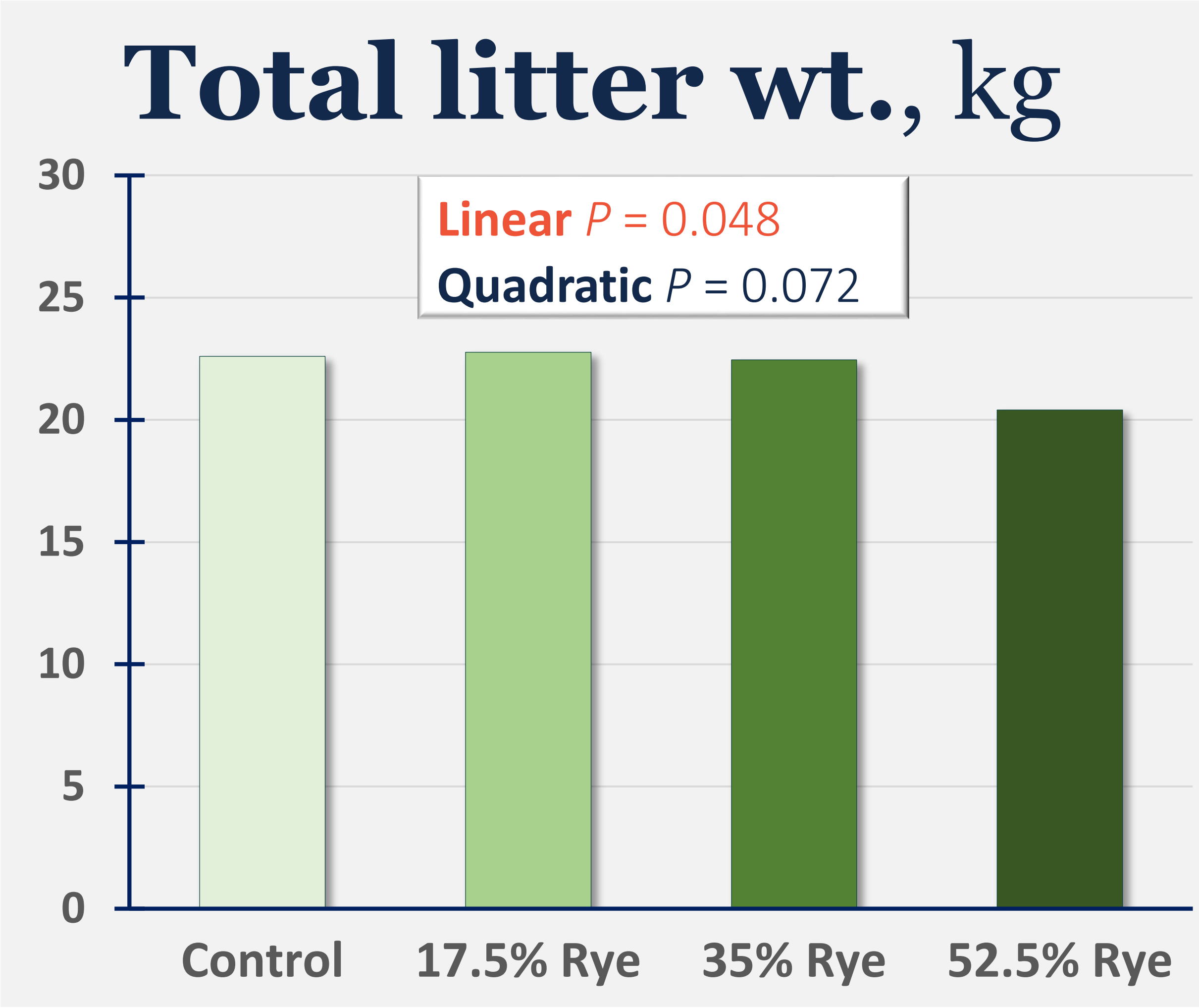

Mortality, %
20
18
16
14
12
10
8
6
4
2
0
Linear P = 0.002
Quadratic P = 0.028
Control
17.5% Rye
35% Rye
52.5% Rye

