Hybrid Rye for Forage

Becca Stokes, PhD
Livestock Nutritionist

SEEDING
THE FUTURE
SINCE 1856

Hybrid Rye

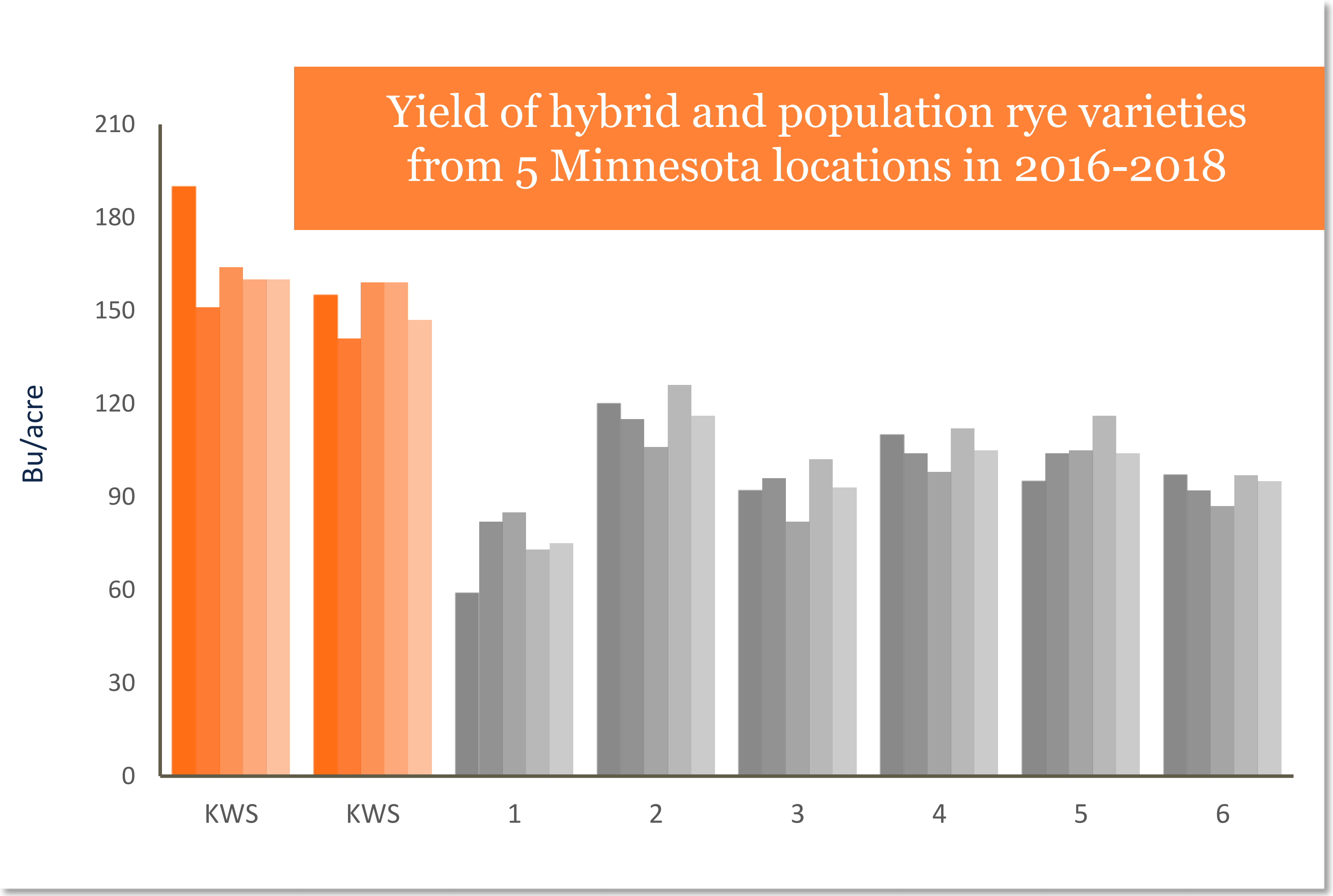
- Hybrid Rye breed program established in the 1980s in Germany

- Launched KWS hybrid rye in Canada in 2014 and in the USA in 2016

- New high yielding cereal crop!

Hybrid Rye

- Yield
- Ergot Resistance
- Standability
- Abiotic Stress



Why Hybrid Rye?

- Crop Versatility
  - Grain
  - Silage
  - Grazing

- Minimized ergot risk – Pollen Plus Technology

- Profit potential
- Diversified production times
- Labor management

Why Hybrid Rye?

- Soil Health
  - Recycles nutrients
  - Builds soil
  - Loosens topsoil
  - Prevents erosion

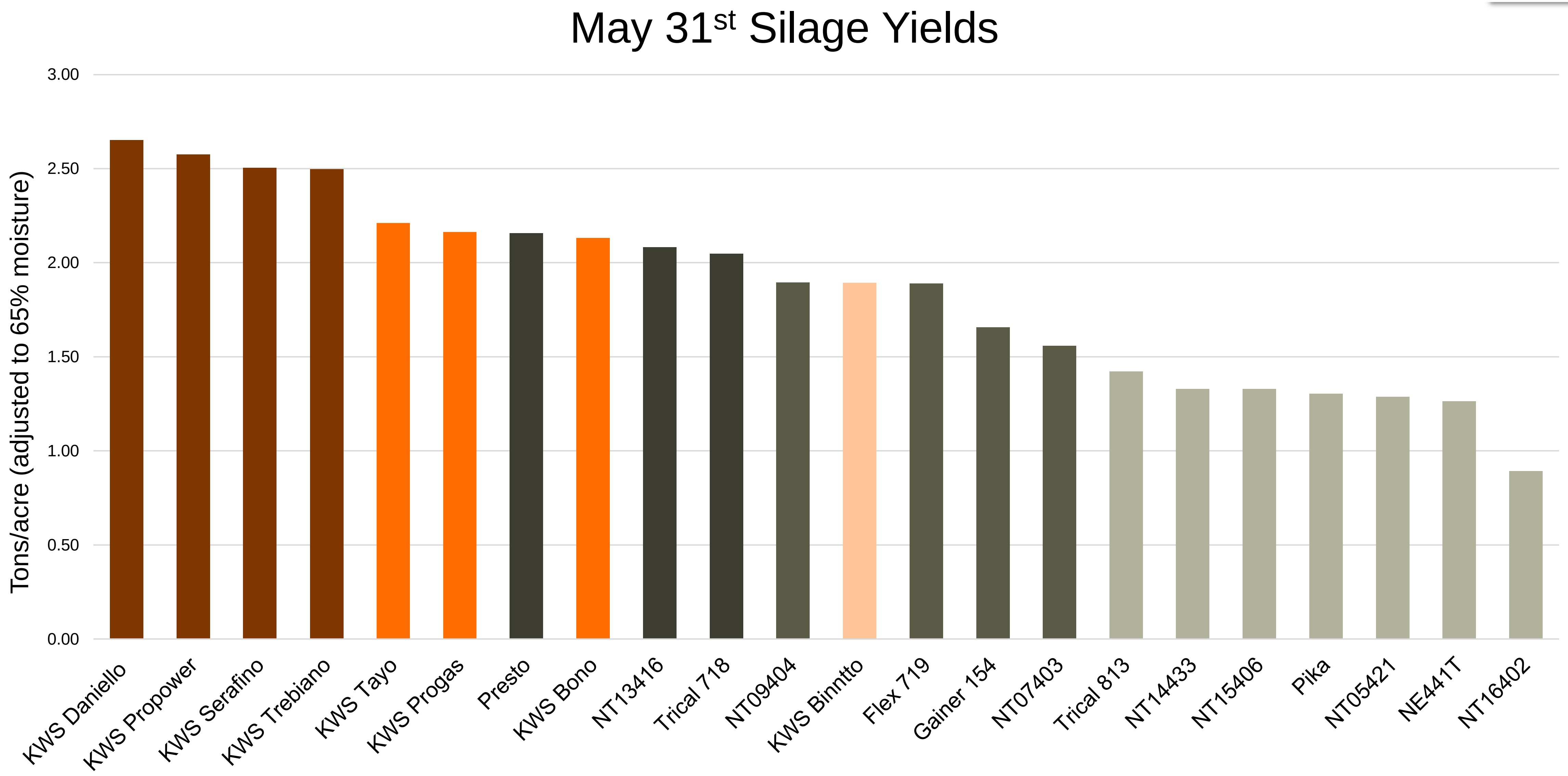
- Spring/Fall Feed Source
  - Additional tonnage on idle acres
  - Corn-soybean rotation
  - Minimal effort

Hybrid Rye for Silage

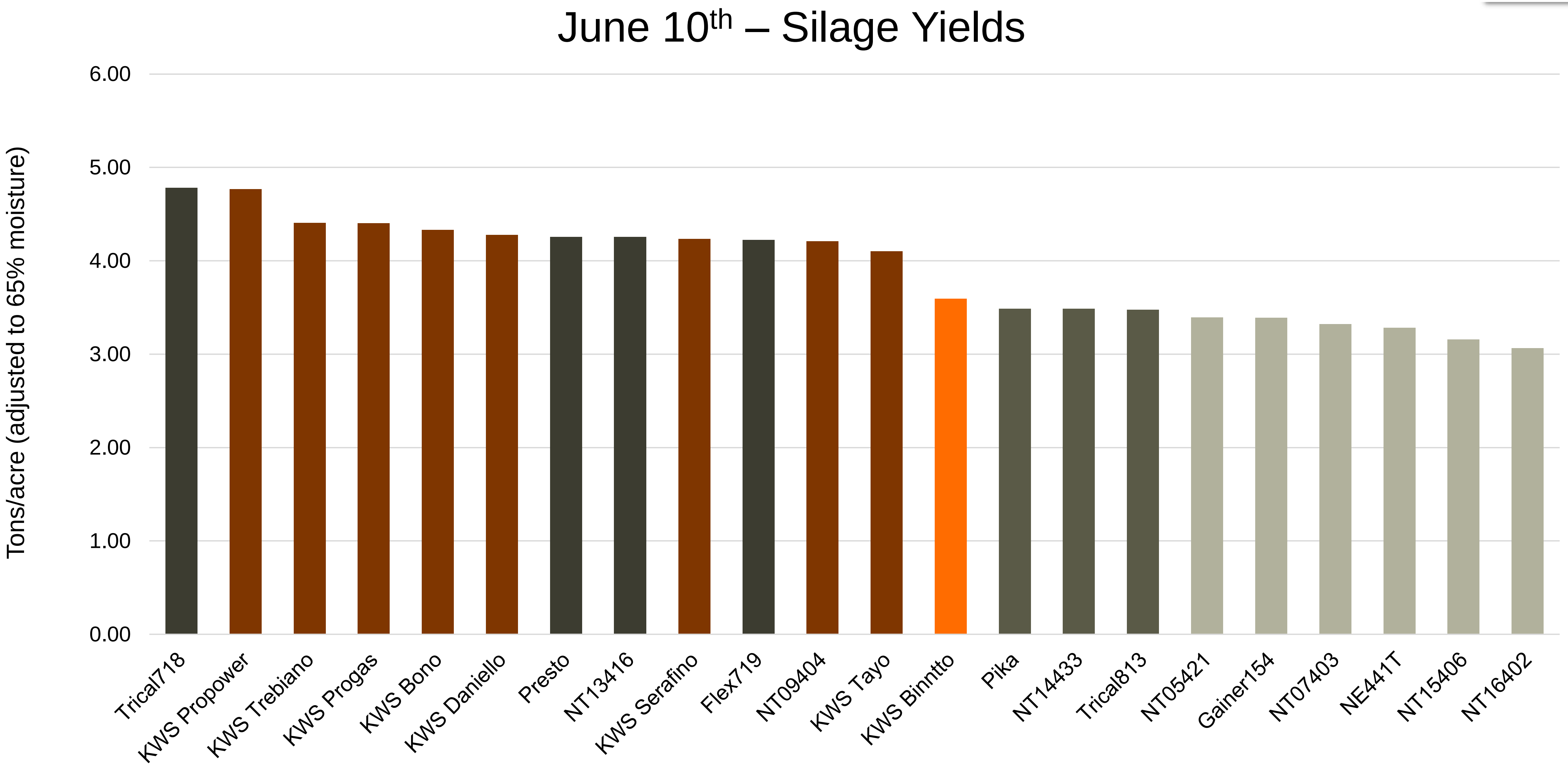
Hybrid Rye – Colorado

- USDA-ARS Central Great Plains Research Station
- Akron, CO
- Silage was harvested at 2 dates
  - May 31st – Ear emergence
  - June 10th – Flowering

Hybrid Rye – Wisconsin Silage Yields



Hybrid Rye – Wisconsin Silage Yields



Hybrid Rye – Colorado State University

Table 1: Analysis of variance showing P values for the effect of variety on rye forage dry yield at various sampling dates.

Source of Variation	df	Sampling date				
		April 2	April 9	April 16	April 23	April 30
Block	3	0.1559	0.6399	0.6086	0.0973	0.5349
Variety	2	0.2296	0.7660	0.8218	0.0819	0.2673
Coefficient of Variation		12.3	37.6	24.3	14.4	15.7

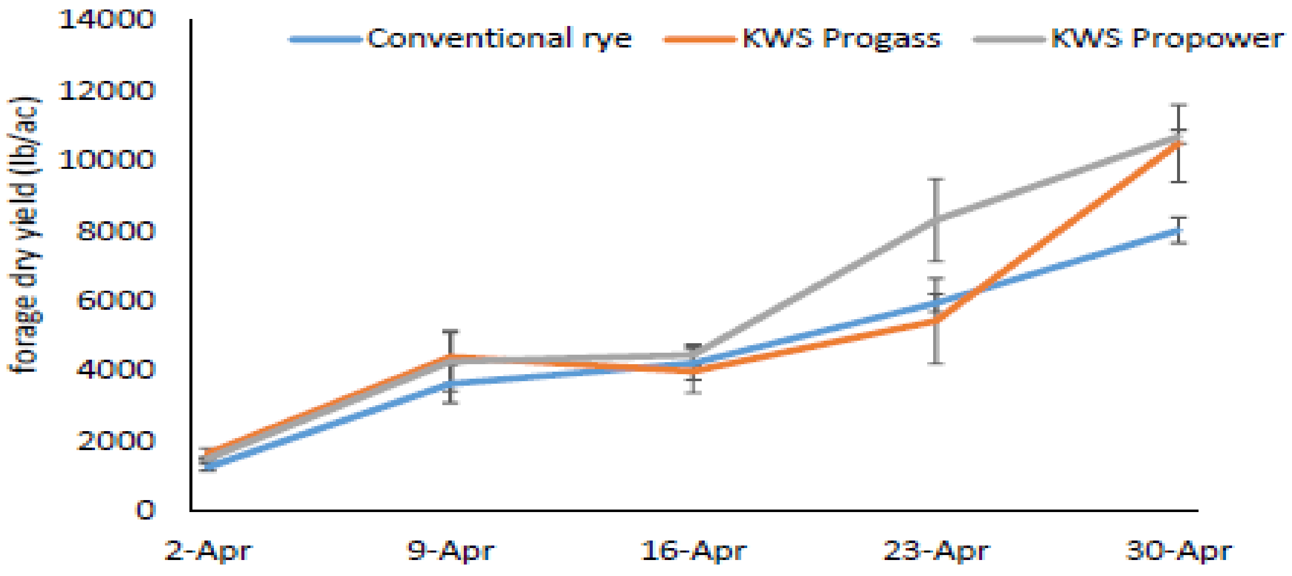
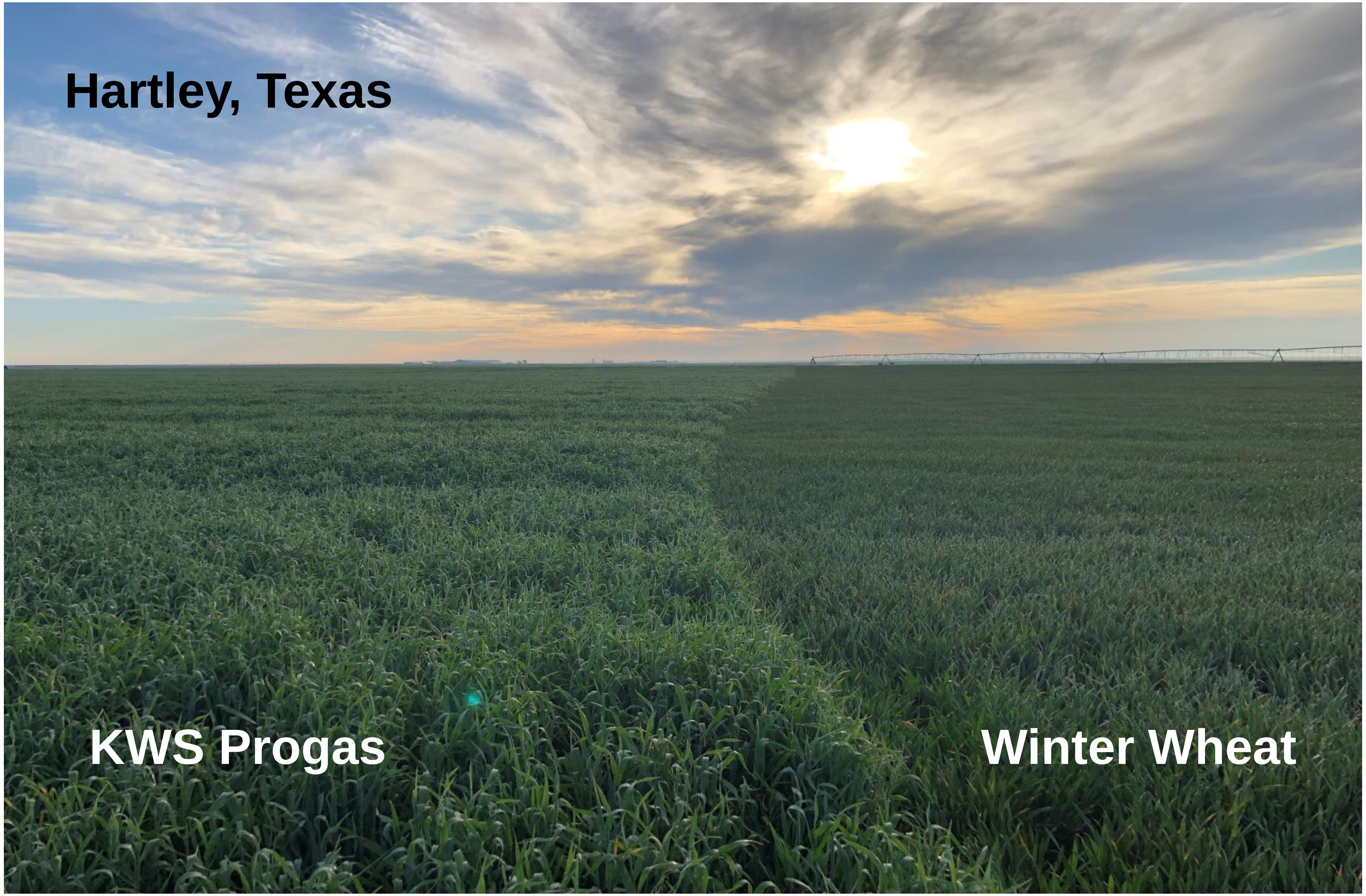


Fig.1: Forage dry yield at various sampling dates. Vertical bars represent standard error of the means (n=4)

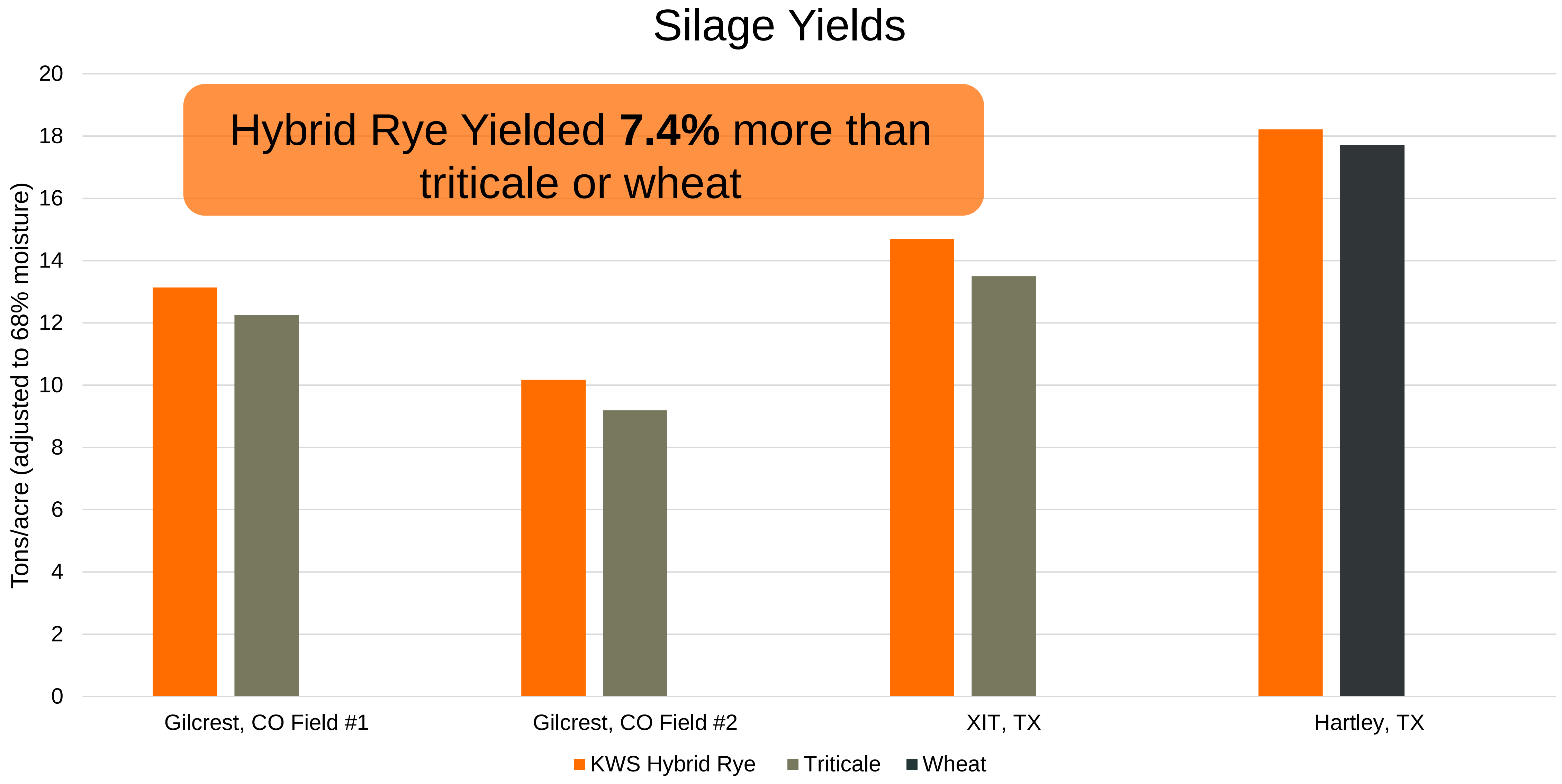
Hybrid Rye – Texas and Colorado

- 2 fields in Texas and 2 fields in Colorado
- 3 fields of hybrid rye vs. triticale
- 1 field of hybrid rye vs. wheat
- All crops were grown on irrigation pivots

Hybrid Rye for Silage – Texas (April 24th)