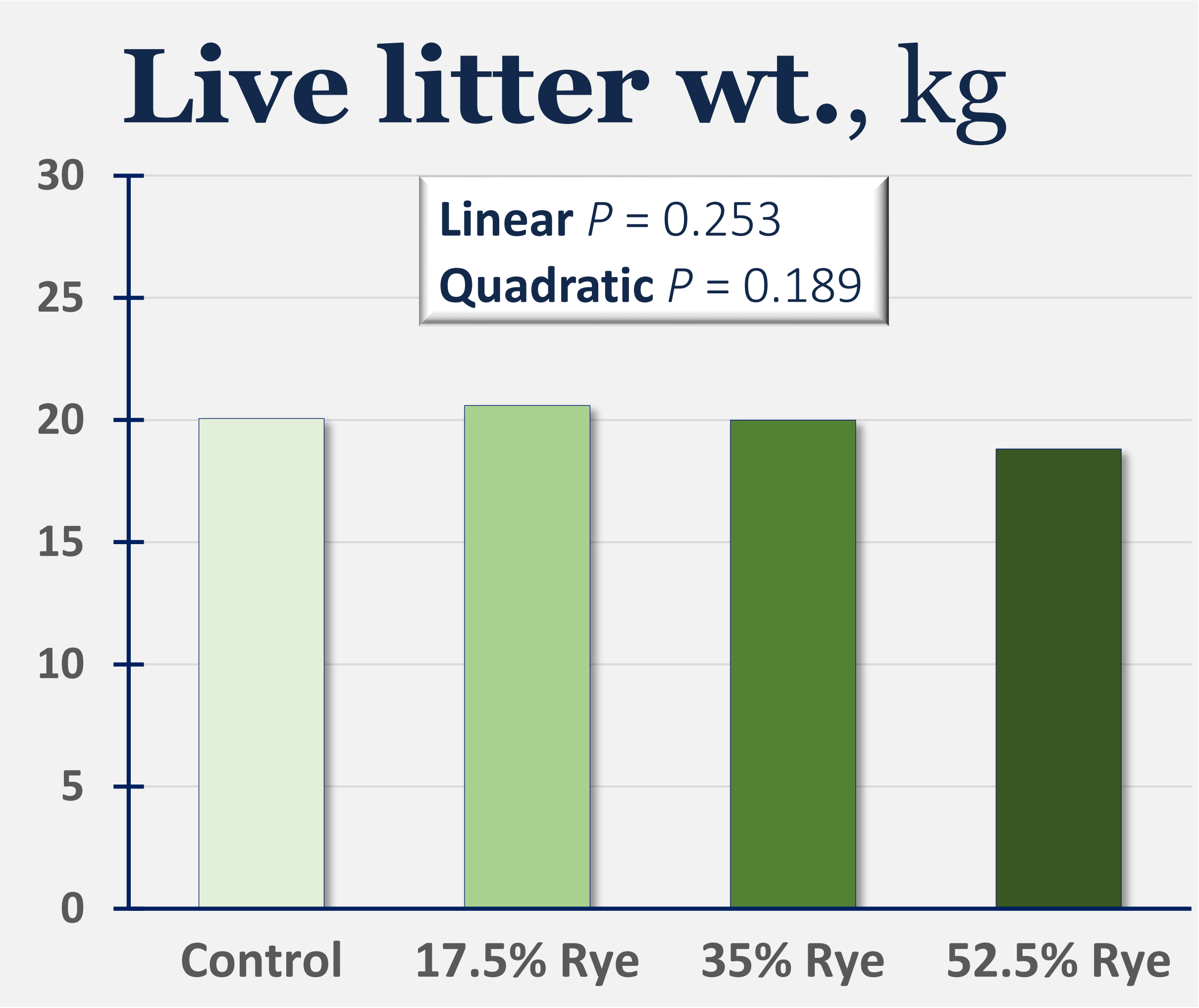
MORTALITY DATA





PIGLET DATA





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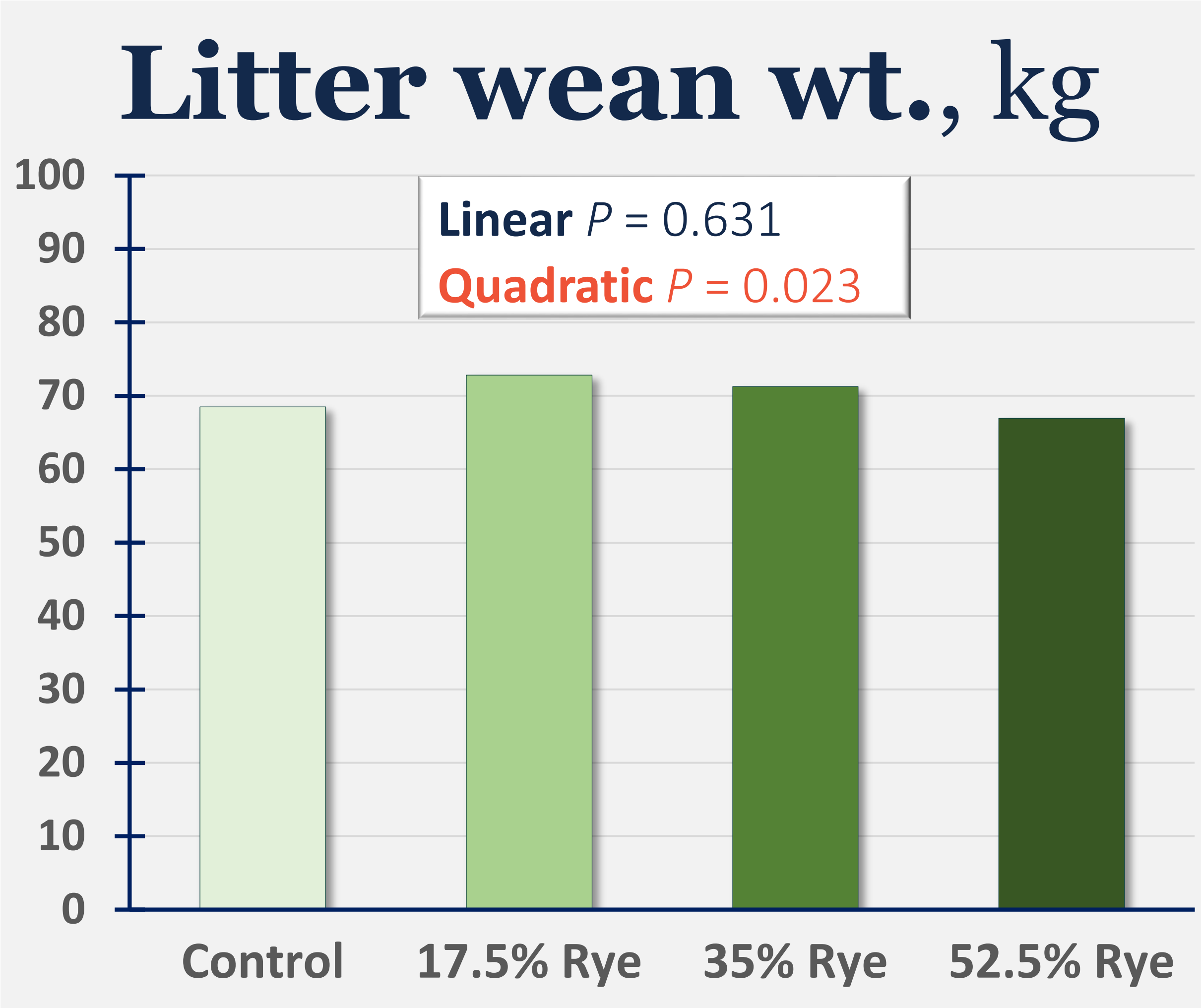
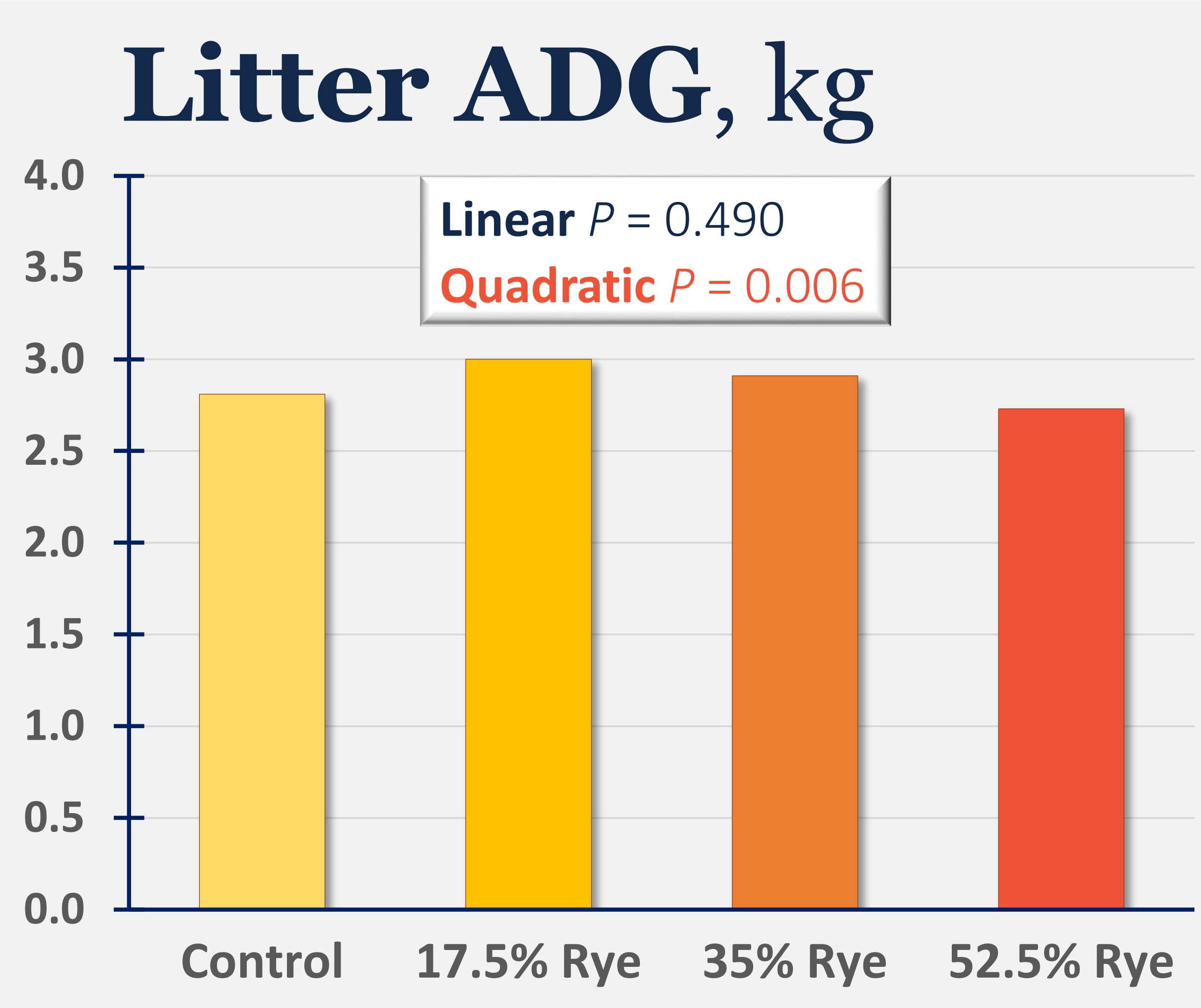
PIGLET DATA