Hybrid Rye – Texas and Colorado



Hybrid Rye – Texas and Colorado

Forage type	Field	Crude protein, %	%N	%P	%K	Nitrates*
Hybrid Rye	Gilcrest, CO #1	12.3	2.0	0.4	2.5	213
Triticale	Gilcrest, CO #1	11.4	1.8	0.3	2.1	60
Hybrid Rye	Gilcrest, CO #2	11.7	1.9	0.4	2.3	78
Triticale	Gilcrest, CO #2	13.1	2.1	0.3	2.0	213
Hybrid Rye	XIT, TX	9.9	1.6	0.3	2.8	70
Triticale	XIT, TX	12.4	2.0	0.4	3.4	400
Hybrid Rye	Hartley, TX	10.2	1.6	0.3	2.2	390
Wheat	Hartley, TX	10.6	1.7	0.2	1.7	160

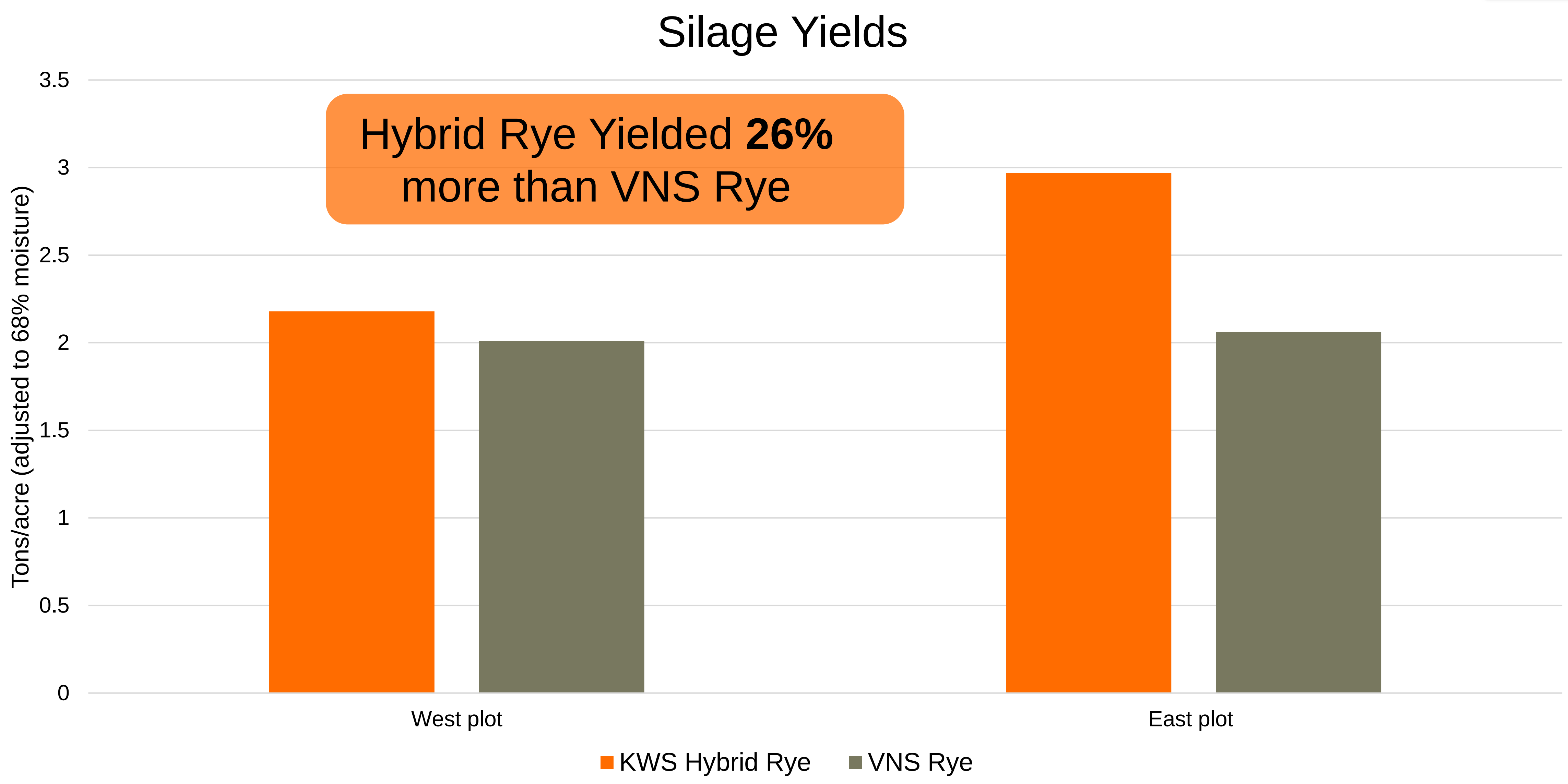
*Nitrate levels <1,000 are safe to feed under most conditions

Hybrid Rye – Wisconsin

- Meffert's Homestead Dairy – Waunakee, WI
- Planted 9.23.18, no till following corn silage
- Seeding rate:
  - VNS – 100 lbs/acre
  - KWS Progas – 44.4 lbs/acre
- Cut 5.22.19 and chopped 5.26.19

Hybrid Rye – Wisconsin (May 20th)

Hybrid Rye – Wisconsin



Hybrid Rye – Wisconisn

Forage type	Plot	NDFD	Crude protein, %	Milk (lbs/acre)
KWS Progas	West	60.81	7.4	**3520**
VNS Rye	West	60.78	7.8	3004
KWS Progas	East	59.97	8.4	**4376**
VNS Rye	East	61.16	9.1	3142

KWS Progas – Pre-boot, first heads emerging but most 2” below top of stem; height = 24-28”
VNS Rye – late boot, early heading; height = 23-26”

Early spring silage source

Two stages for cutting

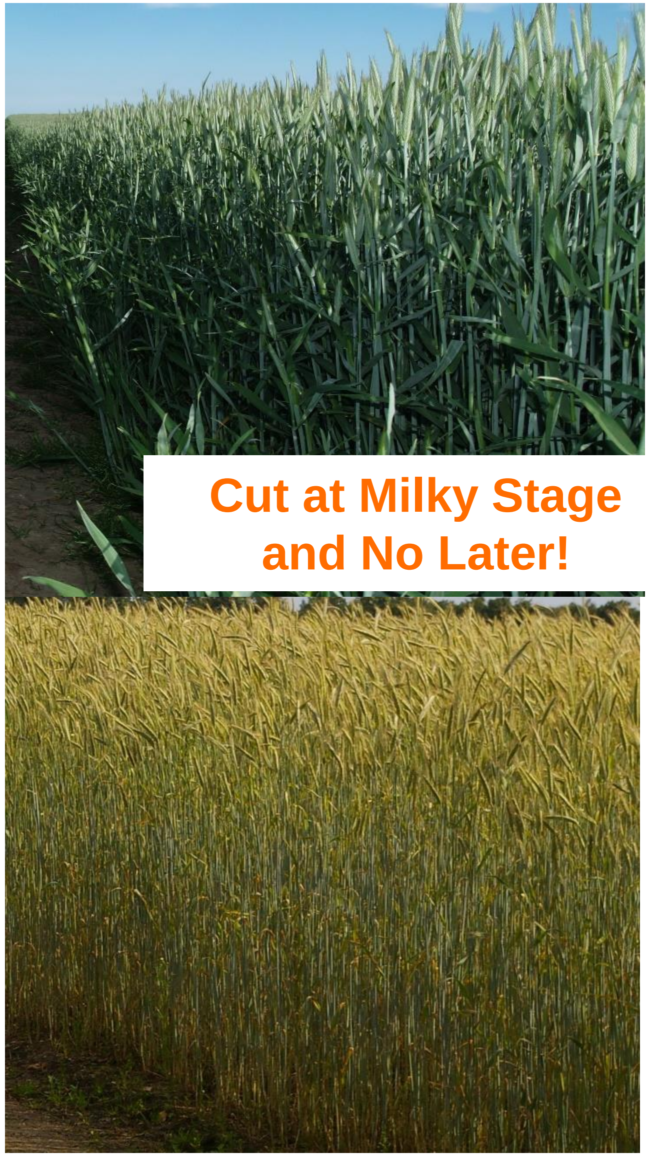
- Flag leaf
  - for high potein – late May early June (15-20% protein)
  - Haylage
  - Doubble cropping

- Milky stage
  - Whole plant silage late June (8-10% protein)
  - Followed by grass or high quality cover crop
  - Or replanted with hybrid rye for autumn grazing

Hybrid Rye for Silage – Considerations

- Moisture level will be high at cutting – leave in windrow for a day before chopping.
- Cut at flag leaf – be aware of how quickly rye grows!

Hybrid Rye for Silage – Considerations



Milky stage

Early dough stage

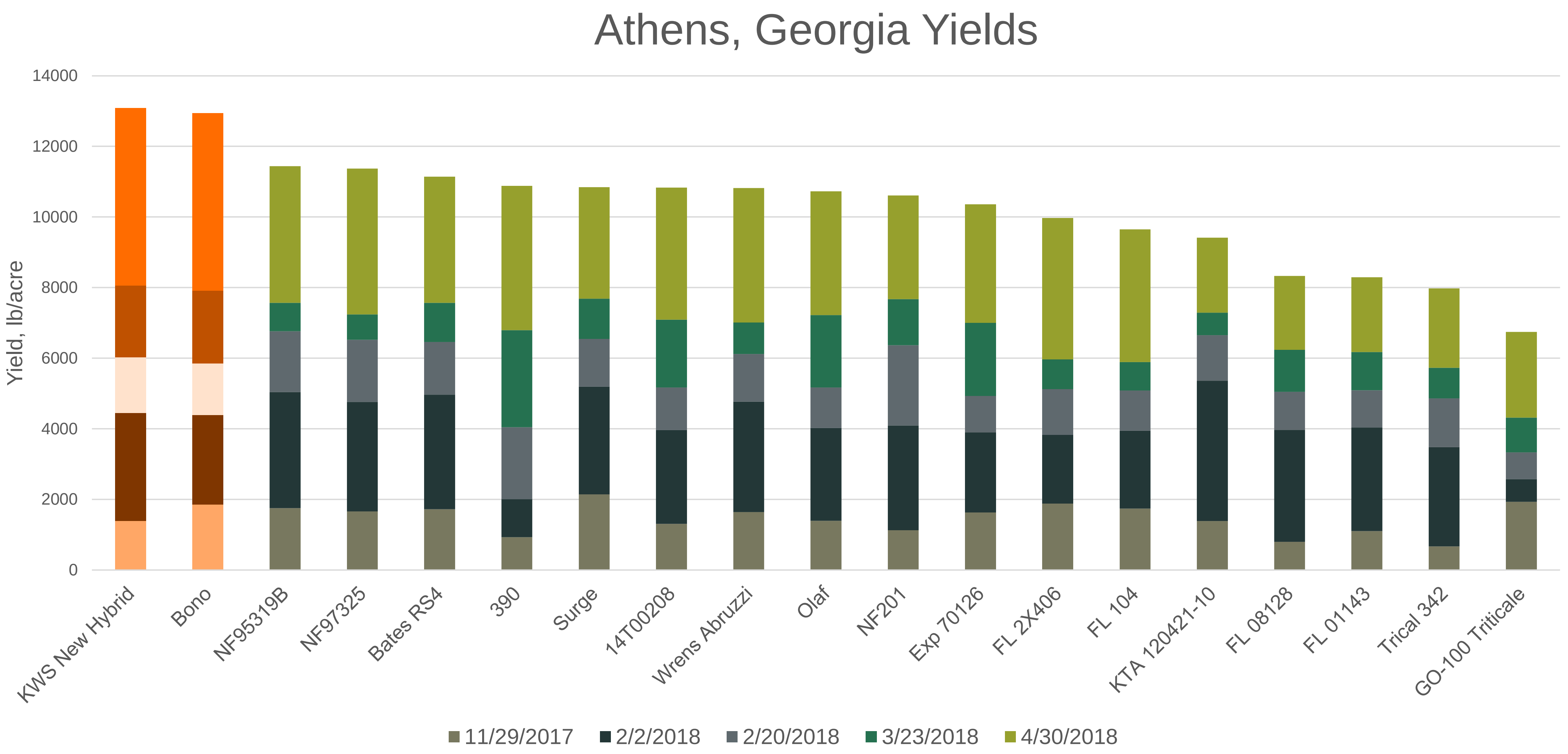
Waiting too long also make it difficult to pack – DM will be too high!

Hybrid Rye for Grazing

Hybrid Rye – Grazing Yields Georgia 2018

- Triticale and Rye Yield Results
- Athens, GA
- Forage harvested numerous times and lb/acre measured
  - Simulates forage available for grazing

Hybrid Rye – Yields



Grazing Research

- Initial results, AAFC Lacombe fall 2018 – 1 year
  - Cows gained 2.2lbs/day on whole trial (annual cereal with hybrid rye) vs loss 0.9lb/day barley swath grazing
  - Crude protein
    - Rye - 18-30% crude protein, estimated 75-80% digestible
    - Barley - 12% crude protein, estimated 65% digestible
  - Forage yield
    - Individual yields still being calculated
    - Hybrid fall rye had the most dense dry matter by the eye

AAFC Research – Hybrid Rye

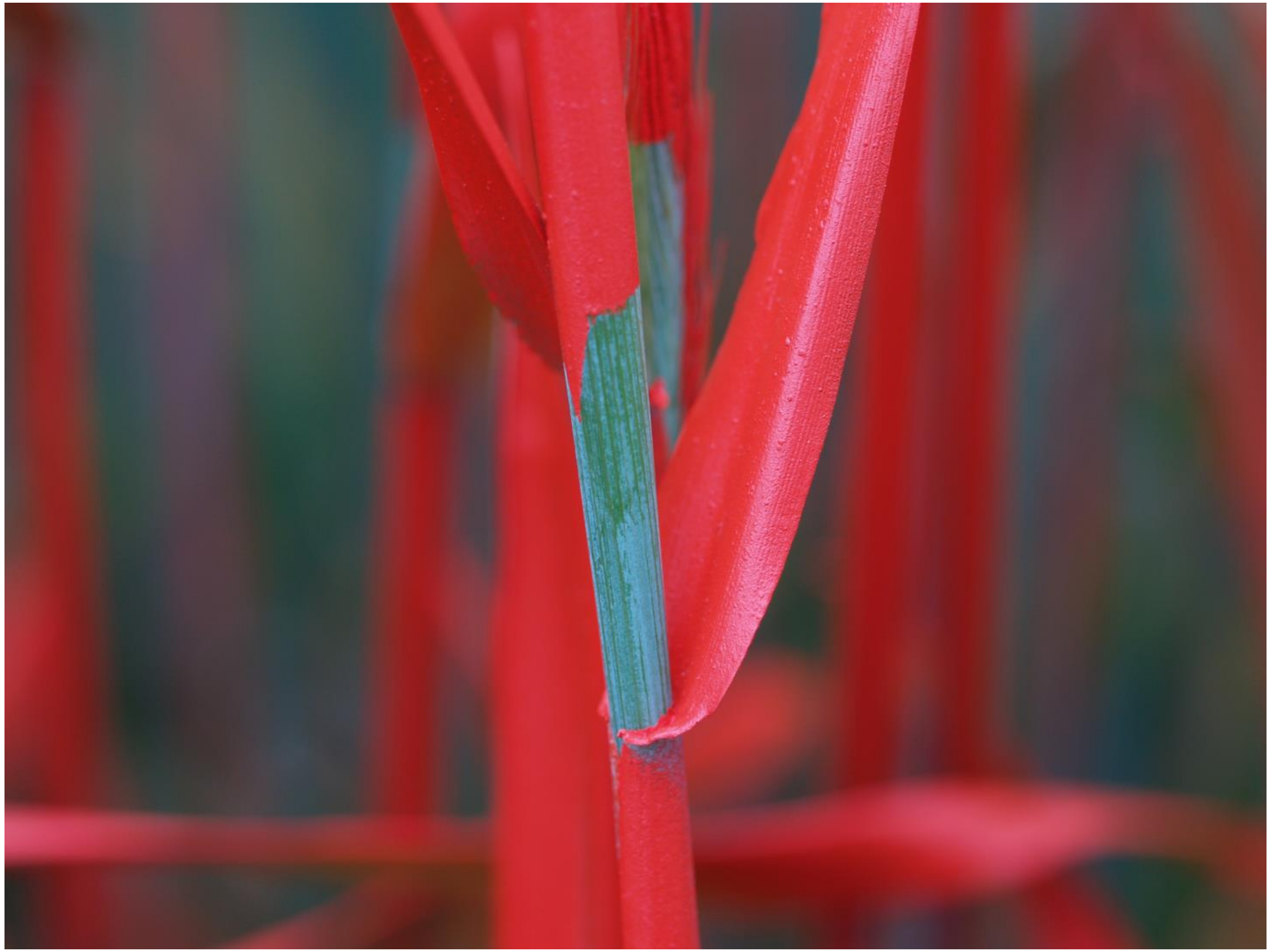
- Preliminary work, AAFC Lacombe fall 2018

AAFC Research – Hybrid Rye

AAFC Research – Hybrid Rye

- AAFC Lacombe Spring 2019

One day growth

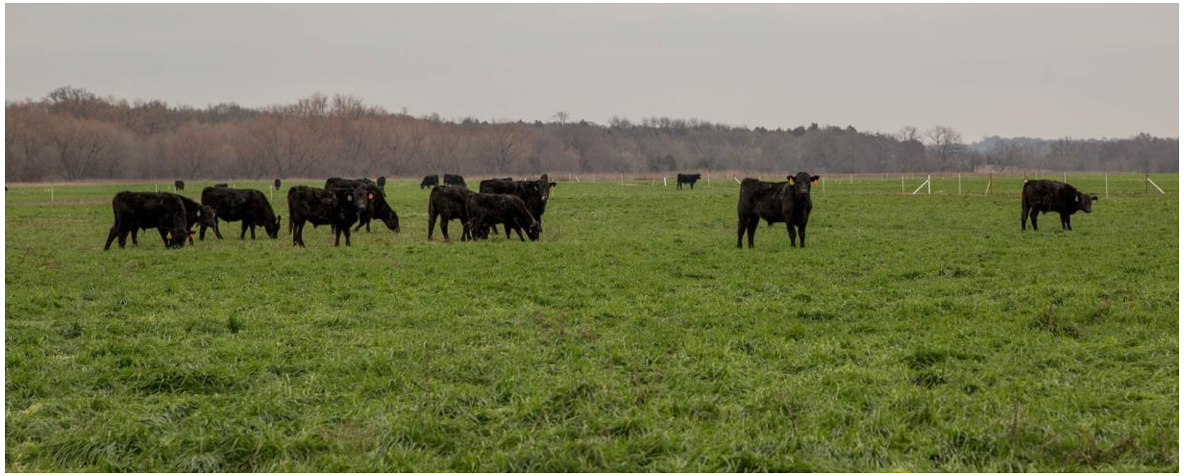


Hybrid Rye for Grazing - Considerations

- Fall and Spring grazing options
  - Late forage available – some growth necessary for winter survival
  - Early emergence – first available forage
  - Good forage management is critical!

- To ensure plant survival graze prior to elongation
  - New tillers = High Crude Protein!

- Recommended grazing methods
  - Strip grazing
  - Mob grazing



Conclusions

Why Hybrid Rye?

- Higher biomass yield than any other winter cereal
  - more beef/acre
  - Higher stocking rates/acre
- Earliest spring feed source
- Possibility for double cropping
  - Silage or grazing
- Diversity
- Strong competitor to weeds
- Soil Health