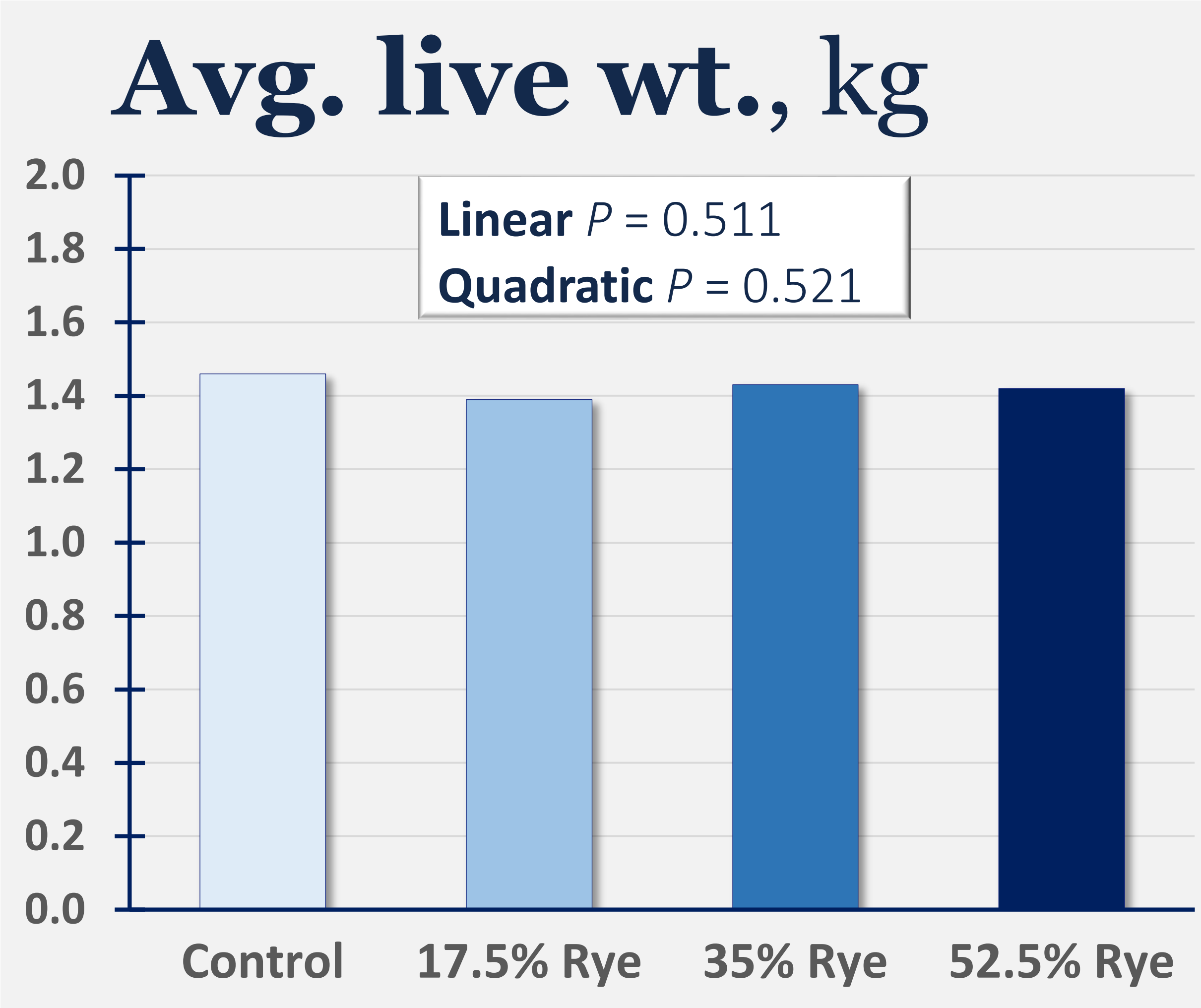


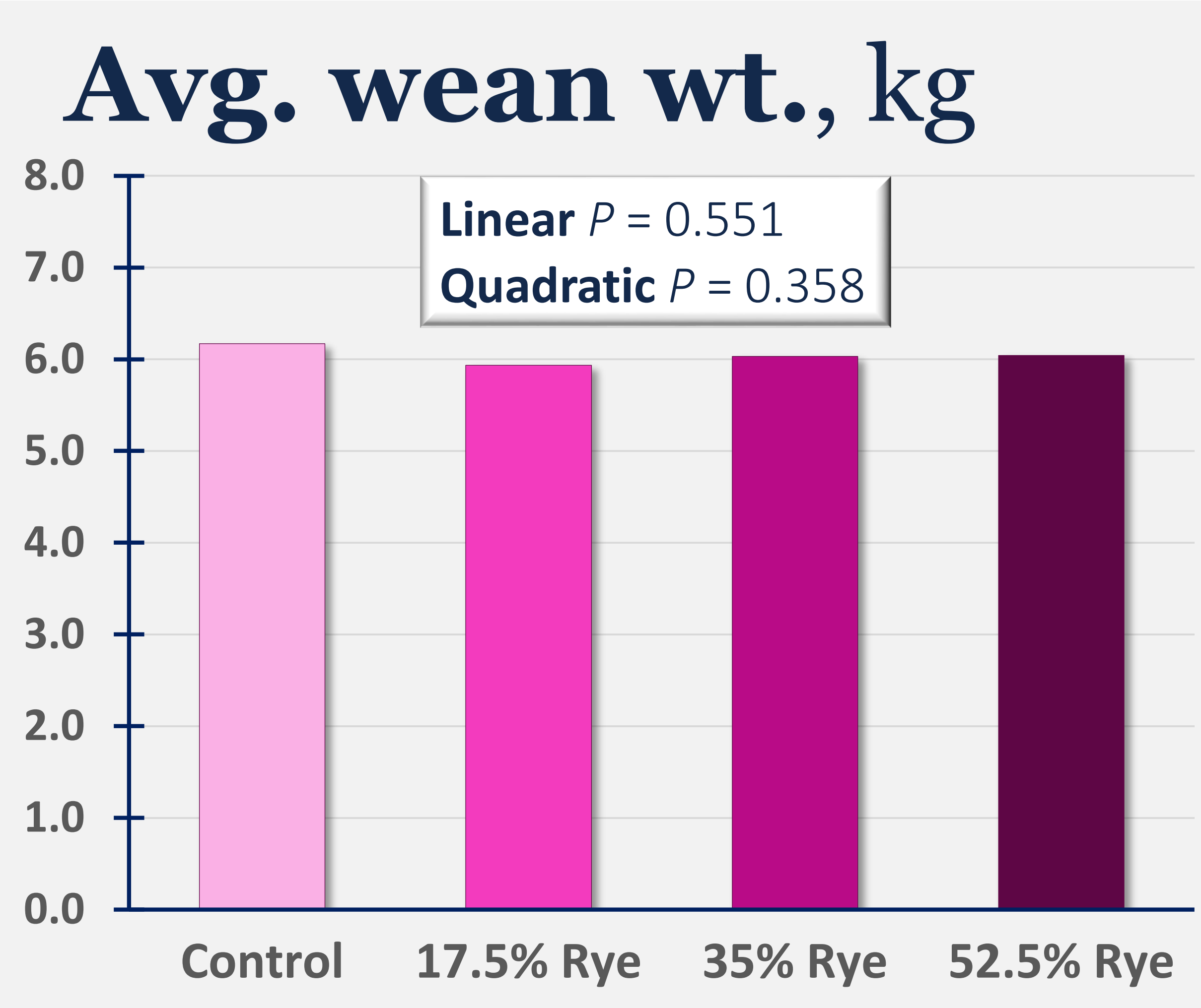
Litter wean wt., kg
Linear P = 0.631
Quadratic P = 0.023
100
90
80
70
60
50
40
30
20
10
0
Control
17.5% Rye
35% Rye
52.5% Rye



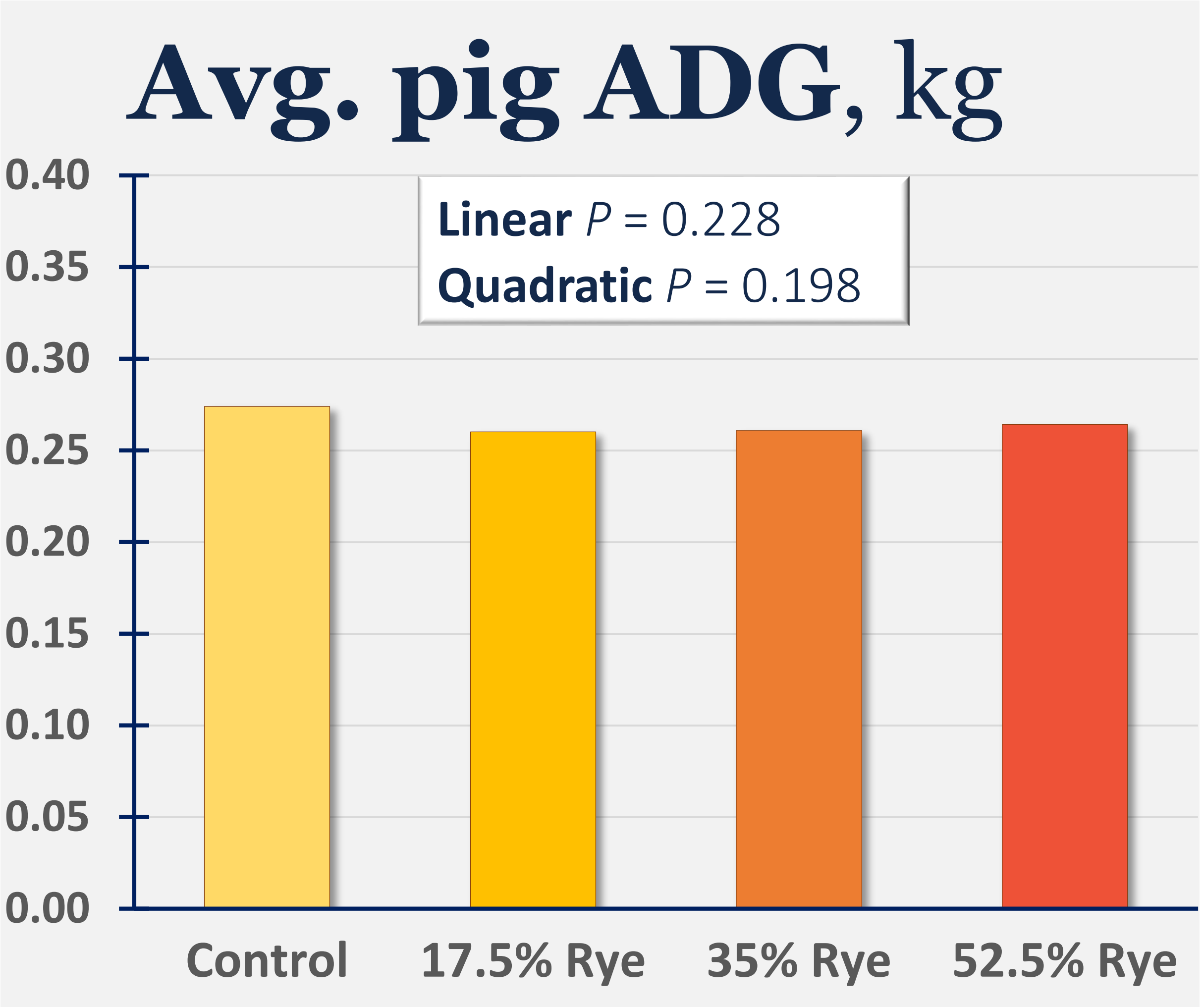
Litter ADG, kg
Linear P = 0.490
Quadratic P = 0.006
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Control
17.5% Rye
35% Rye
52.5% Rye