Nutritional Value of Hybrid Rye for Pigs

Molly McGhee

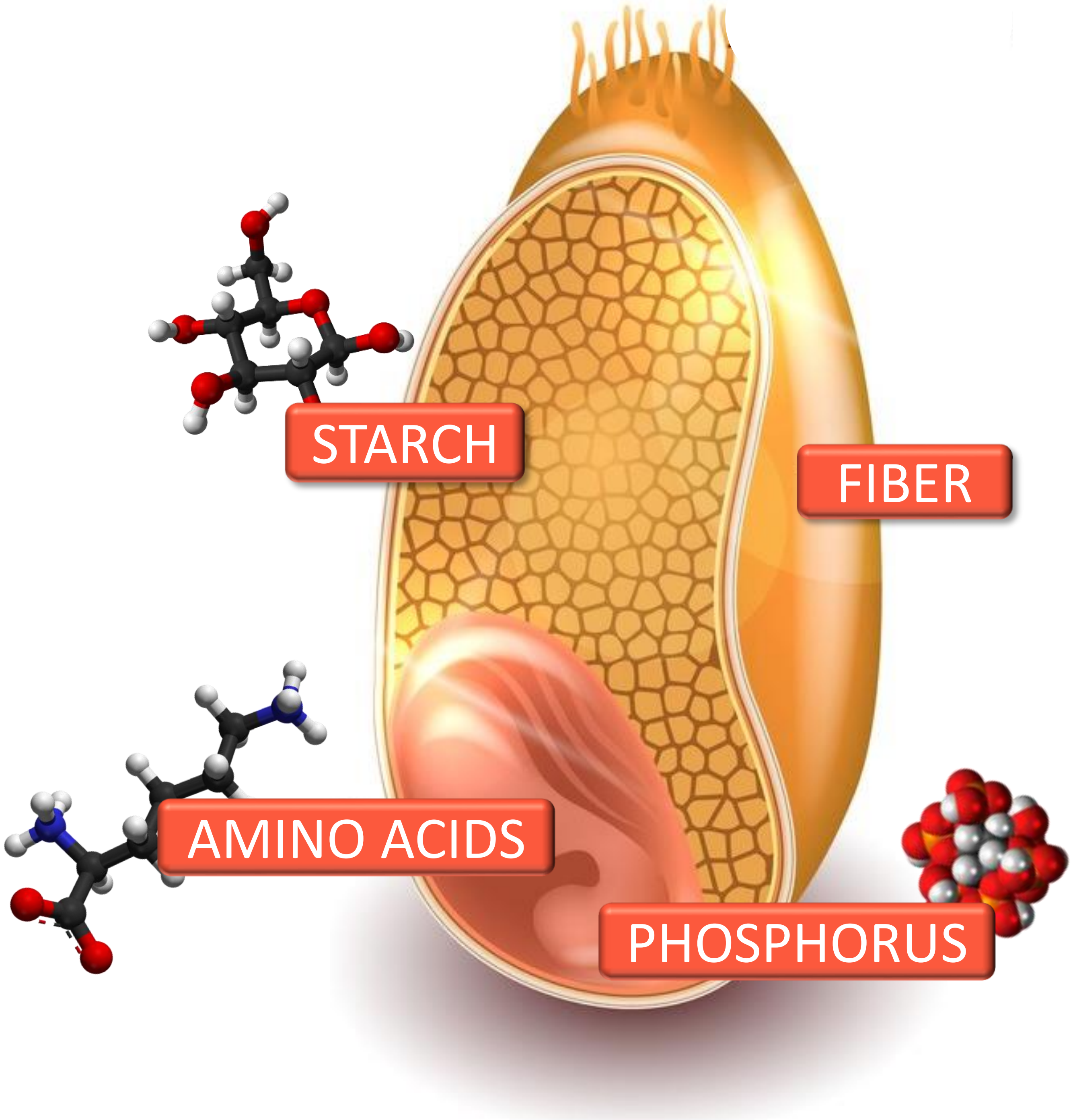
UNIVERSITY OF ILLINOIS

Outline

BACKGROUND

DIGESTIBLE NUTRIENTS

PIG PERFORMANCE



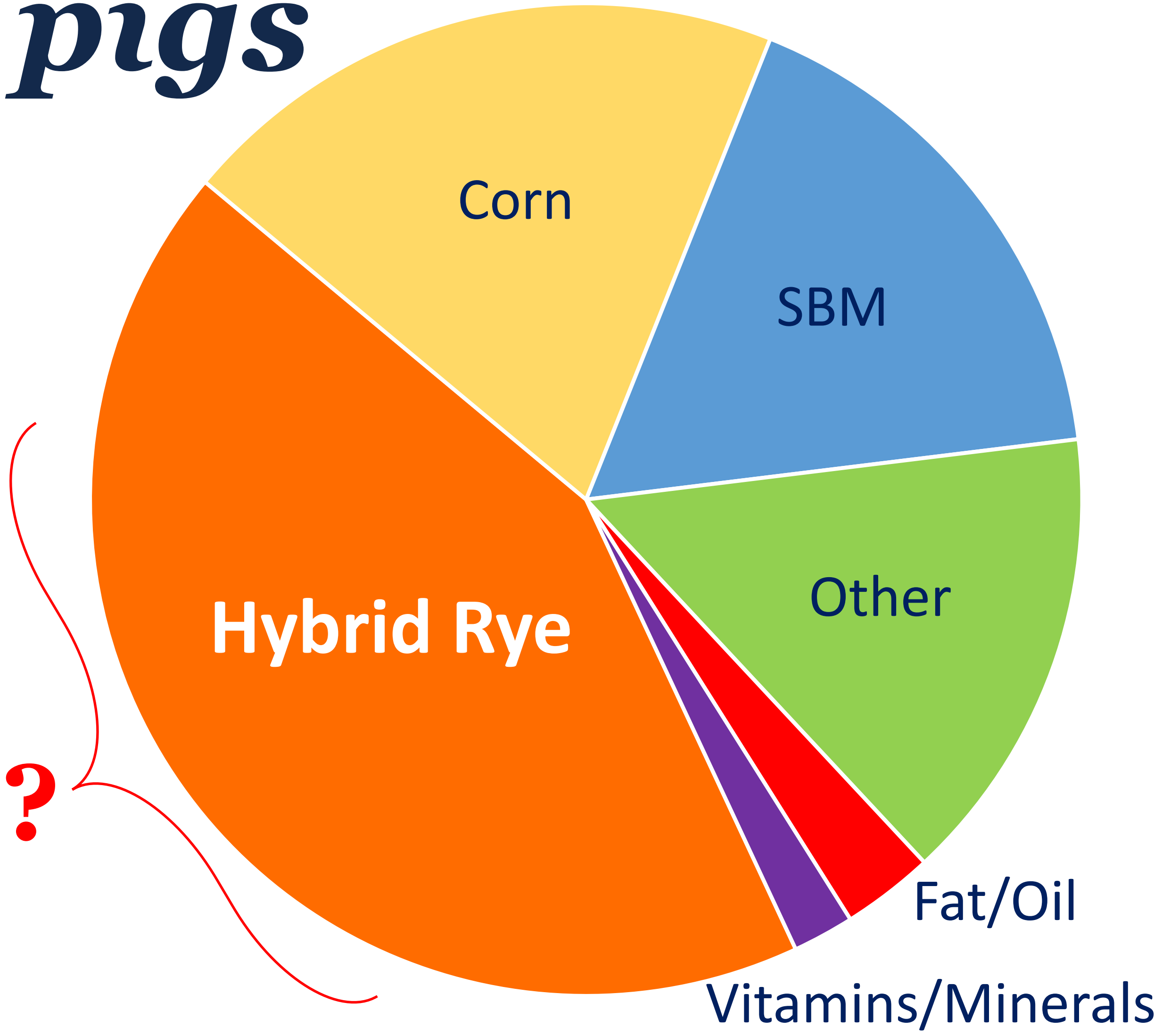
Hybrid Rye

Hybrid Rye *for pigs*

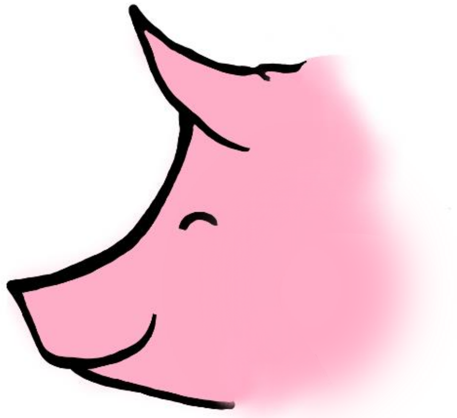
Objective of swine nutrition

"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."

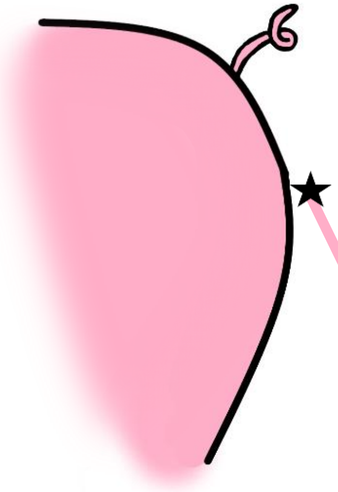
-Dr. Robert Easter



FEED INGESTION

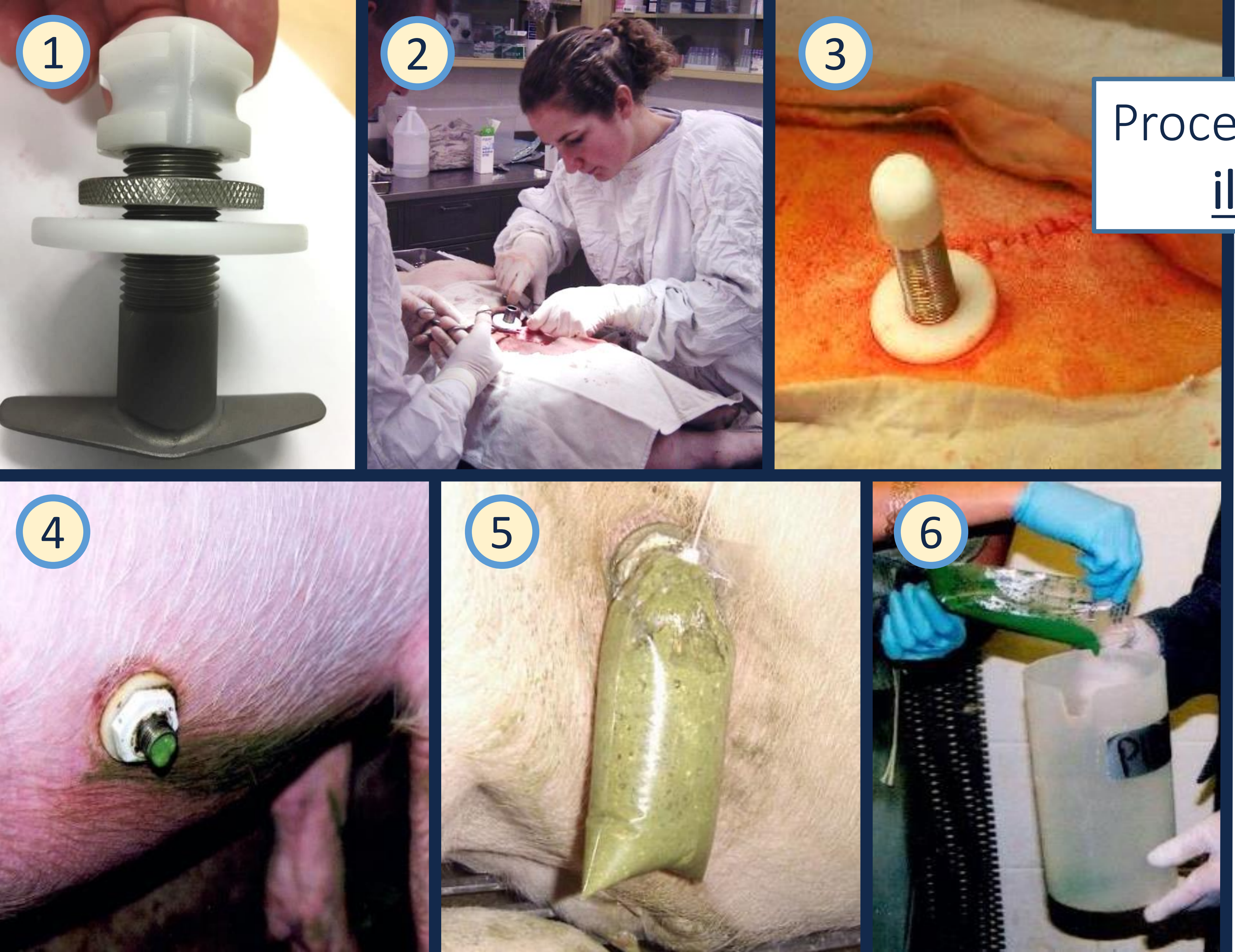


ILEAL OUTPUT =
ileal digestibility



FECAL OUTPUT=
total tract digestibility

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



Used for:

AMINO ACIDS

STARCH

Procedure for measuring

total tract digestibility

Used for:

ENERGY

MINERALS

FIBER

day 1	5	10
ADAPTATION	COLLECTION	

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

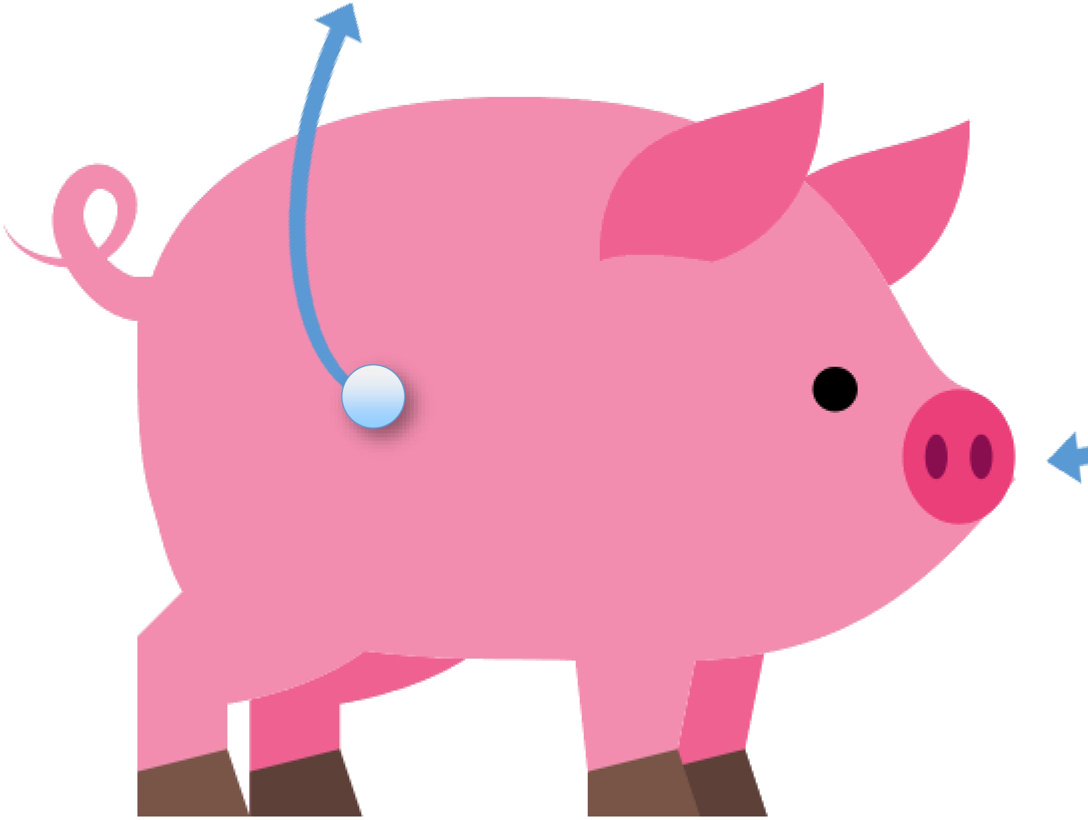
ABSTRACT: An experiment was conducted to determine the apparent ileal digestibility (**AID**) of AA and starch and the standardized ileal digestibility (**SID**) of AA in three varieties of hybrid rye and in one source of barley, wheat, and corn. Seven growing barrows (initial BW = 26.1 ± 2.4 kg) were 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

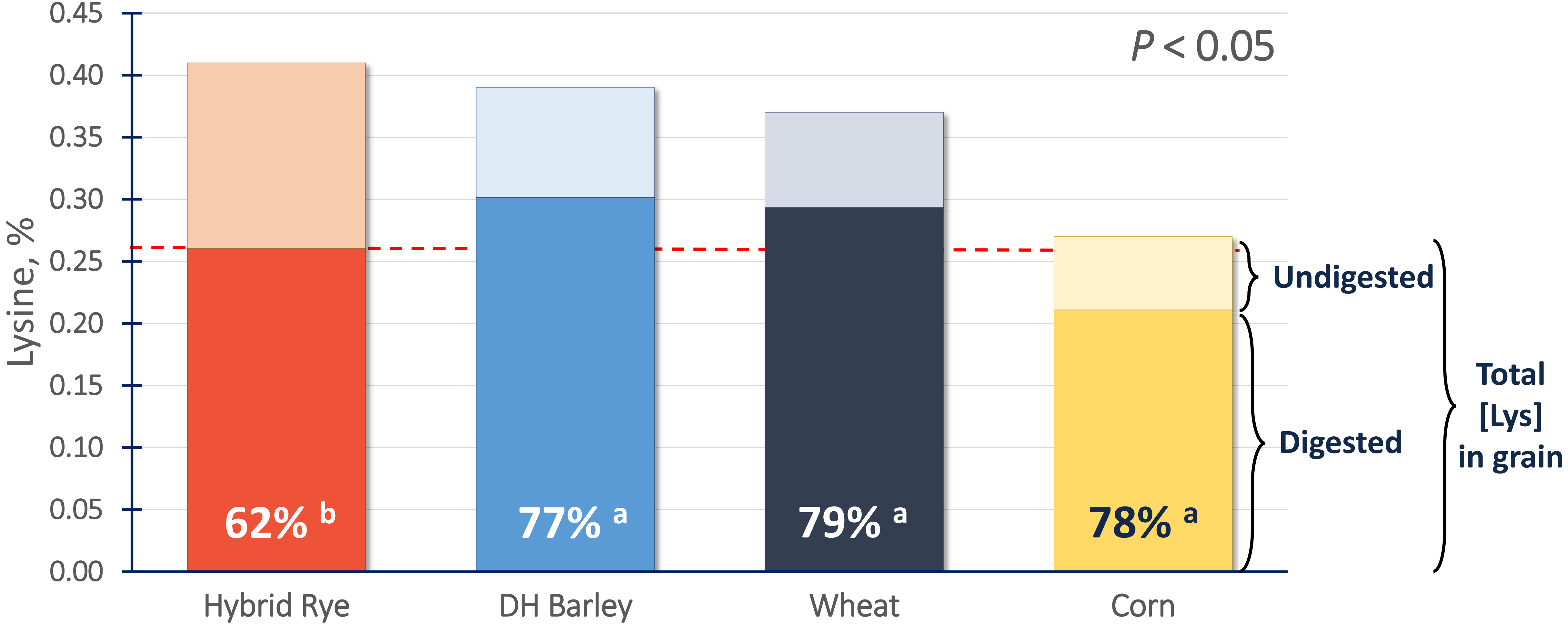
SID = 64%



0.41% Lysine

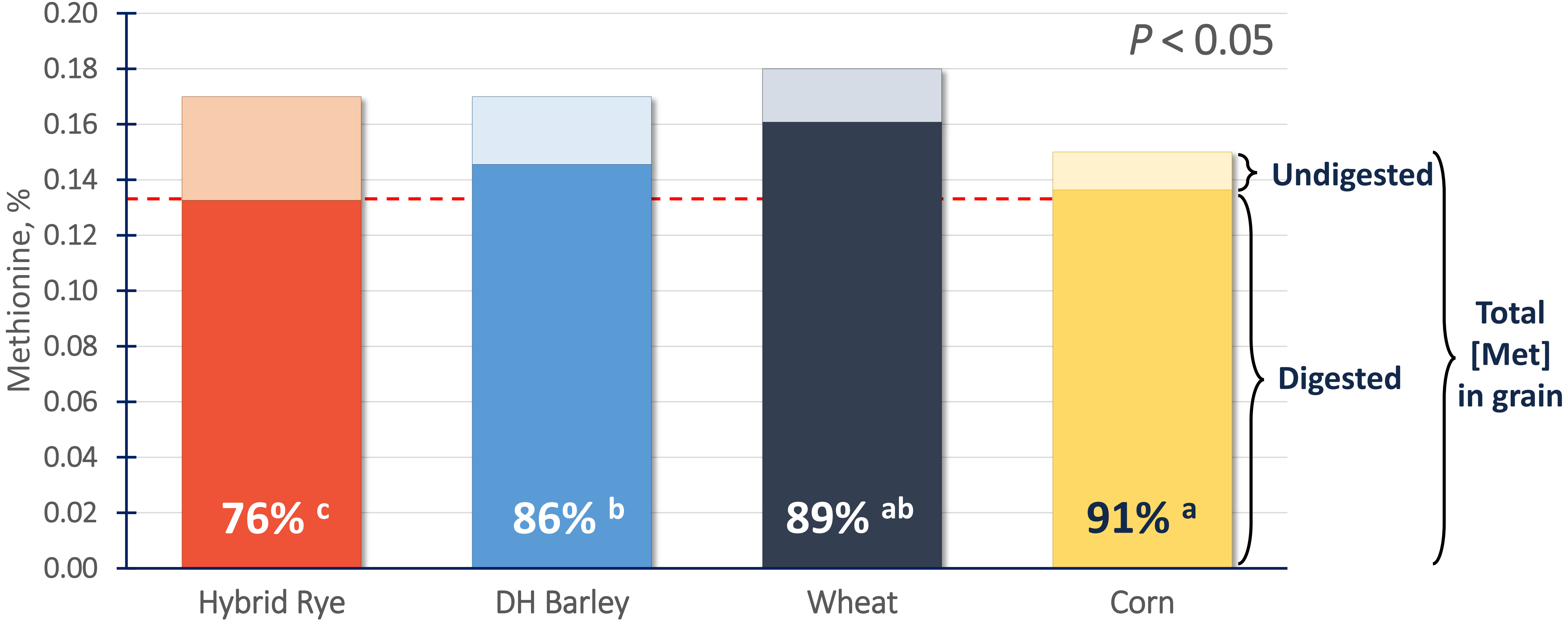
0.26% *SID* Lysine

Digestible Lysine (SID)

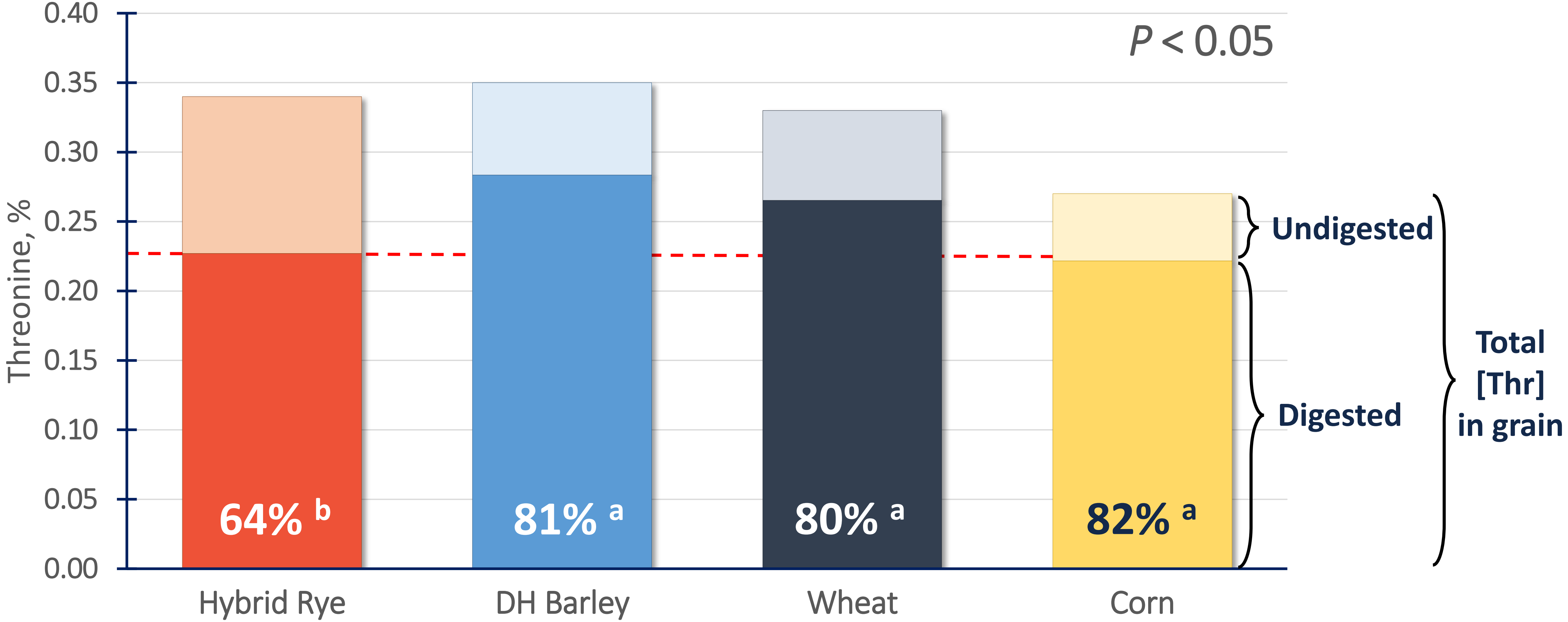


ILLINOIS

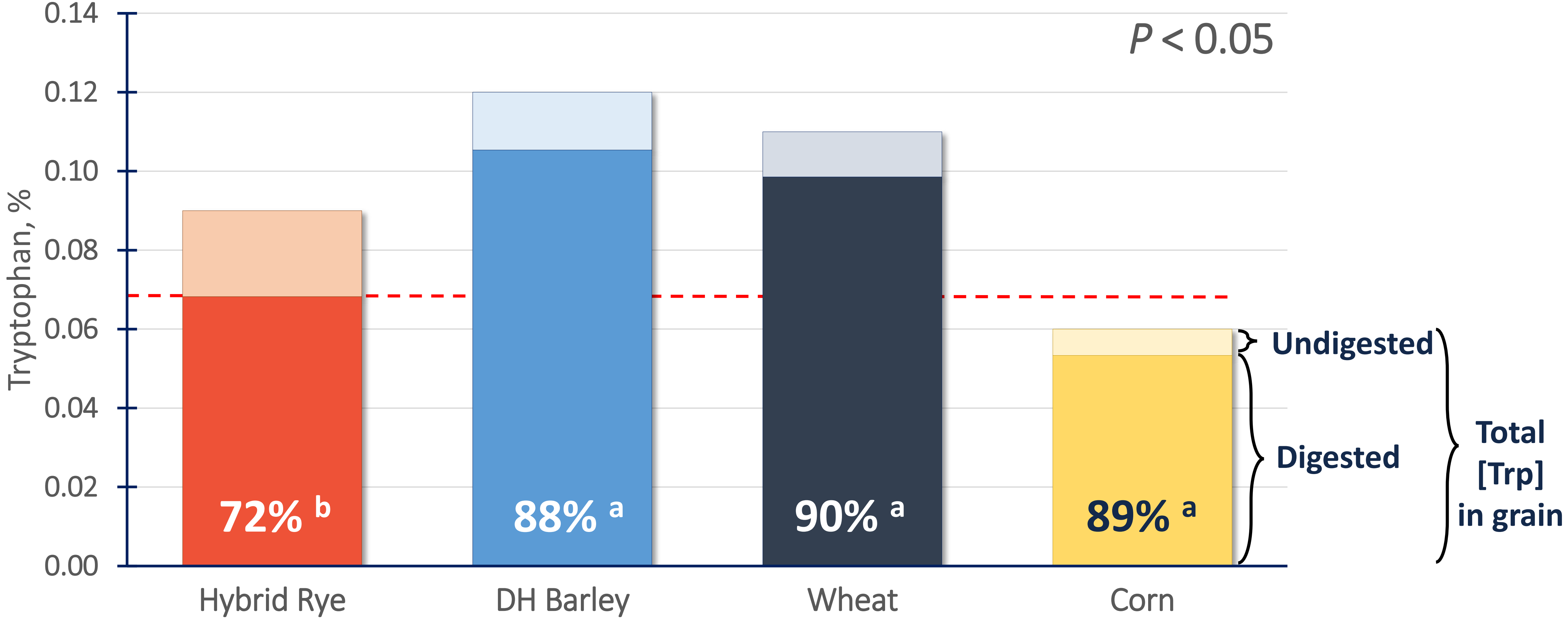
Digestible Methionine (SID)



Digestible Threonine (SID)



Digestible Tryptophan (SID)



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

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.

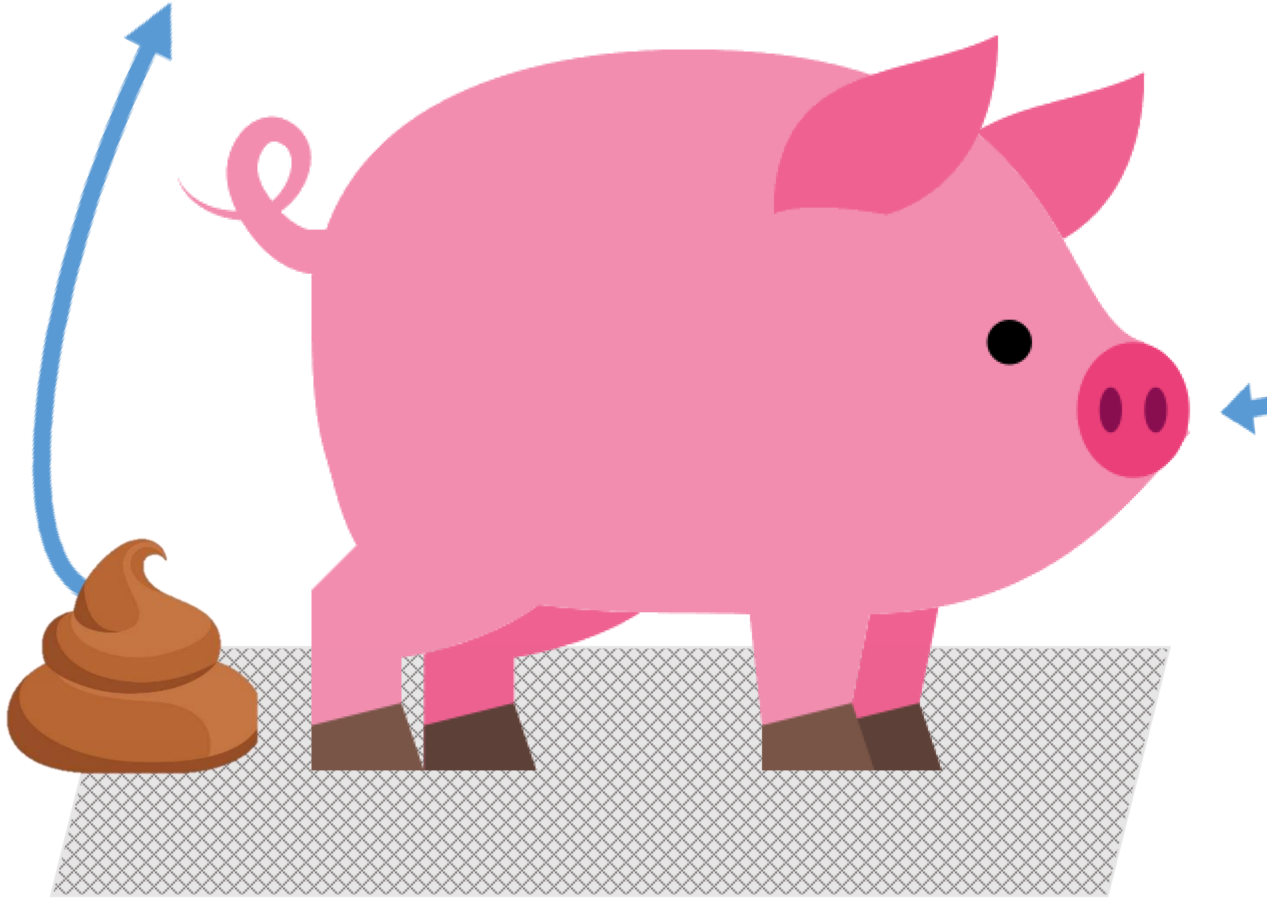
Key words: calcium, cereal grains, digestibility, hybrid rye, phosphorus, pigs

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

EXP. 2

Phosphorus Digestibility

STTD = 49%

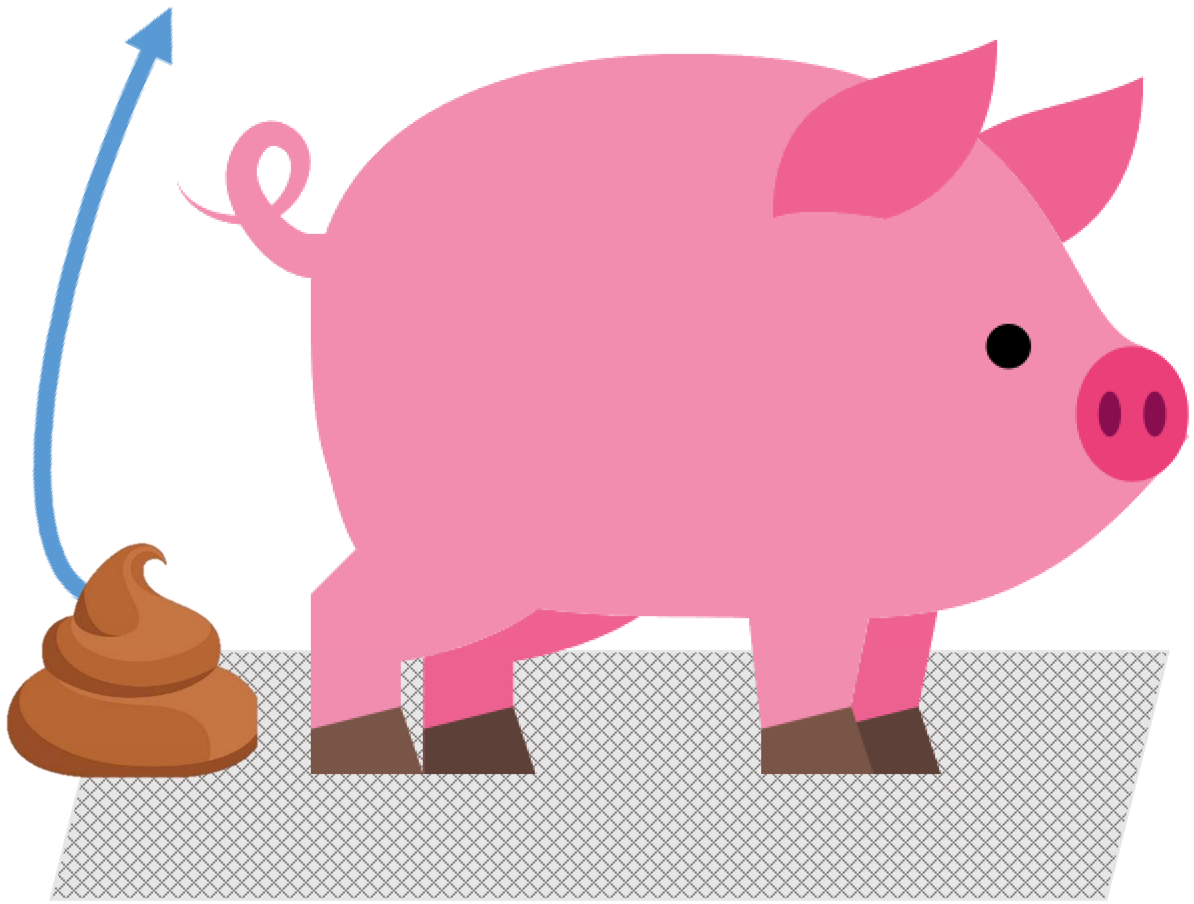


0.29% Phosphorus

0.14% *STTD P*

WHAT IF WE ADD PHYTASE?

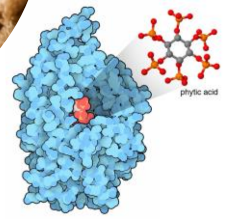
STTD = ~~49%~~ 63%



0.29% Phosphorus

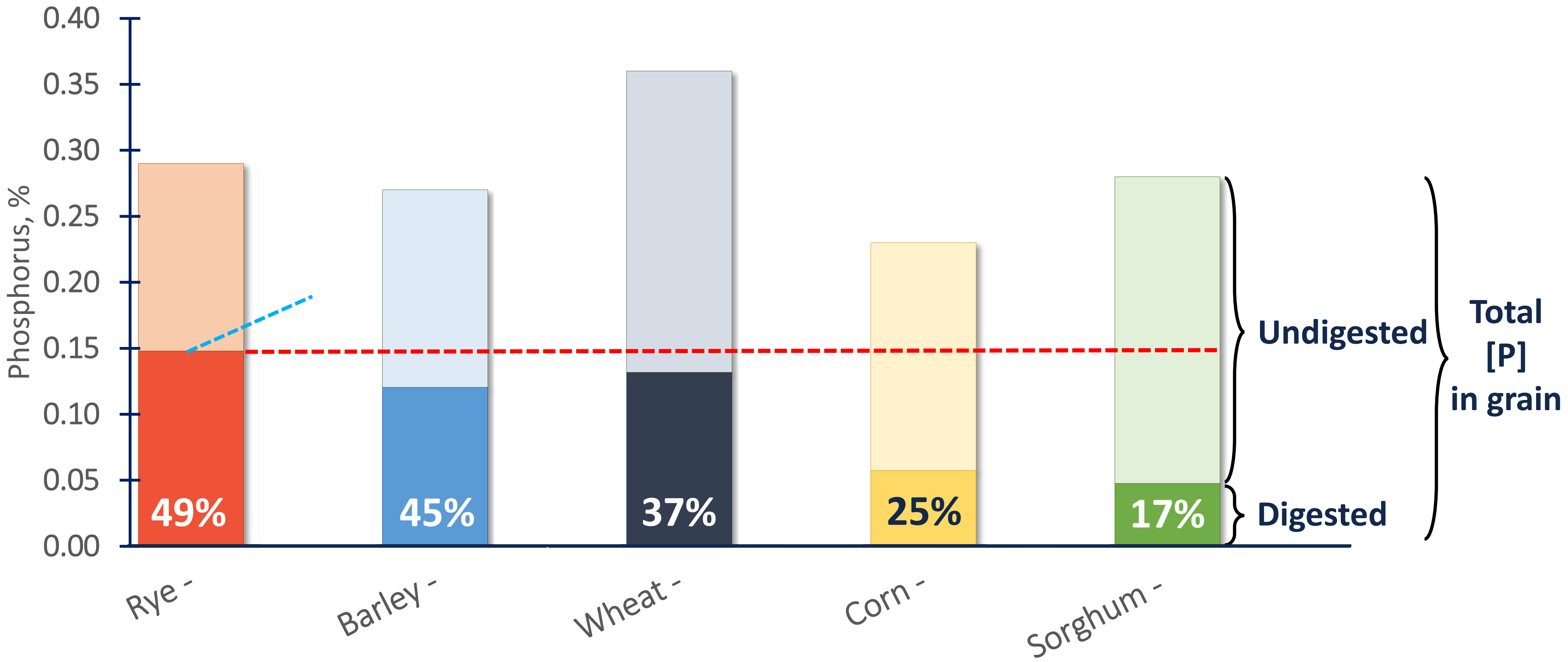
0.18% *STTD P*

+

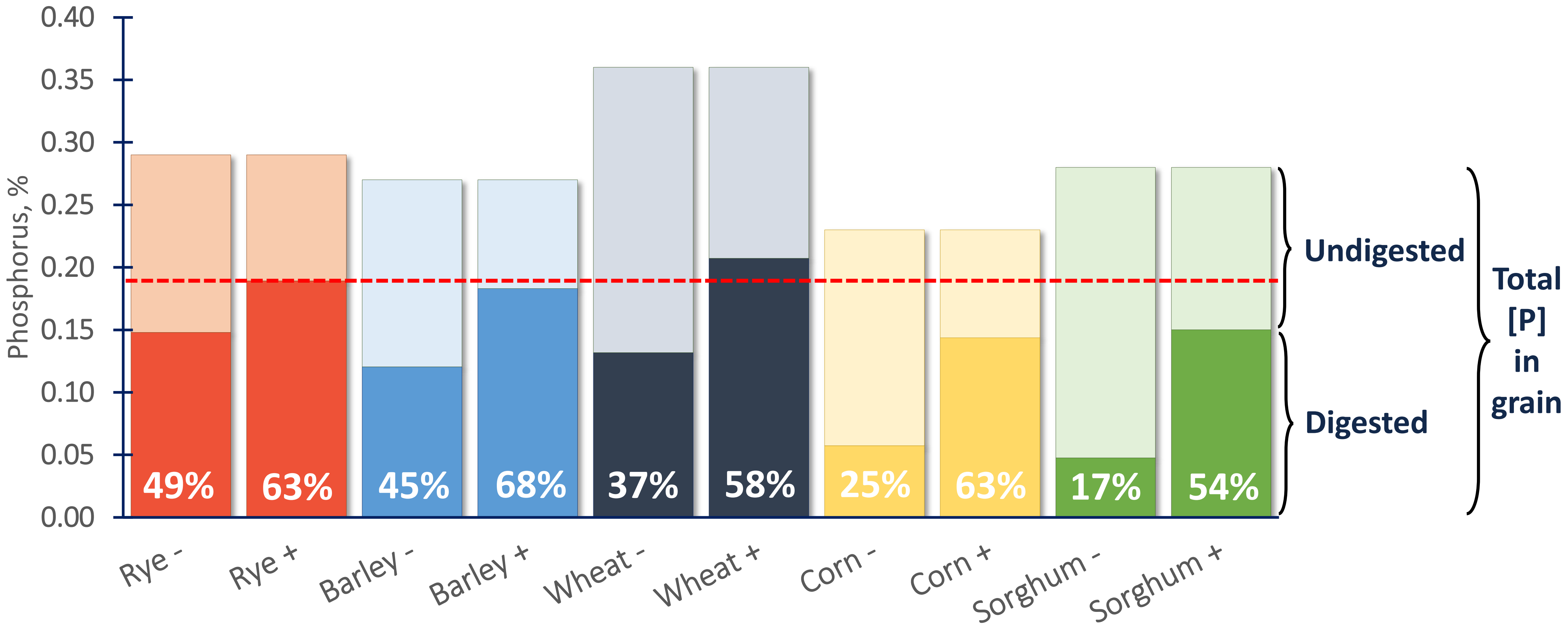


WHAT IF WE ADD PHYTASE?

Digestible Phosphorus (STTD)

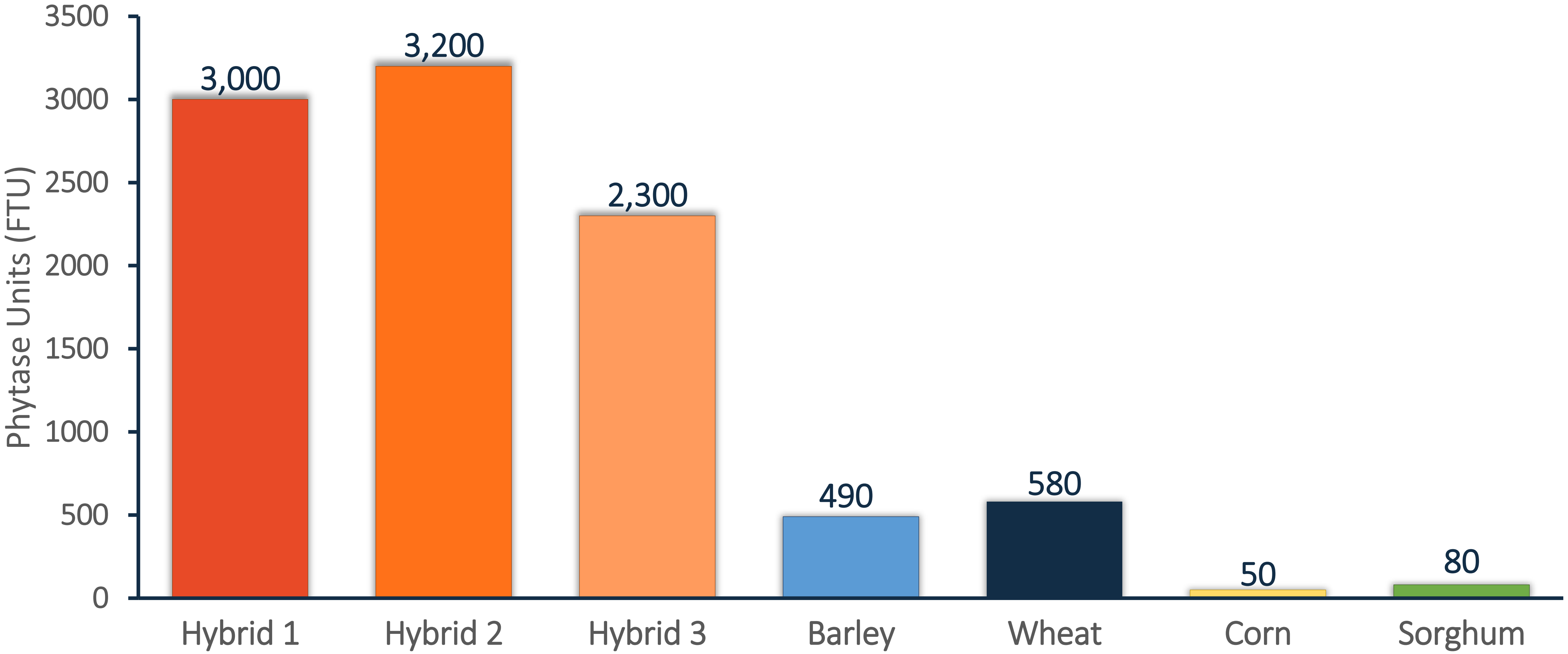


Digestible Phosphorus (STTD)



ILLINOIS

Intrinsic phytase



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**.

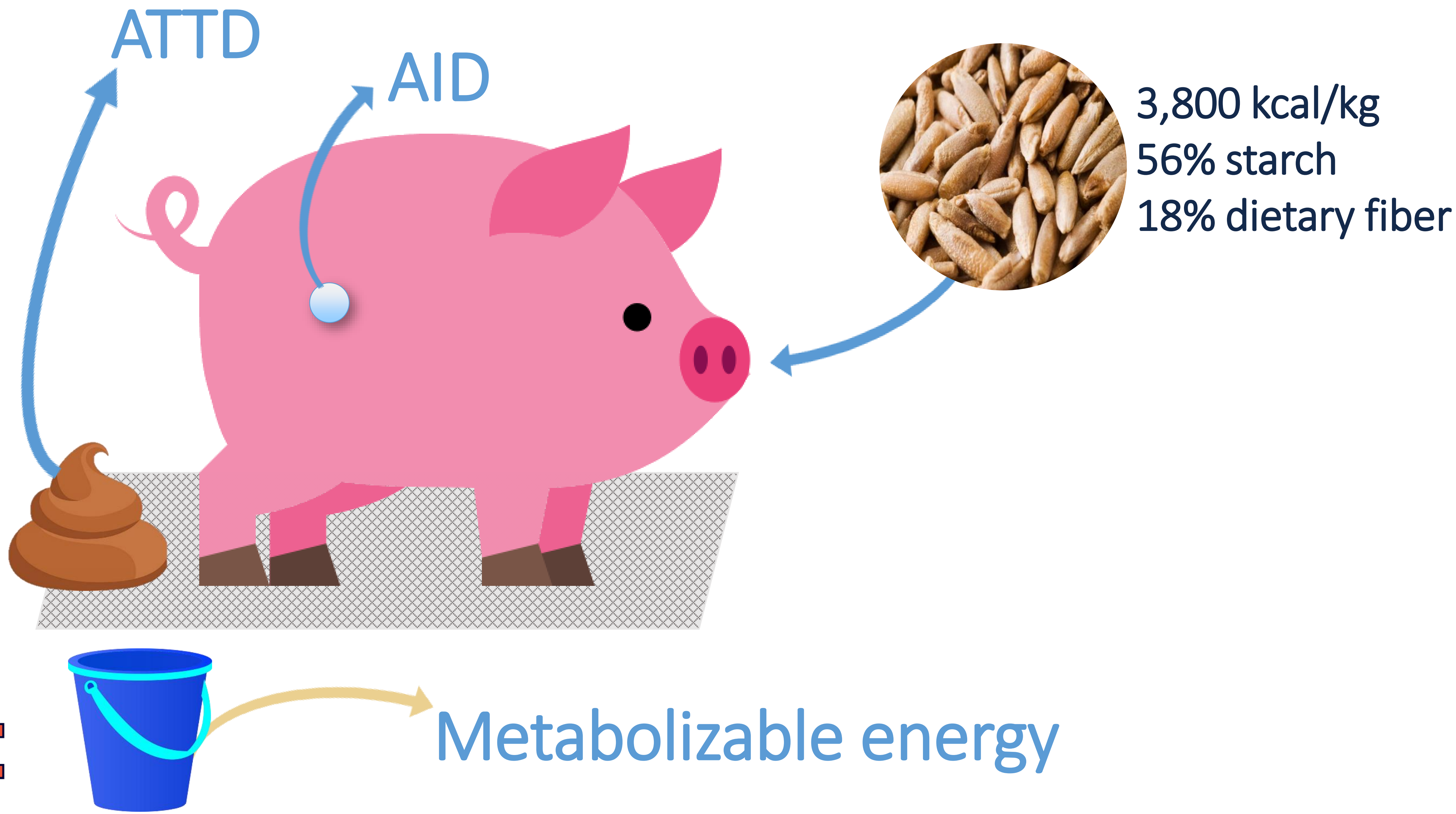
In rye, the increase was significant, but less pronounced.