PIGLET DATA

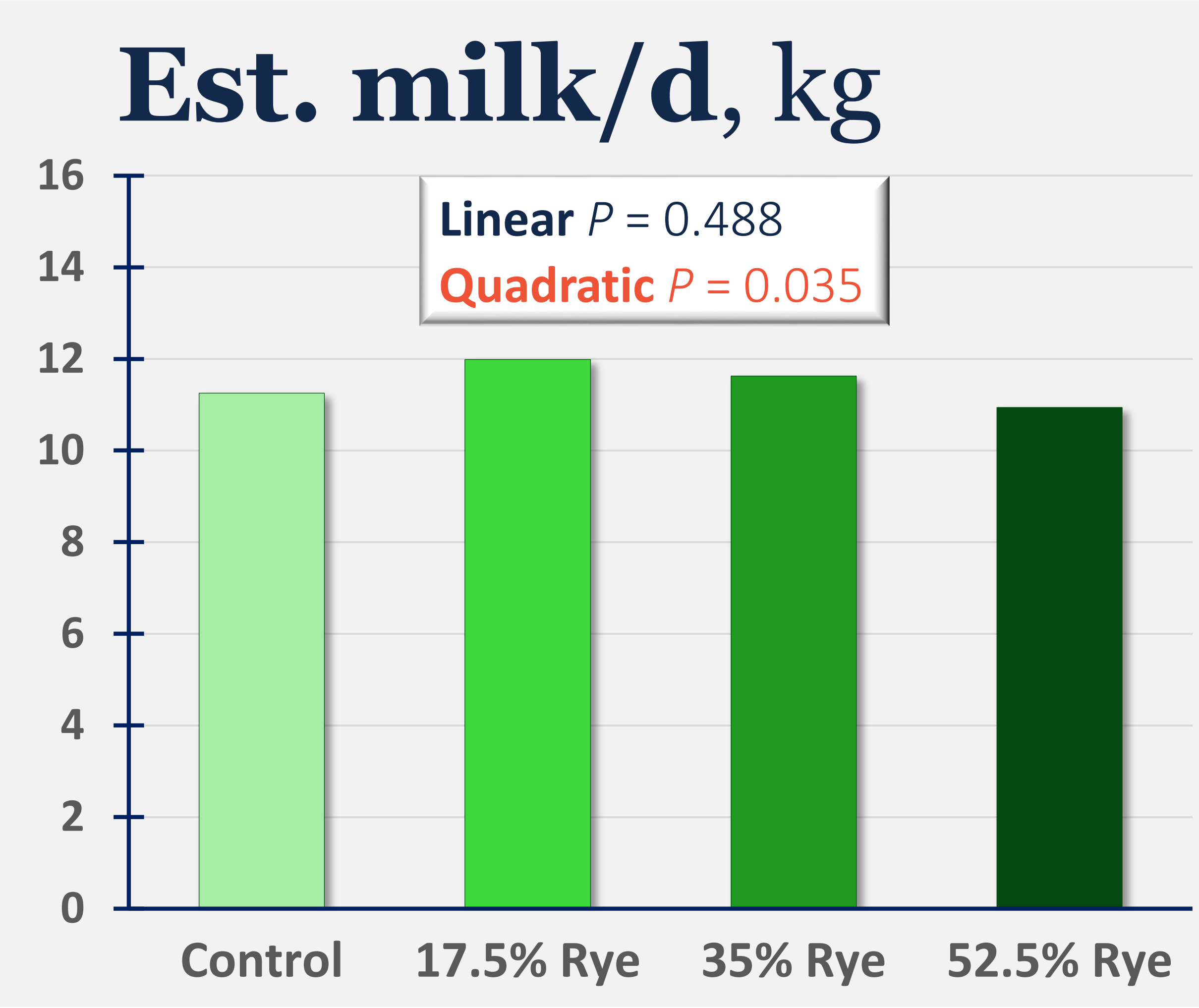

Avg. live wt., kg
Linear P = 0.511
Quadratic P = 0.521
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Control
17.5% Rye
35% Rye
52.5% Rye


Avg. wean wt., kg
Linear P = 0.551
Quadratic P = 0.358
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Control
17.5% Rye
35% Rye
52.5% Rye

PIGLET DATA



Avg. pig ADG, kg
Linear *P* = 0.228
Quadratic *P* = 0.198