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

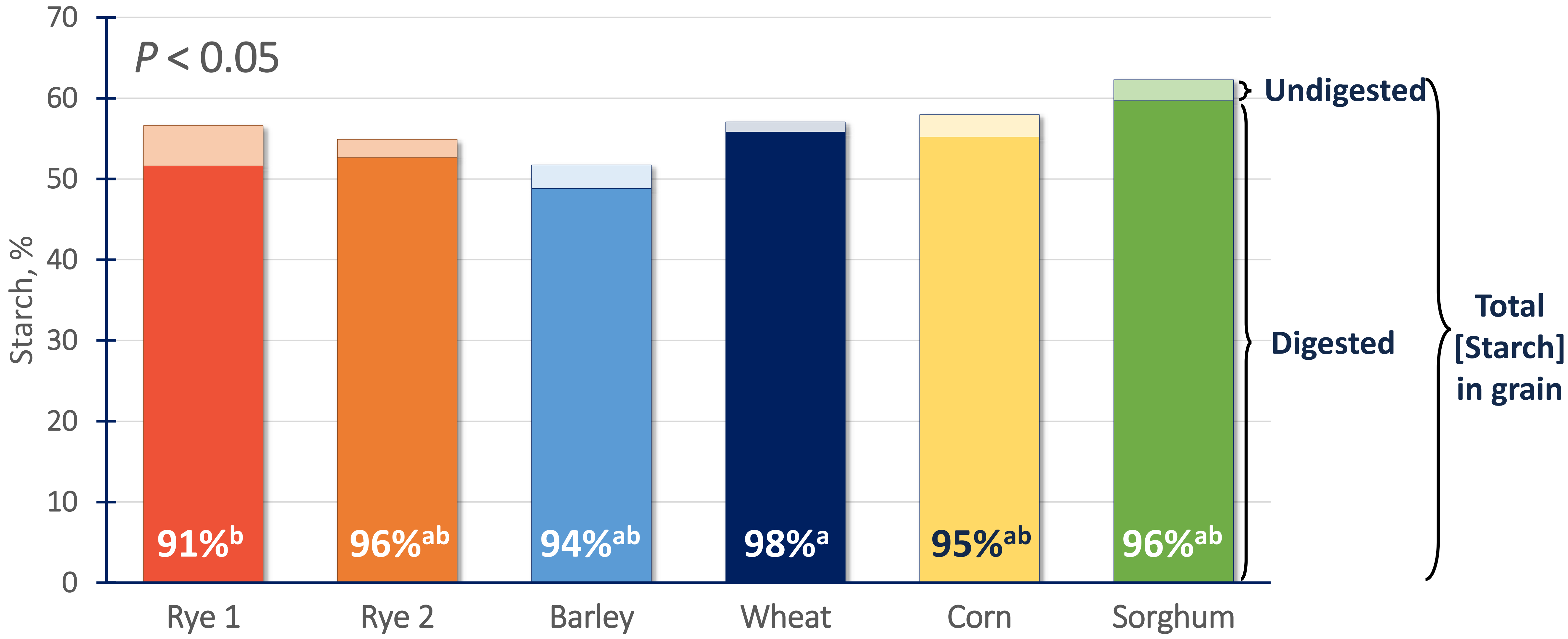
Less inorganic P needed in diets, less P excreted in feces

EXP. 3

Carbohydrate and Energy Digestibility

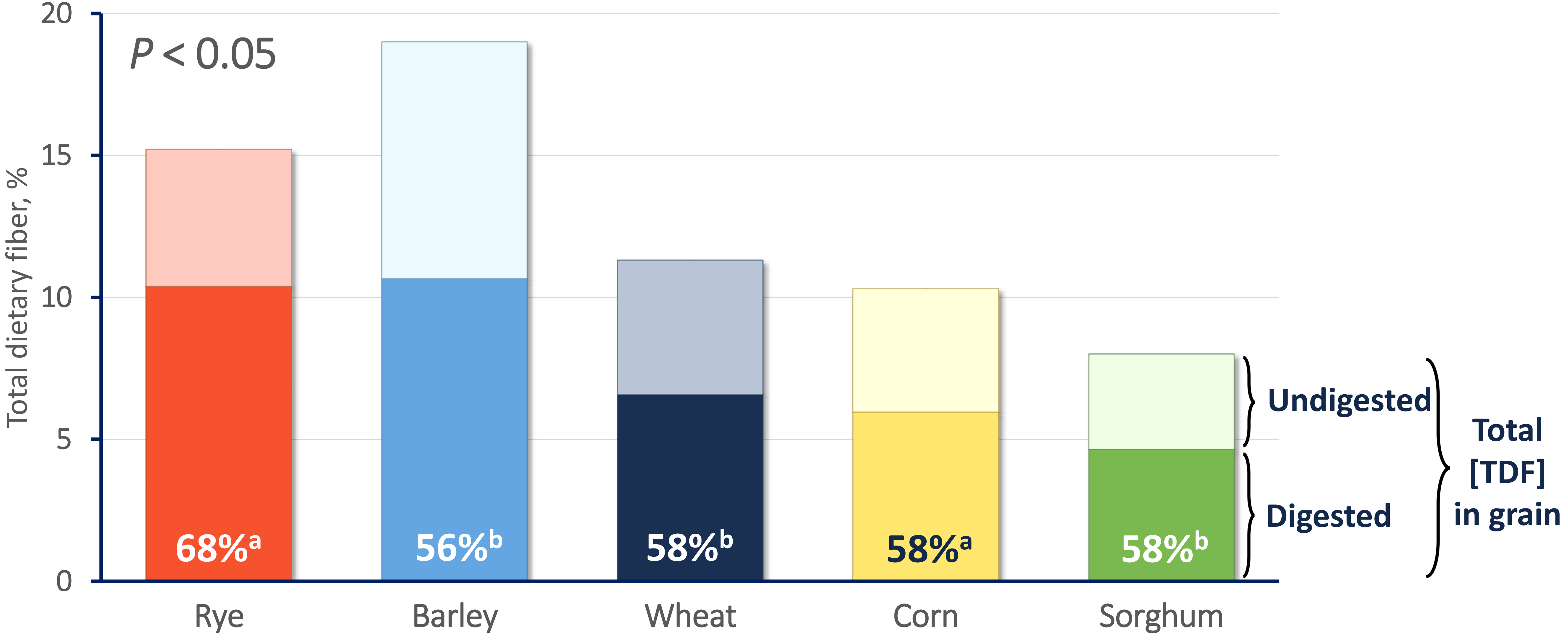

ATTD
AID
3,800 kcal/kg
56% starch
18% dietary fiber
Metabolizable energy

Starch (AID)

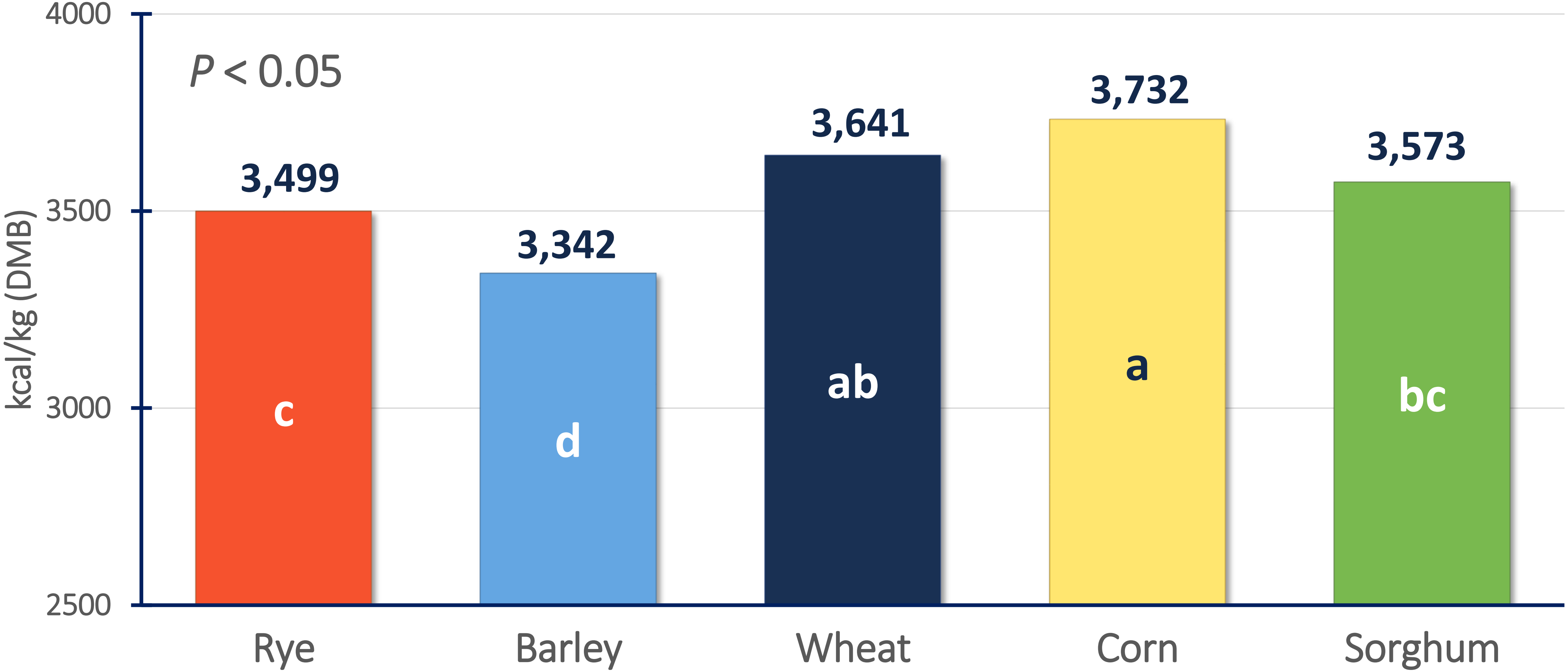


P < 0.05
Starch, %
70
60
50
40
30
20
10
0
91%b
96%ab
94%ab
98%a
95%ab
96%ab
Rye 1
Rye 2
Barley
Wheat
Corn
Sorghum
Undigested
Digested
Total [Starch] in grain

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 ≅ barley ≅ sorghum

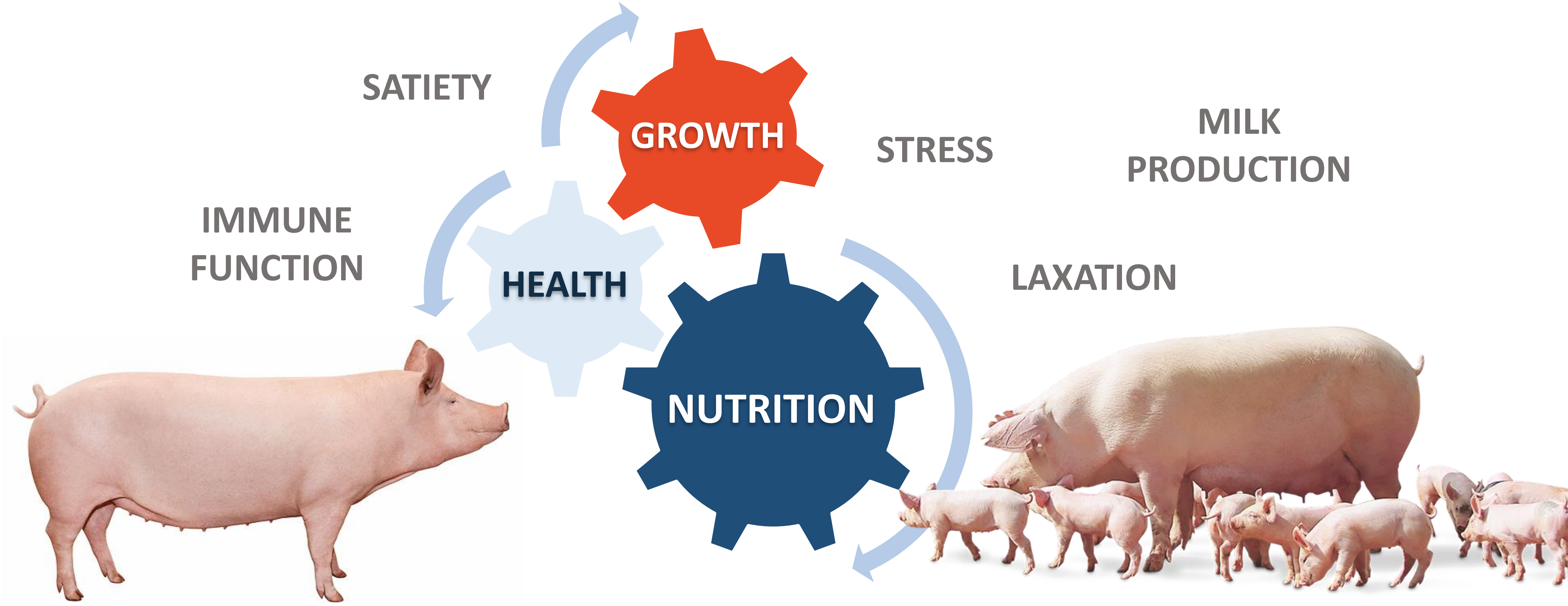
(Less than corn and wheat)