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Control
17.5% Rye
35% Rye
52.5% Rye



Est. milk/d, kg
Linear *P* = 0.488
Quadratic *P* = 0.035
16
14
12
10
8
6
4
2
0
Control
17.5% Rye
35% Rye
52.5% Rye

Results: Lactation

Linear

- TOTAL LITTER WEIGHT, kg
- MORTALITY, %

Quadratic

- LITTER WEAN WEIGHT, kg
- LITTER ADG, kg
- ESTIMATED MILK PRODUCTION, kg

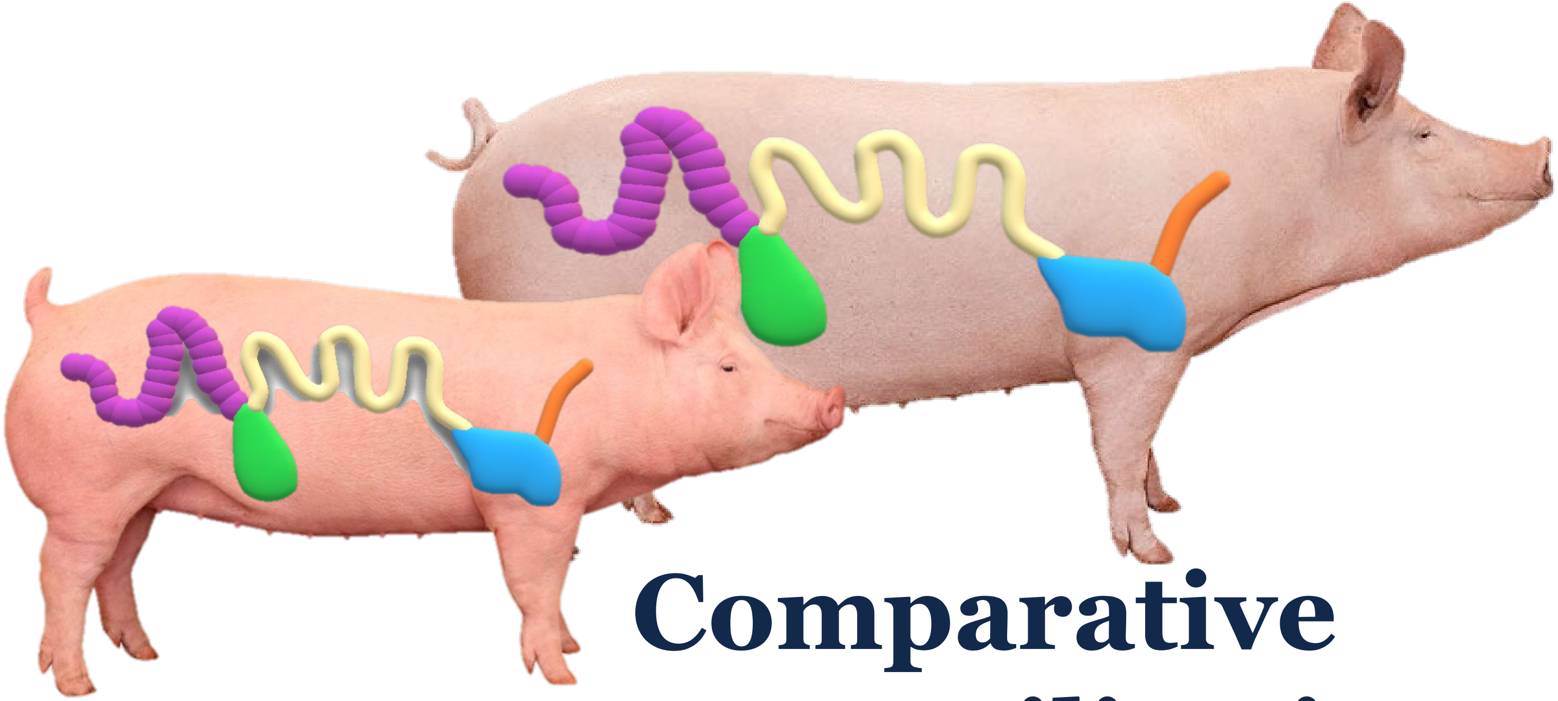
PRELIMINARY CONCLUSIONS:

Hybrid rye in **lactation** diets results in **no reduction** in sow or piglet performance.

Mortality was reduced as hybrid rye inclusion in the diet increased.

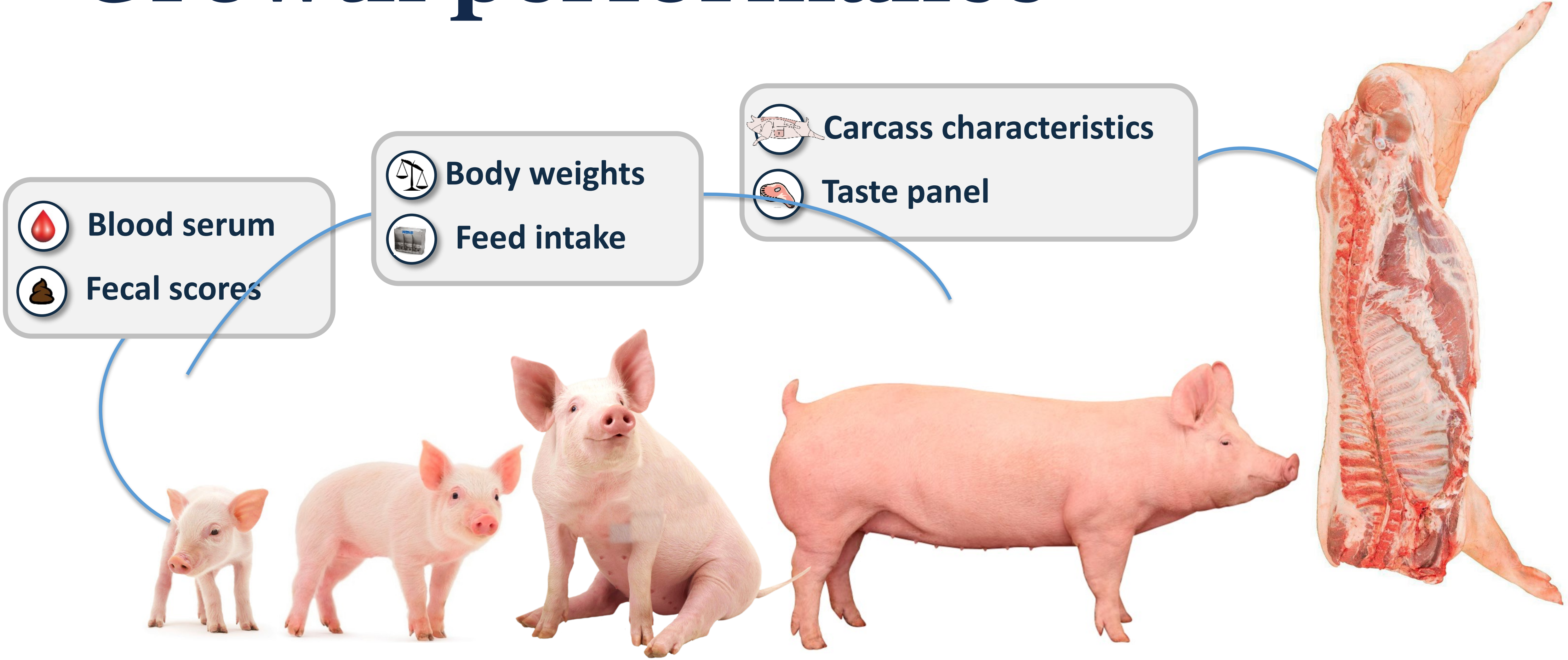
Upcoming research

Taste preference



Comparative energy utilization

Growth performance



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