EXP. 4

Sow performance

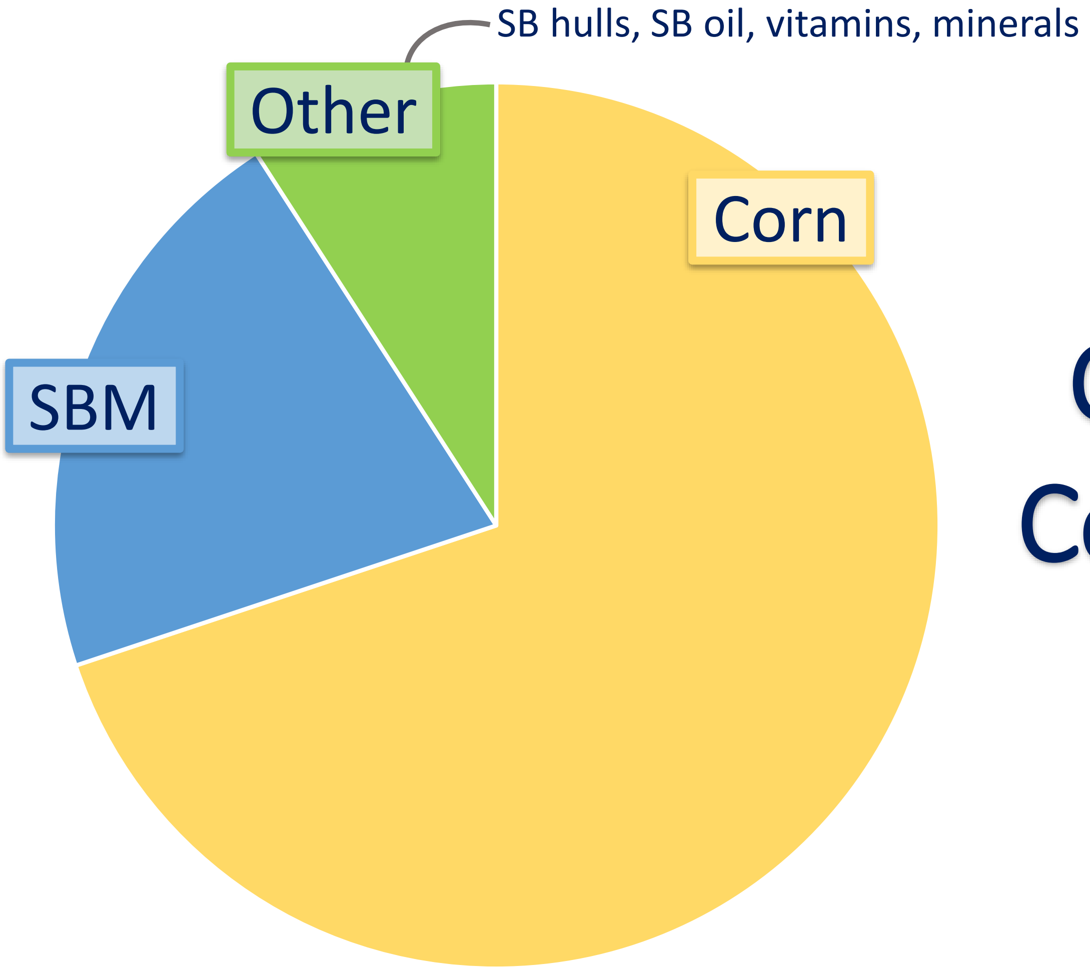
OCTOBER 2018 – AUGUST 2019

Hybrid rye for sows



Sow dietary treatments

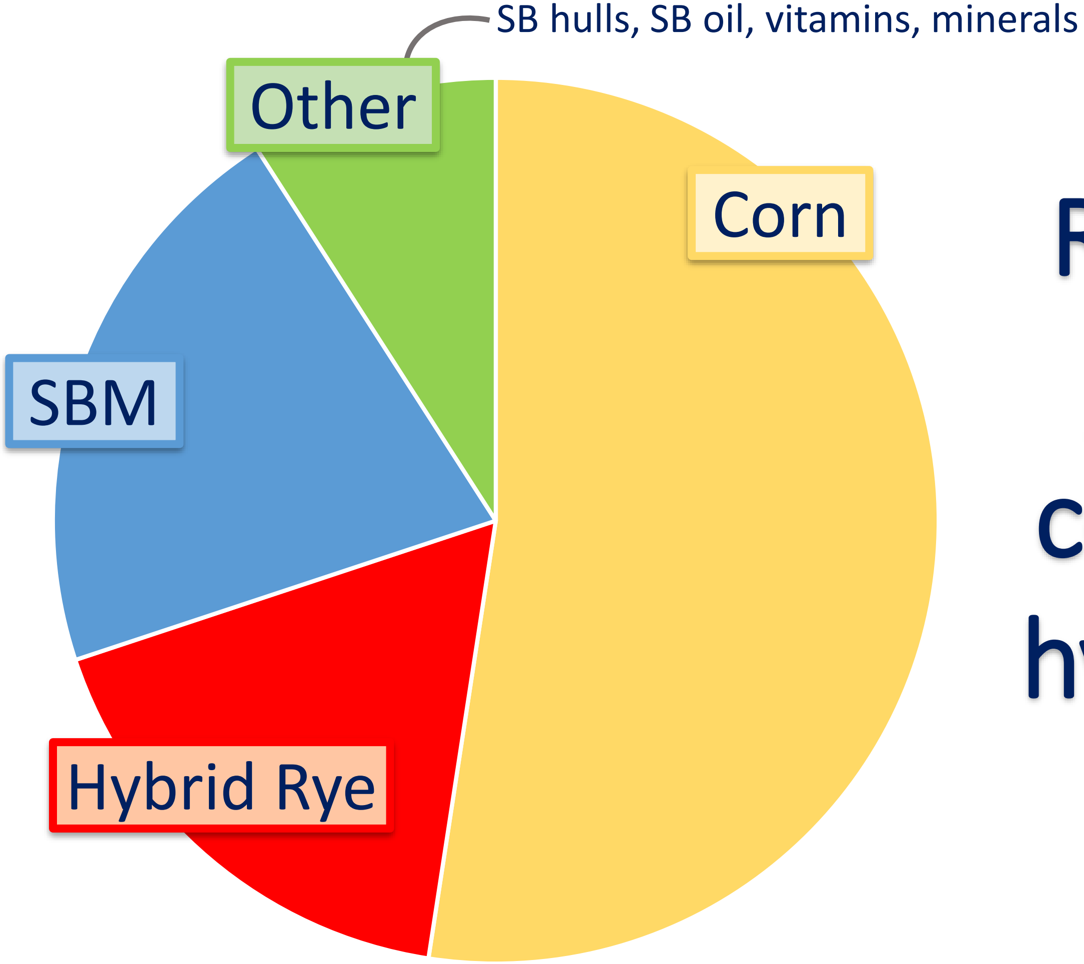
FORMULATED FOR GESTATION + LACTATION



Control:
Corn/SBM

Sow dietary treatments

FORMULATED FOR GESTATION + LACTATION

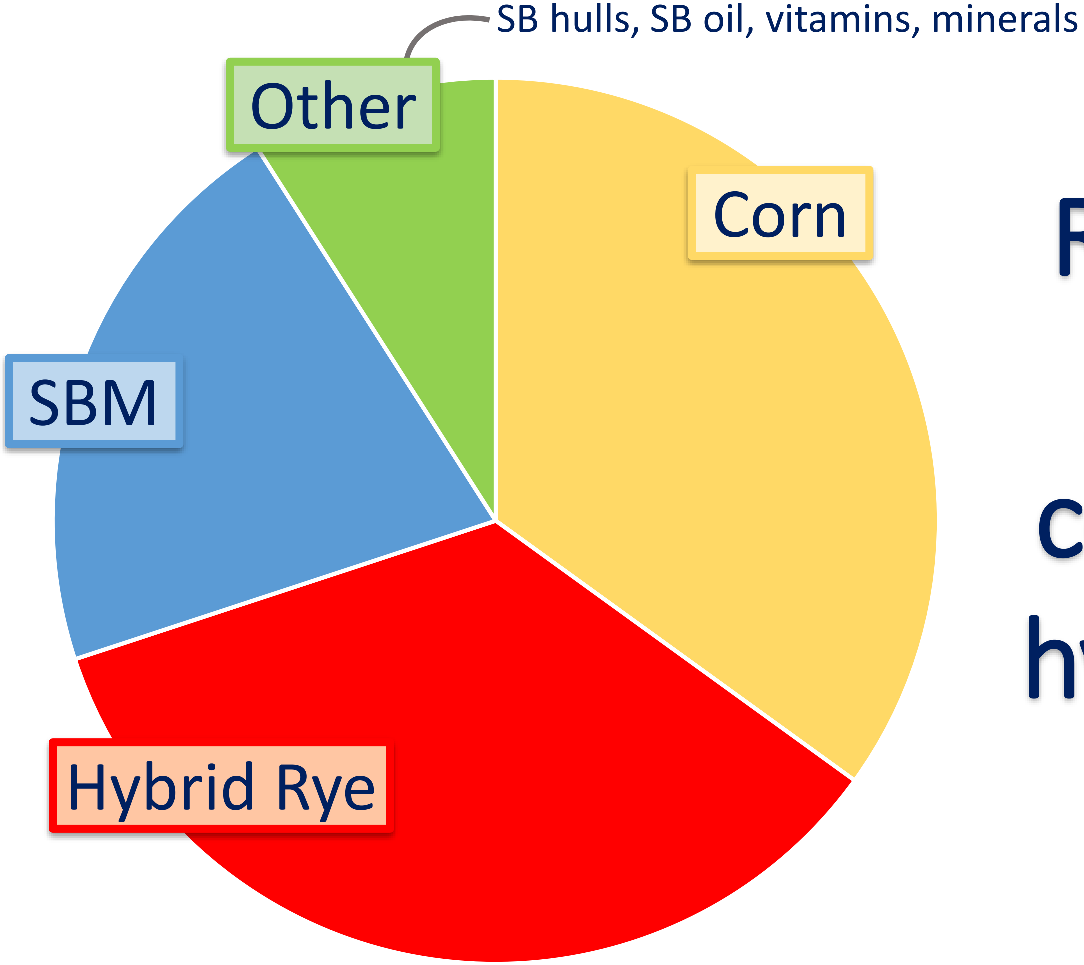


Replaces **25%** of corn with hybrid rye

ILLINOIS

Sow dietary treatments

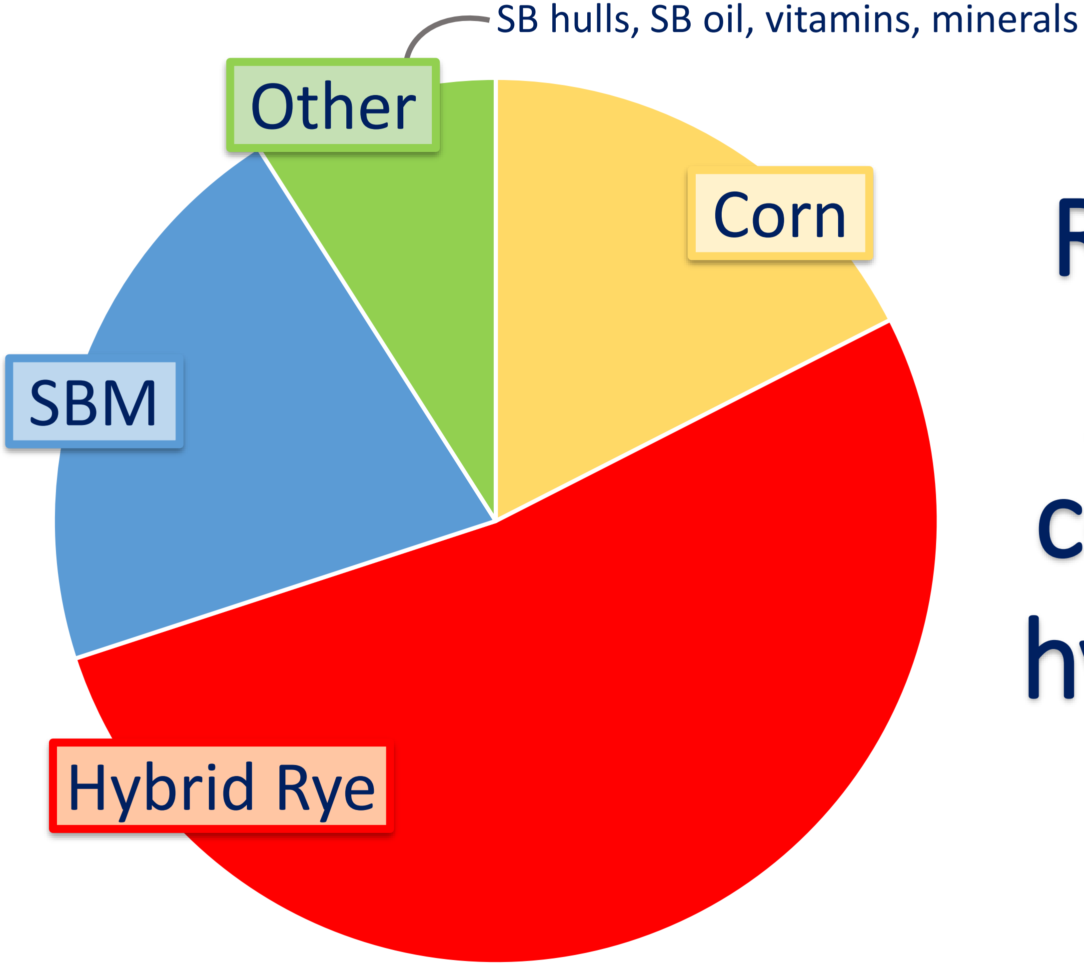
FORMULATED FOR GESTATION + LACTATION



Replaces **<u>50%</u>** of corn with hybrid rye

Sow dietary treatments

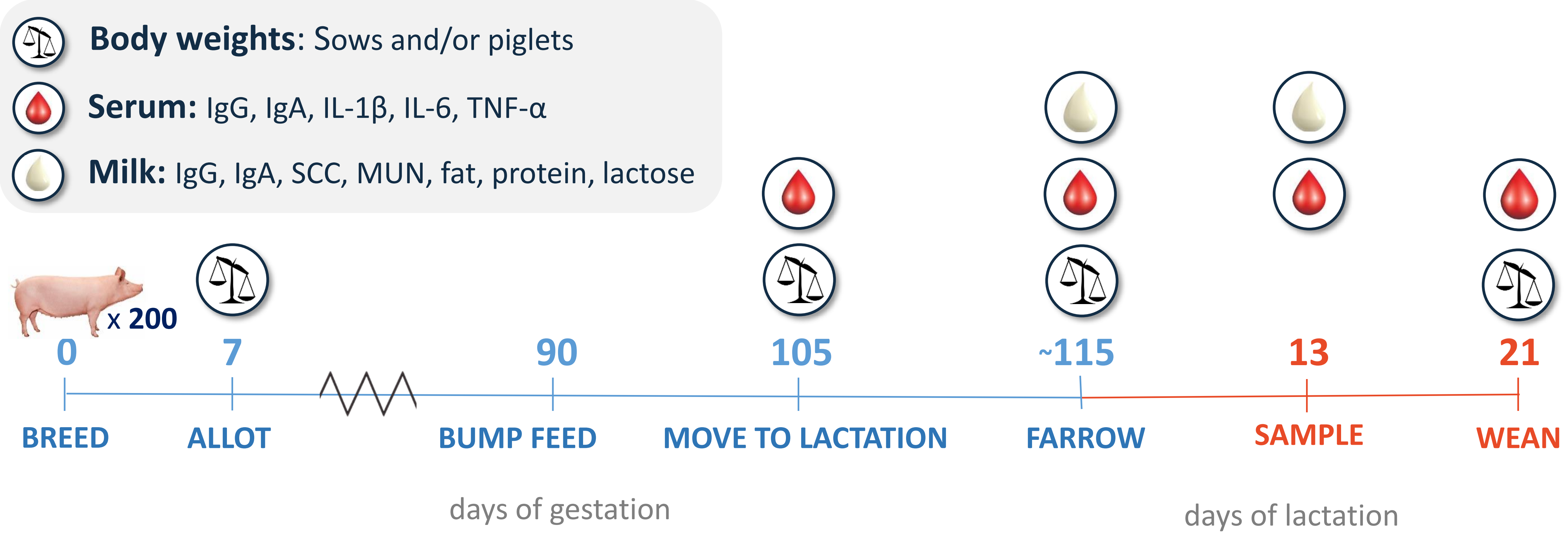
FORMULATED FOR GESTATION + LACTATION



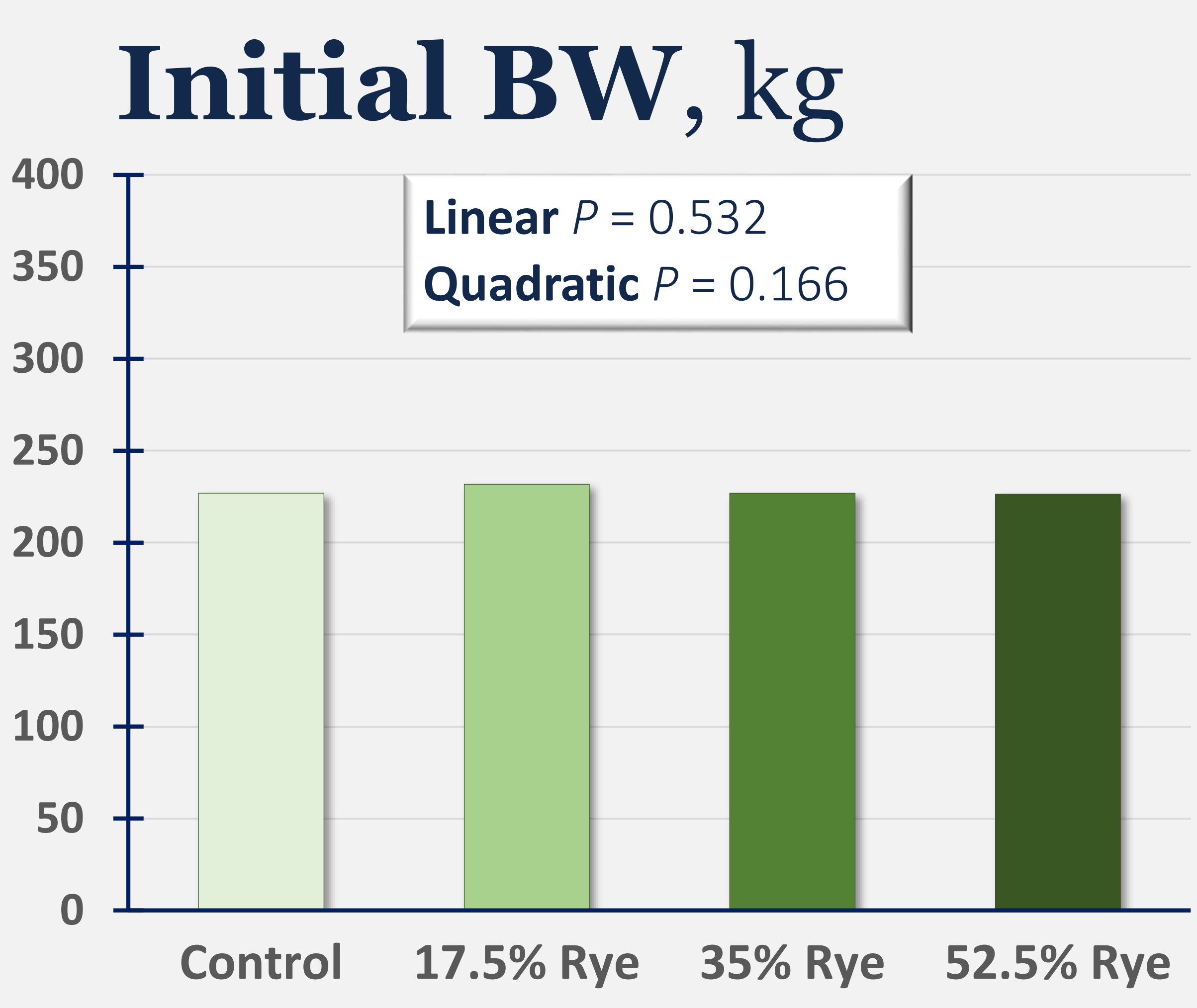
Replaces **75%** of corn with hybrid rye

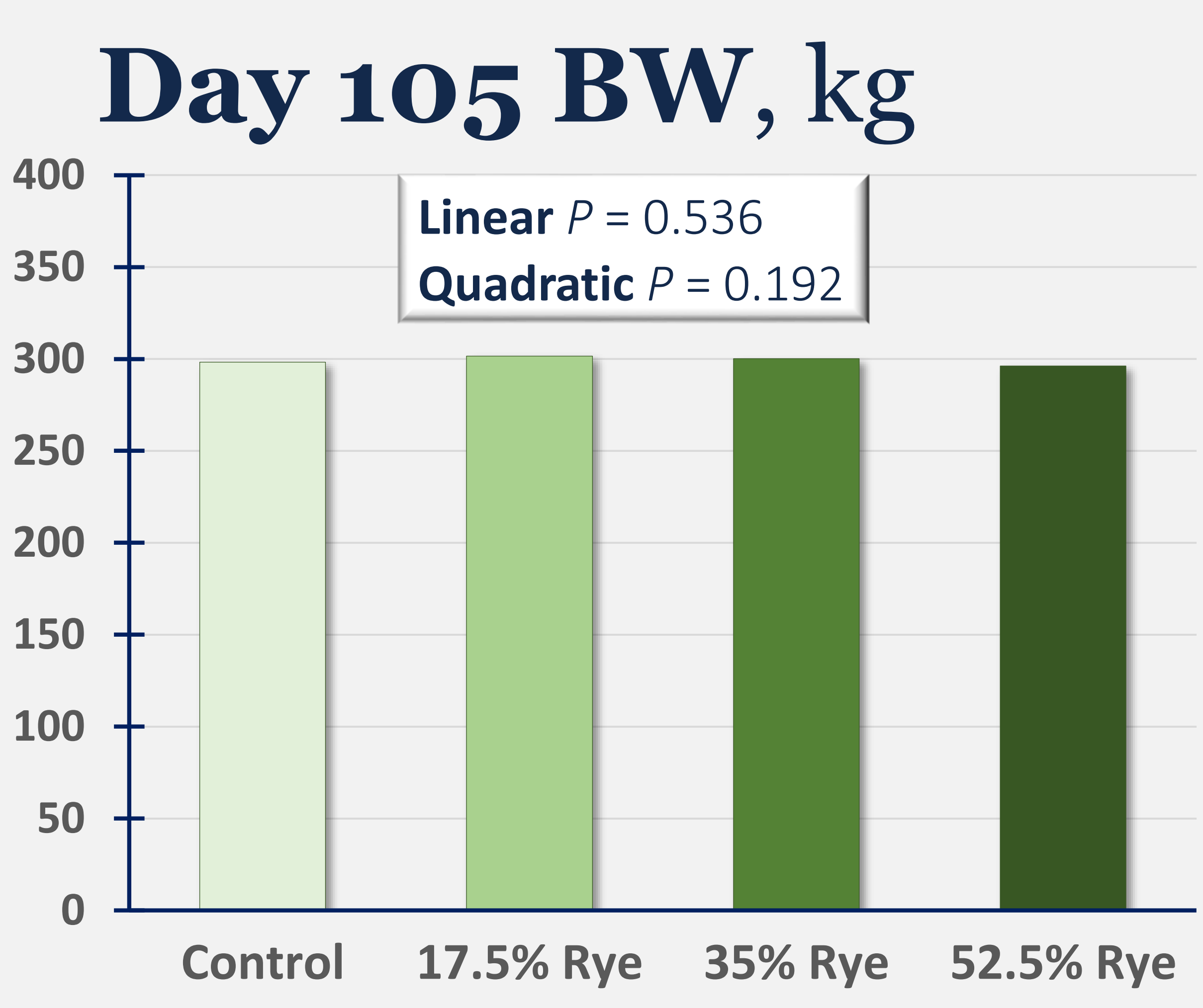
ILLINOIS

Methods

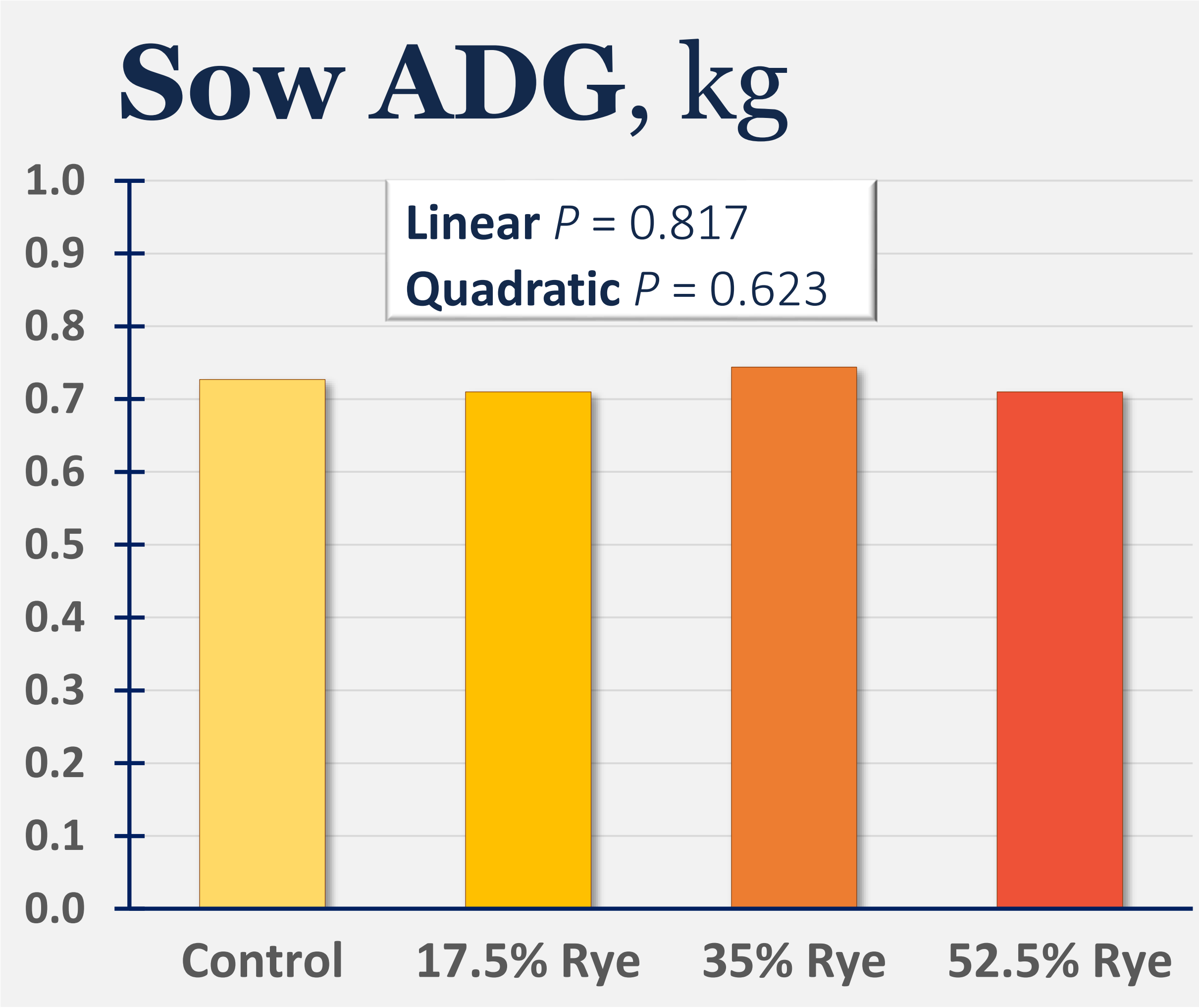

Body weights: Sows and/or piglets
Serum: IgG, IgA, IL-1β, IL-6, TNF-α
Milk: IgG, IgA, SCC, MUN, fat, protein, lactose
x 200
0
7
90
105
~115
13
21
BREED
ALLOT
BUMP FEED
MOVE TO LACTATION
FARROW
SAMPLE
WEAN
days of gestation
days of lactation

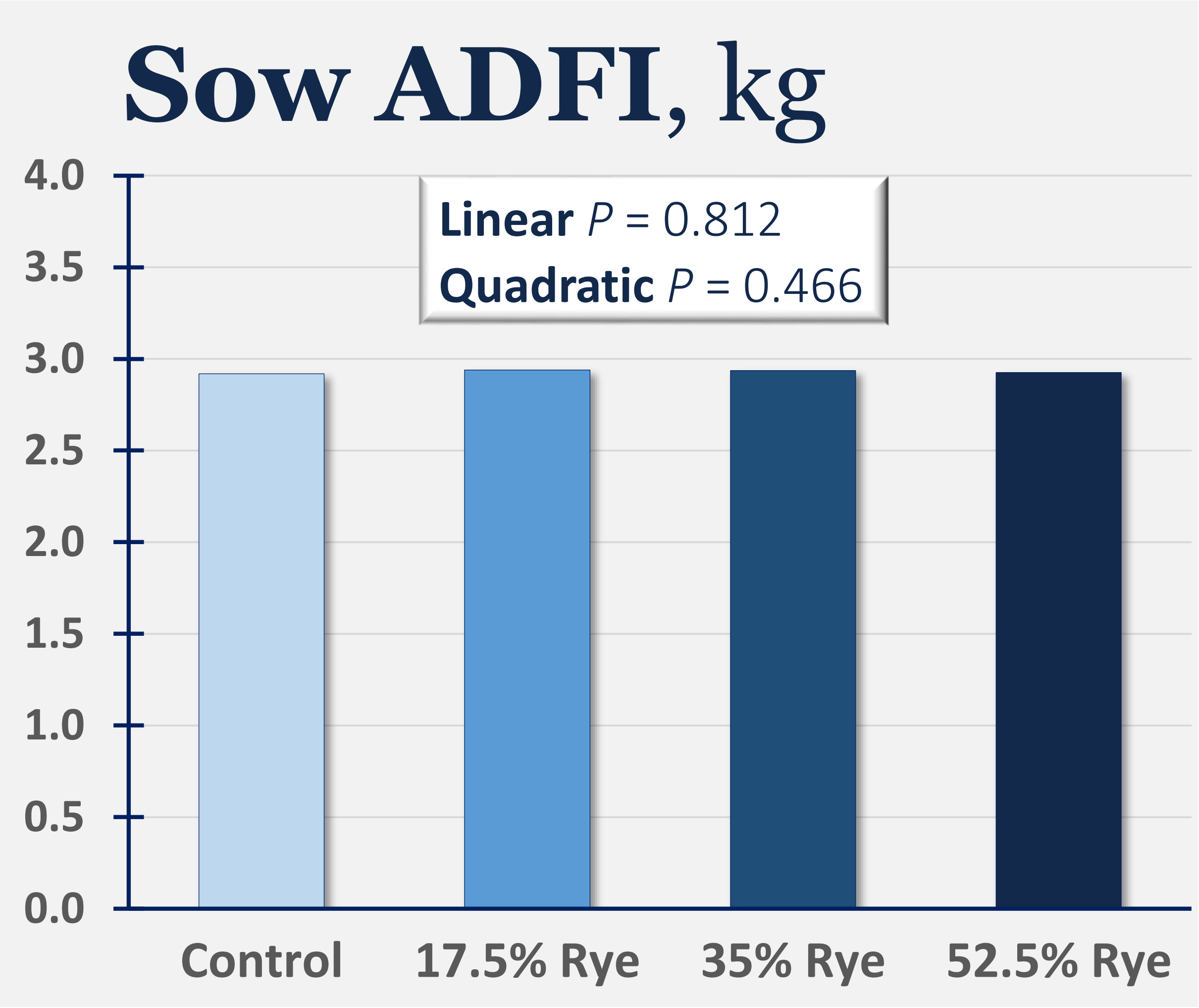
GESTATION DATA





GESTATION DATA





Results: Gestation

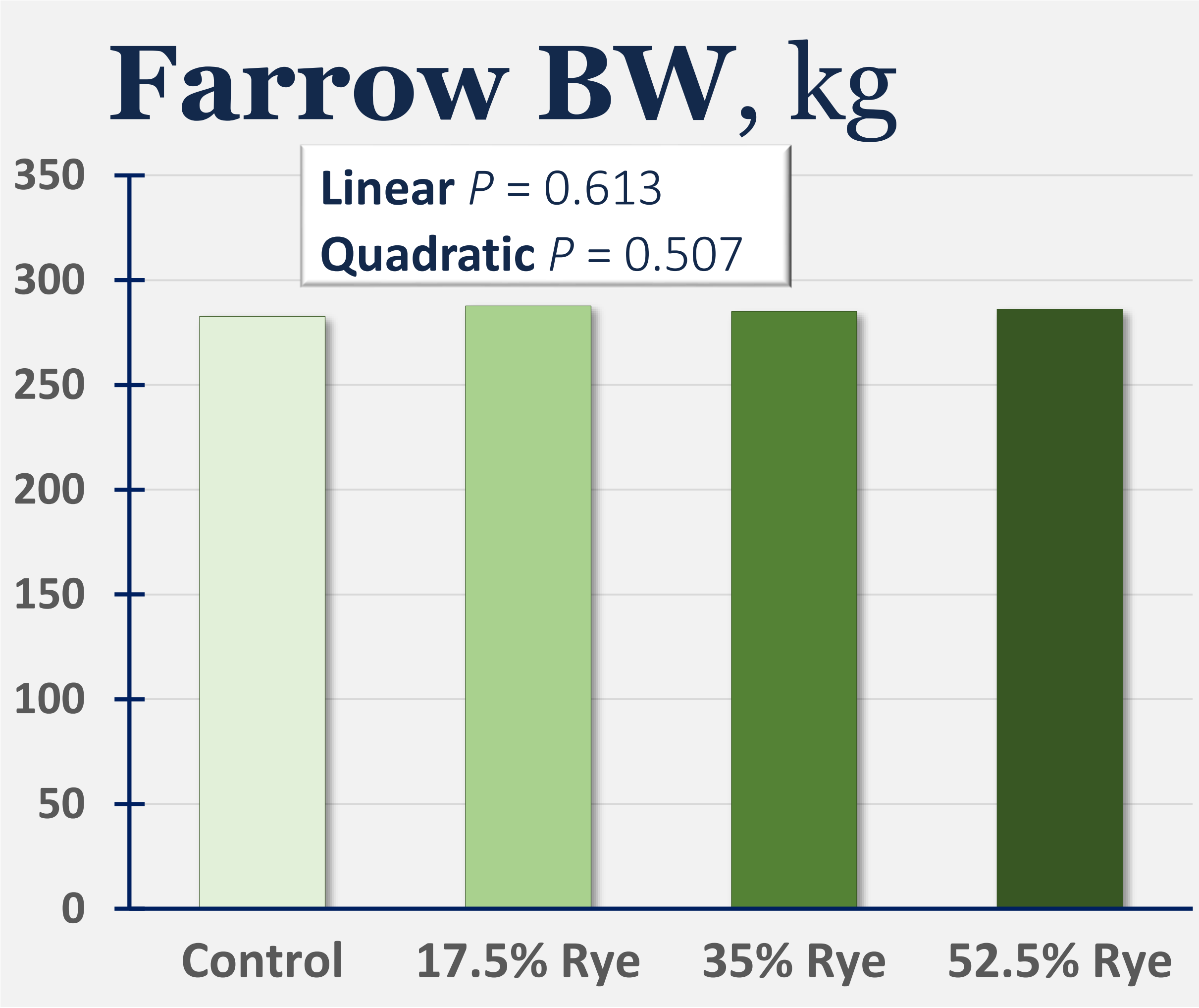
$P > 0.05$

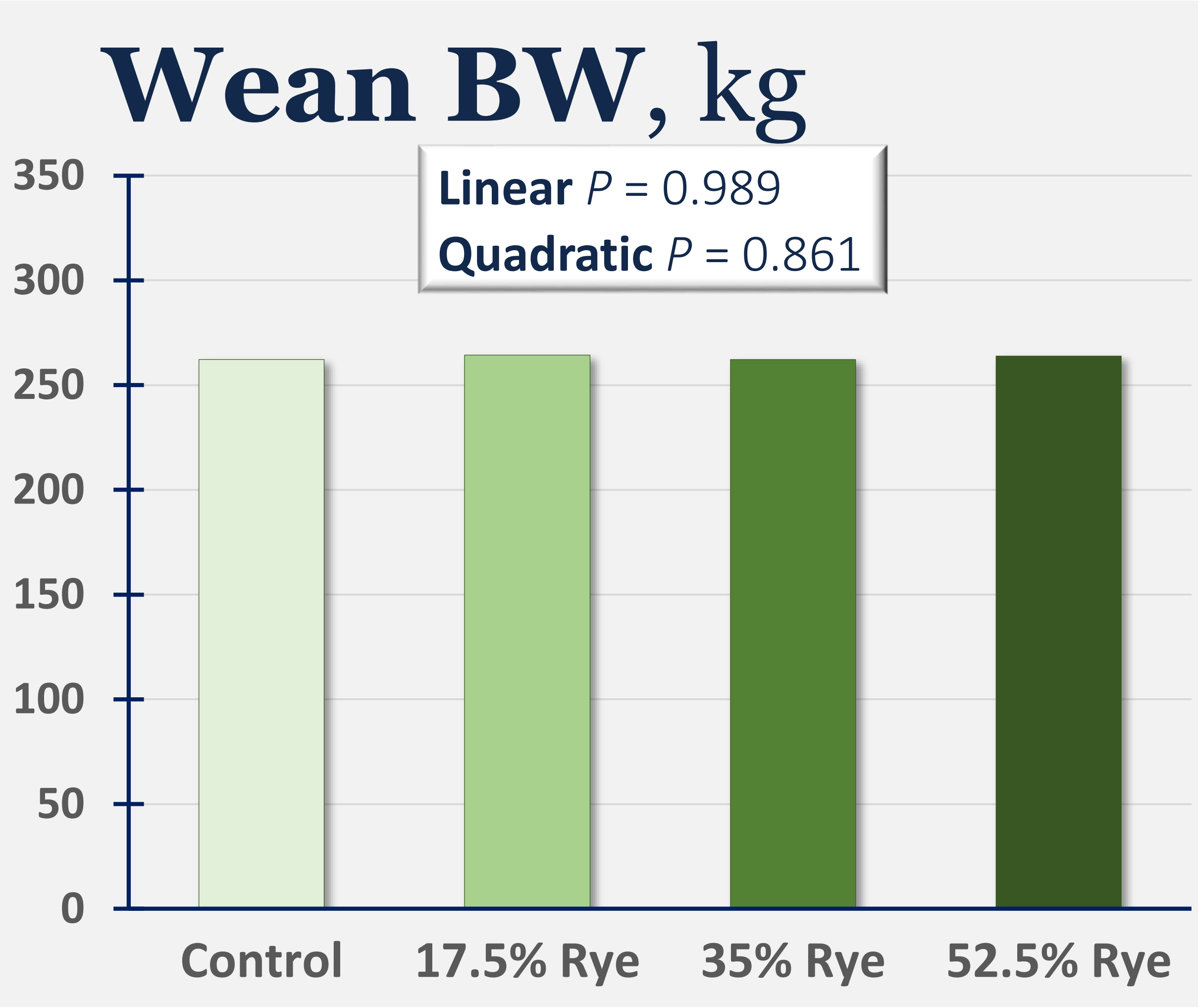
- INITIAL BODY WEIGHT, kg
- DAY 105 BODY WEIGHT, kg
- AVERAGE DAILY GAIN, kg
- AVERAGE DAILY FEED INTAKE, kg

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

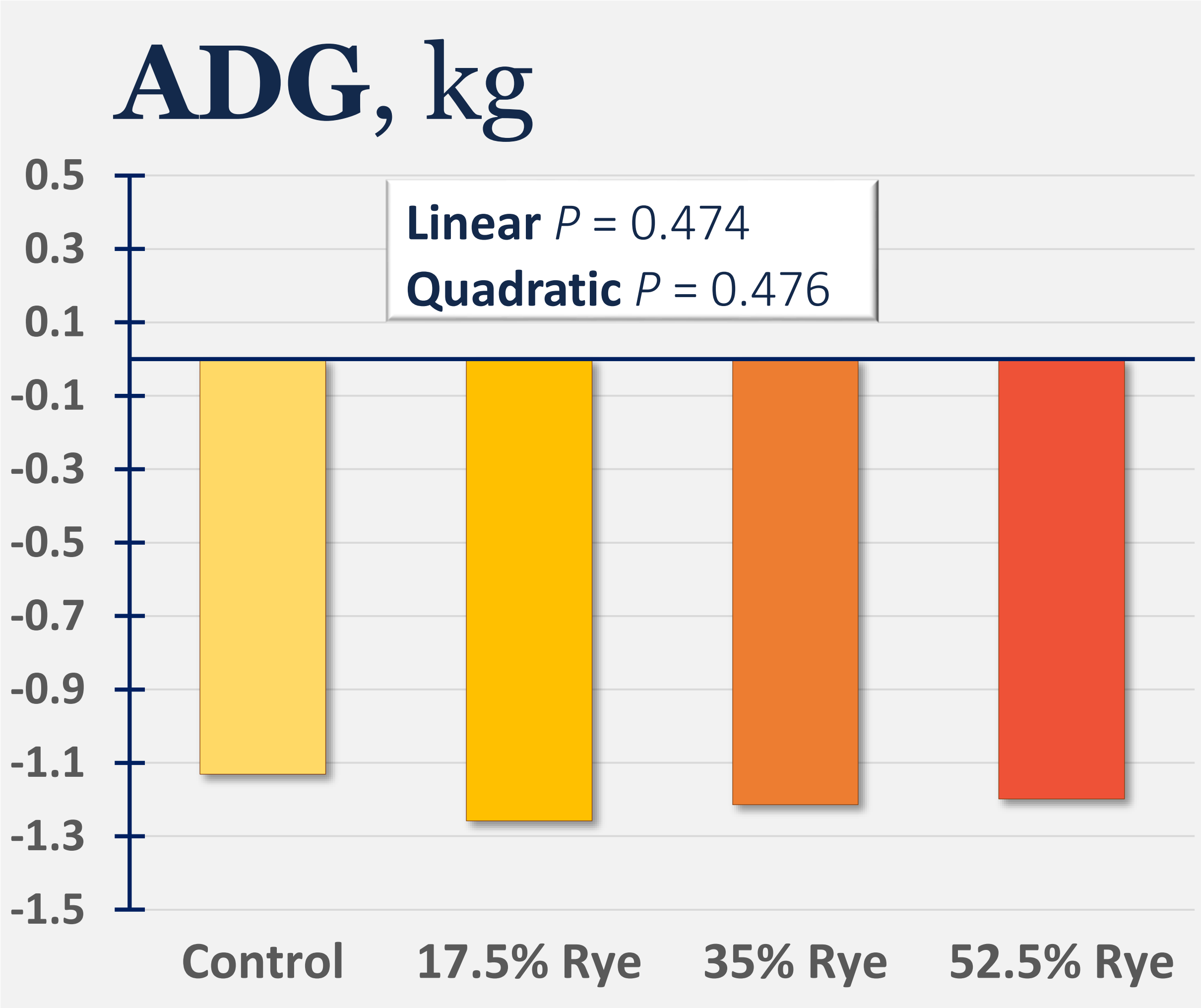
If no ergot is present, **it is predicted that 70%** hybrid rye in gestation diets would also be safe.

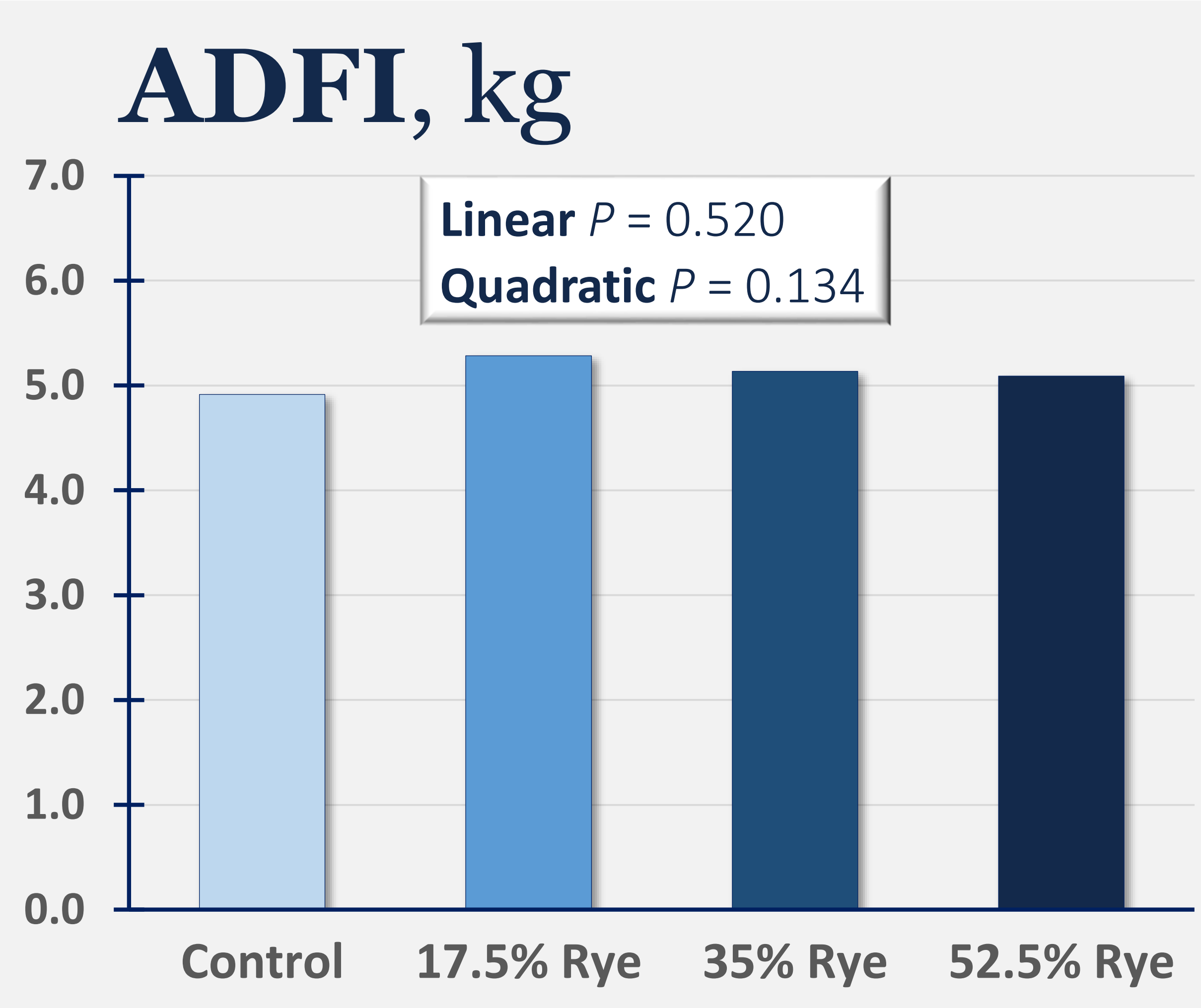
SOW LACTATION DATA



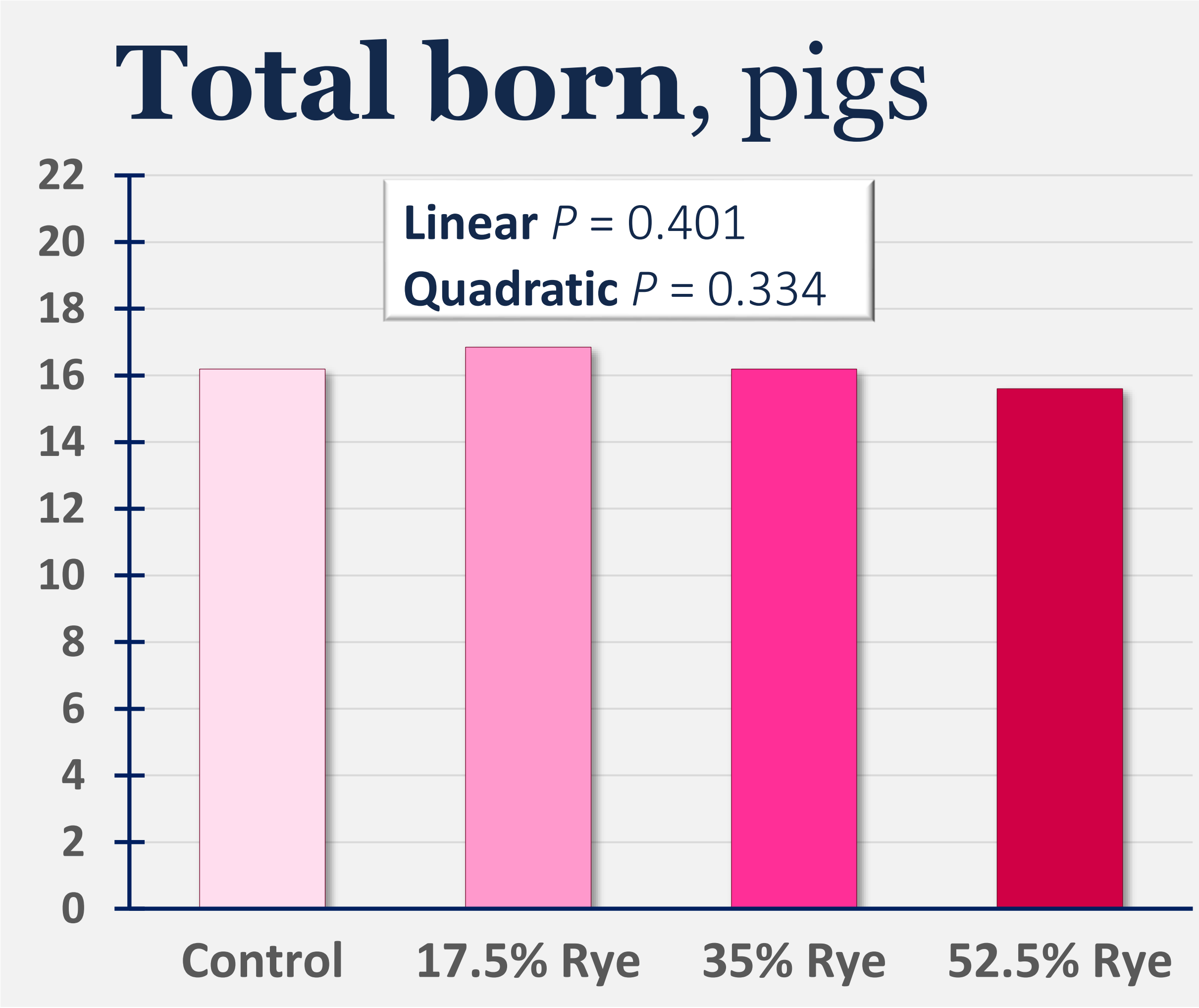


SOW LACTATION DATA

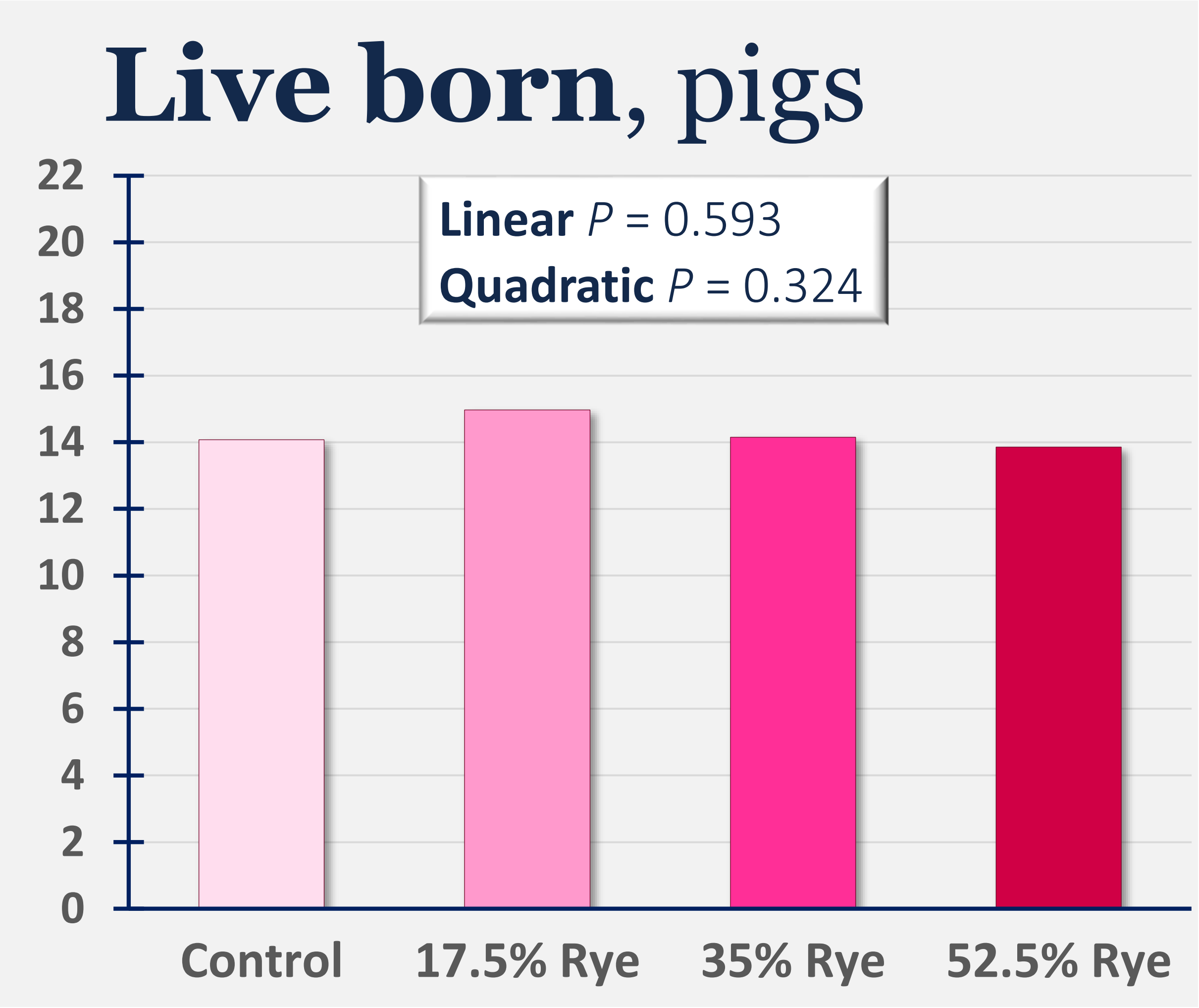




PIGLET DATA

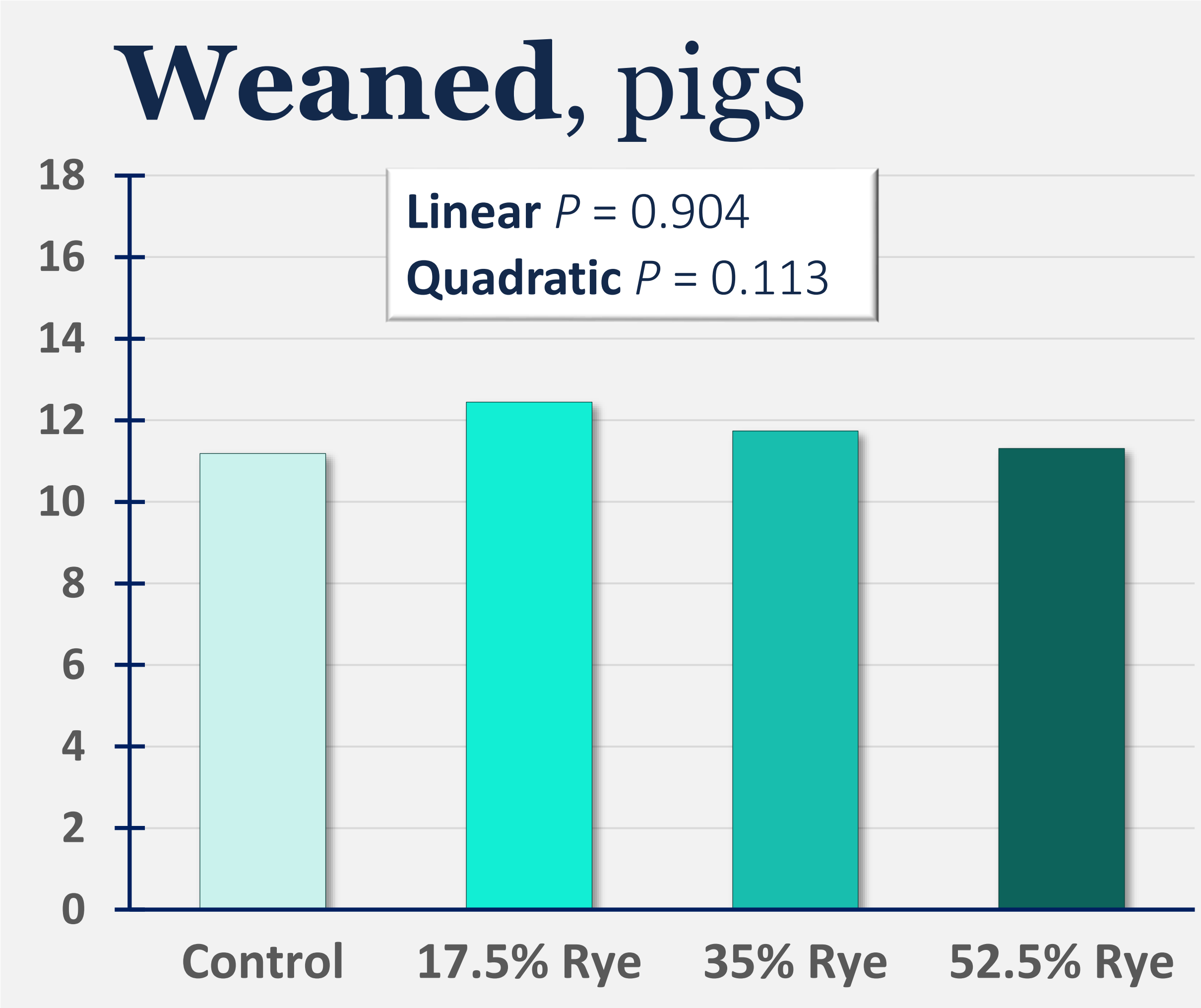


Total born, pigs
Linear *P* = 0.401
Quadratic *P* = 0.334
22
20
18
16
14
12
10
8
6
4
2
0
Control
17.5% Rye
35% Rye
52.5% Rye

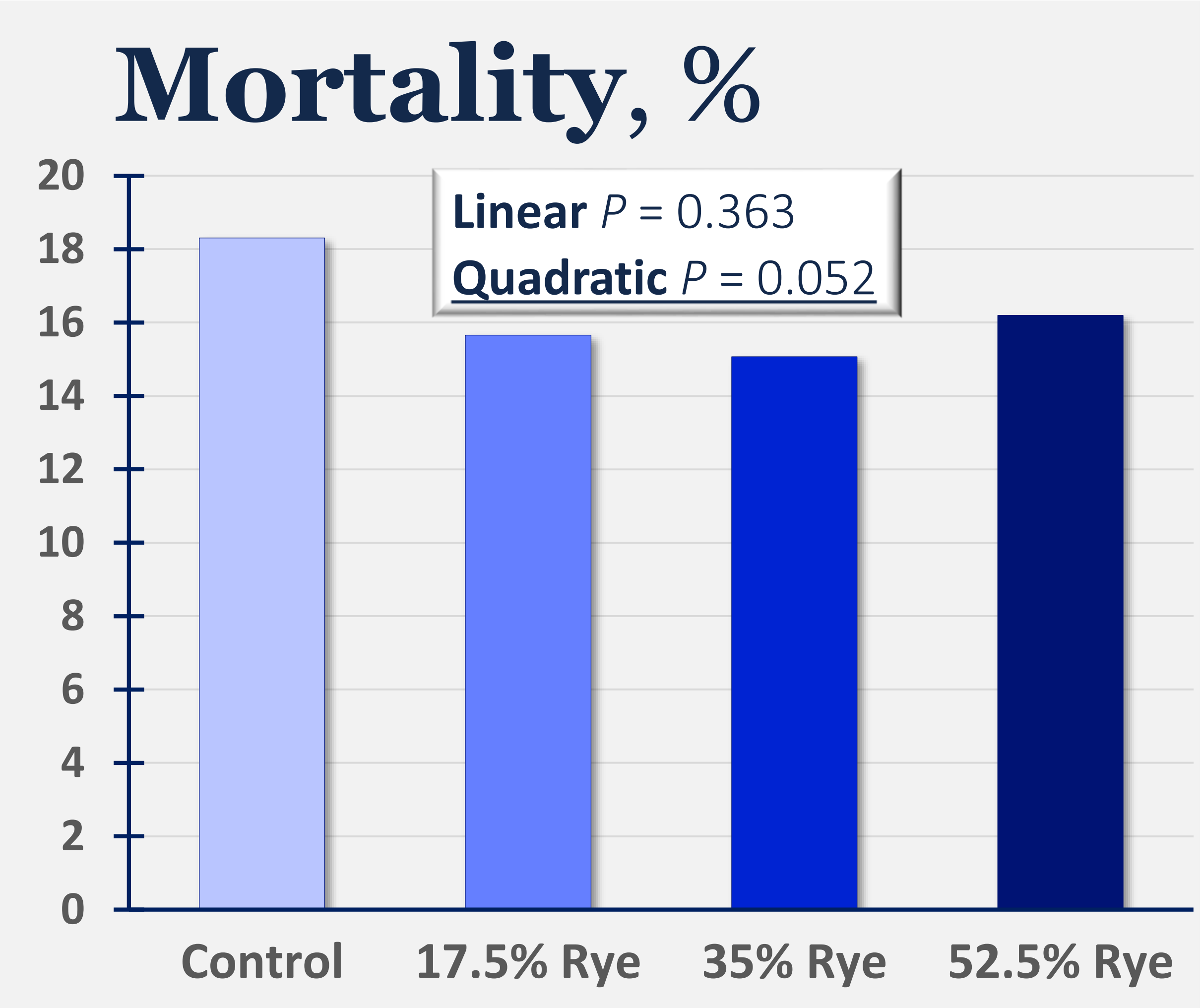


Live born, pigs
Linear *P* = 0.593
Quadratic *P* = 0.324
22
20
18
16
14
12
10
8
6
4
2
0
Control
17.5% Rye
35% Rye
52.5% Rye

PIGLET DATA

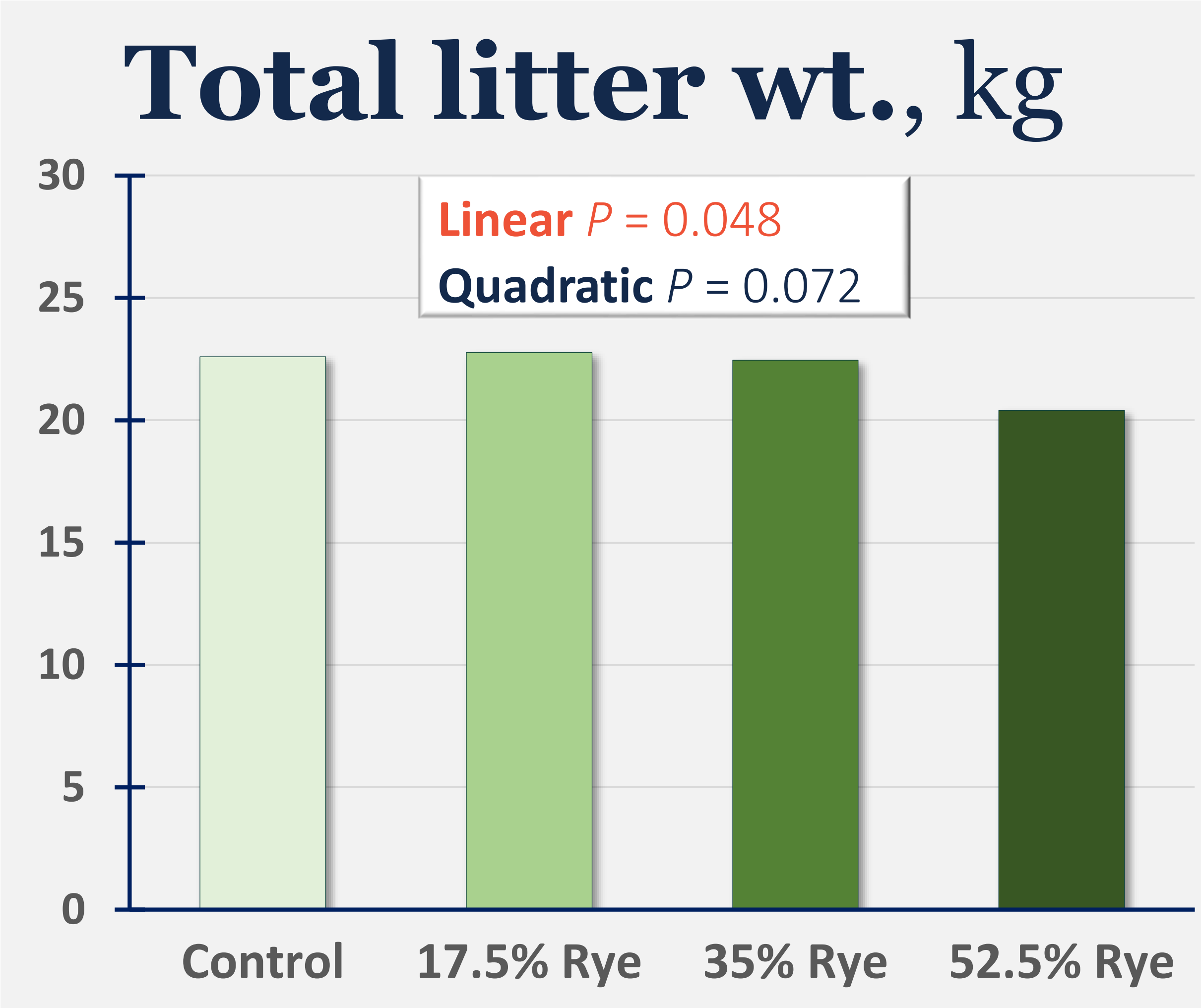


Weaned, pigs
Linear P = 0.904
Quadratic P = 0.113
18
16
14
12
10
8
6
4
2
0
Control
17.5% Rye
35% Rye
52.5% Rye

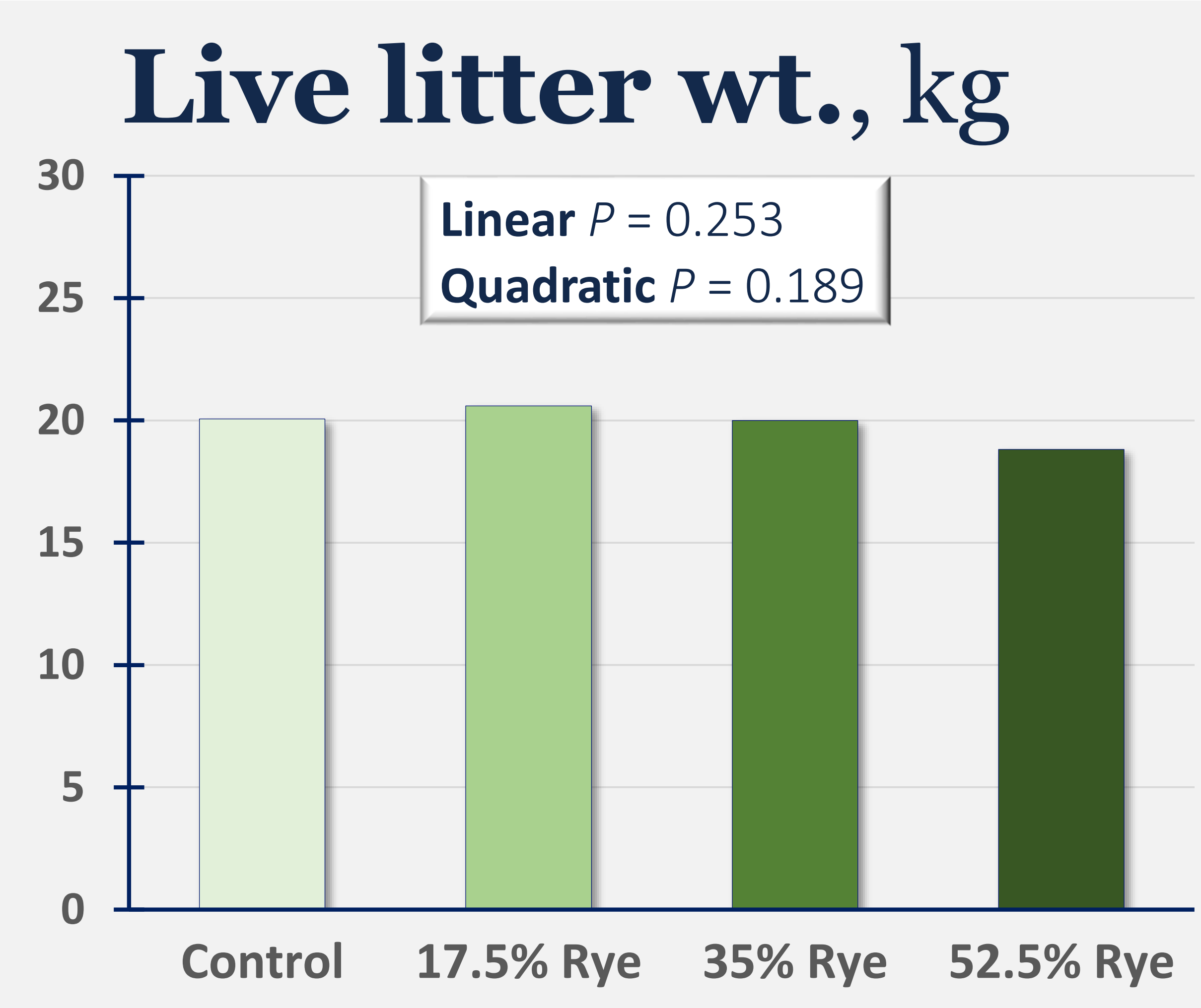


Mortality, %
Linear P = 0.363
Quadratic P = 0.052
20
18
16
14
12
10
8
6
4
2
0
Control
17.5% Rye
35% Rye
52.5% Rye

PIGLET DATA

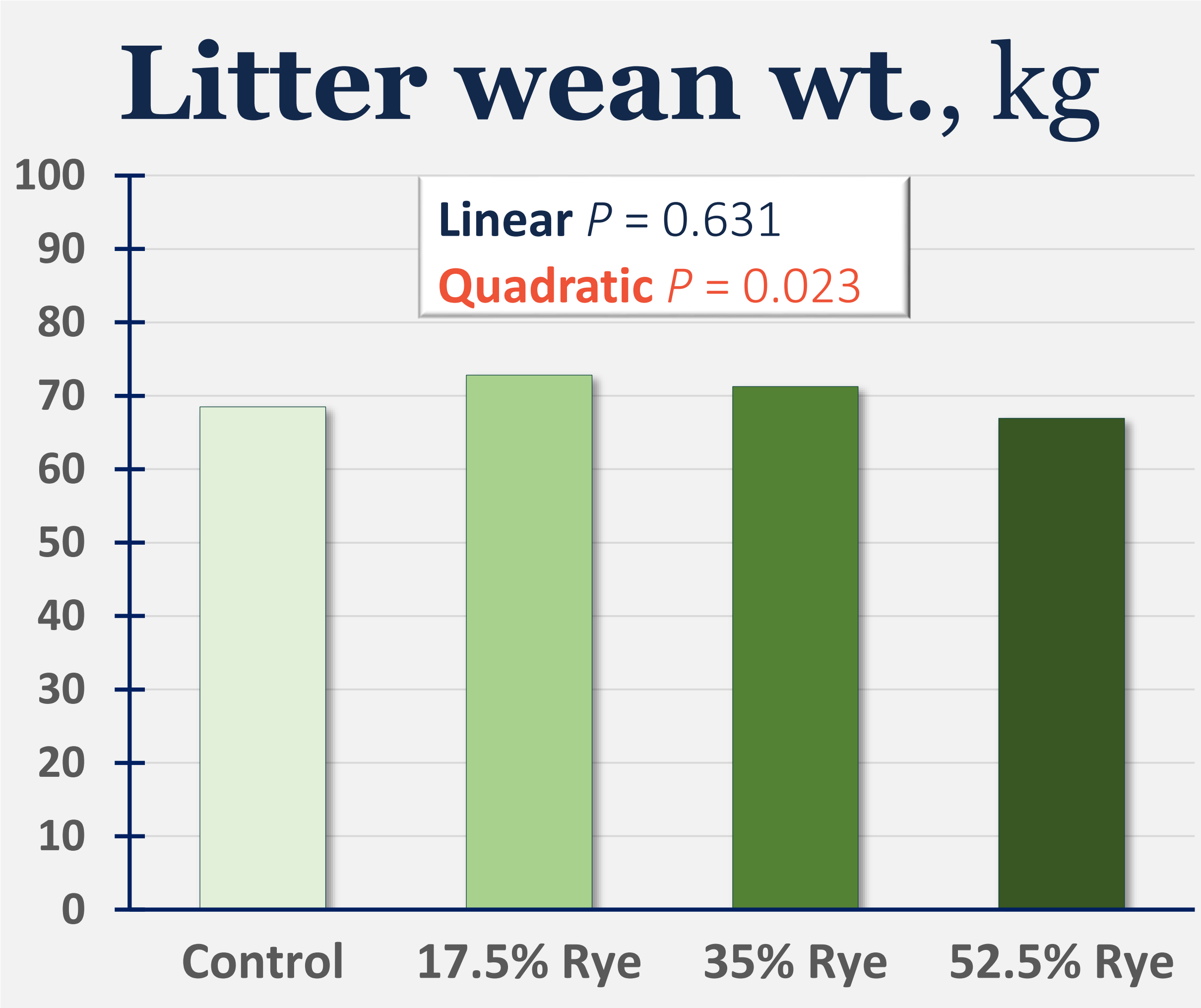


Total litter wt., kg
Linear P = 0.048
Quadratic P = 0.072
30
25
20
15
10
5
0
Control
17.5% Rye
35% Rye
52.5% Rye

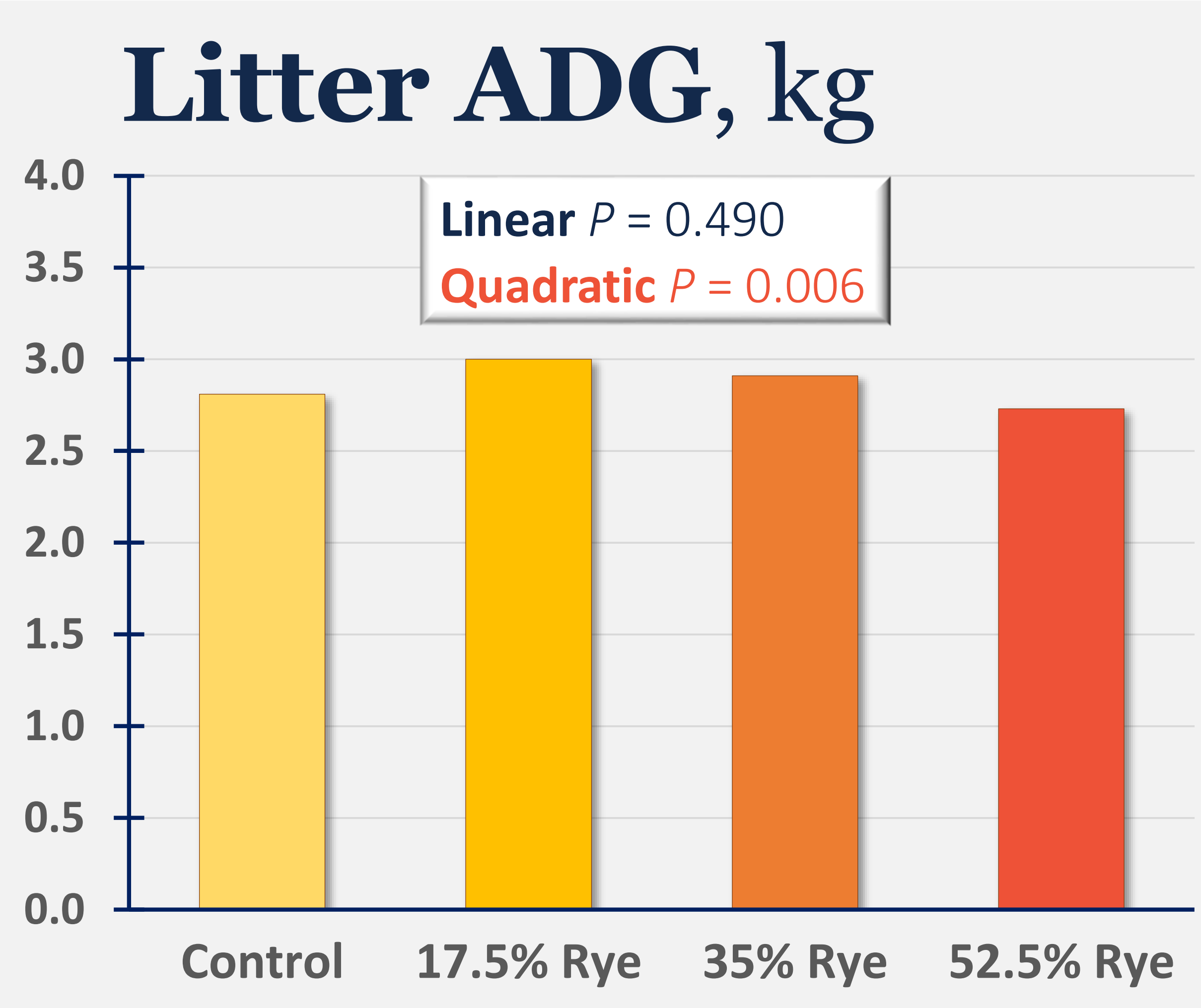


Live litter wt., kg
Linear P = 0.253
Quadratic P = 0.189
30
25
20
15
10
5
0
Control
17.5% Rye
35% Rye
52.5% Rye

PIGLET DATA

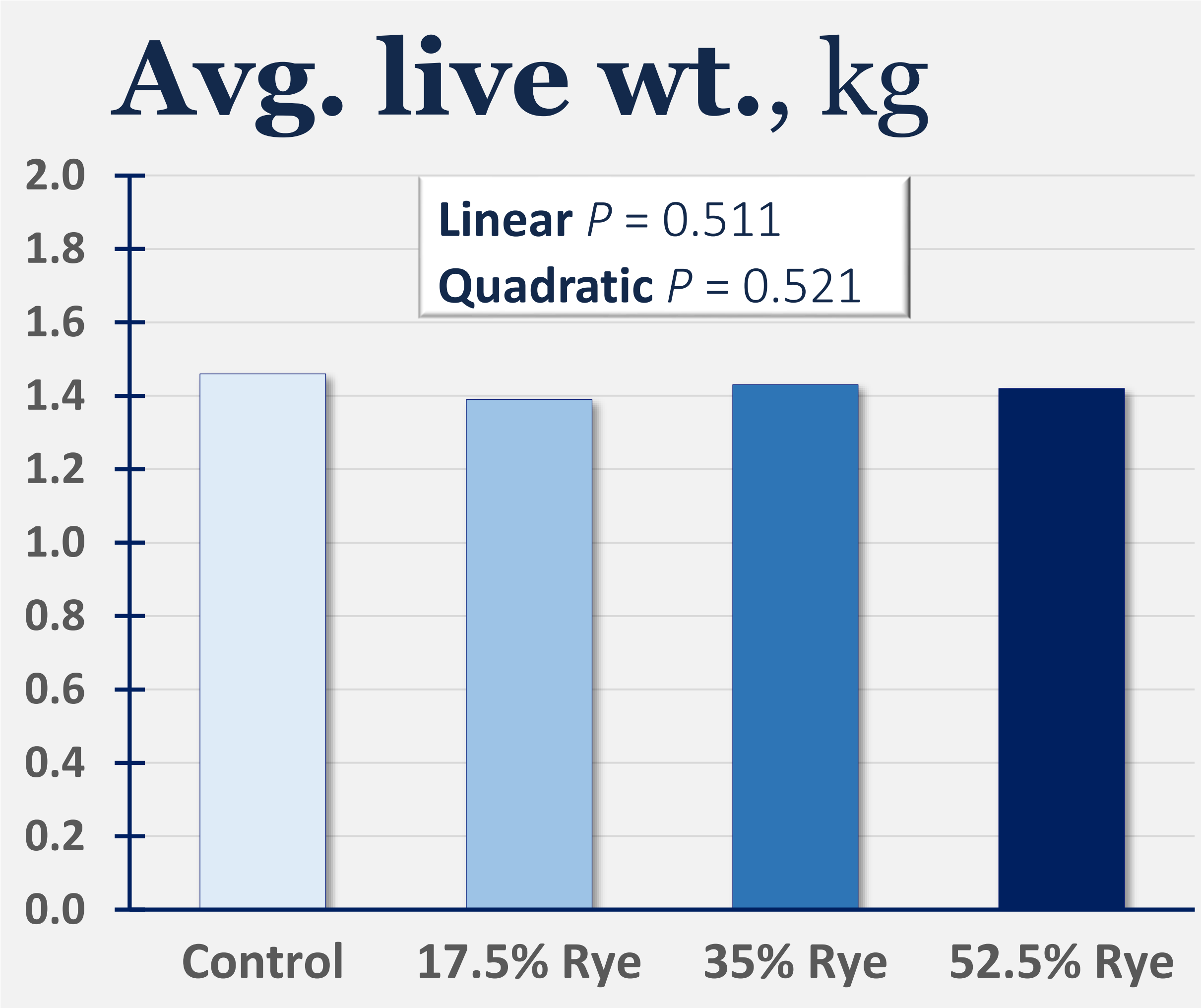


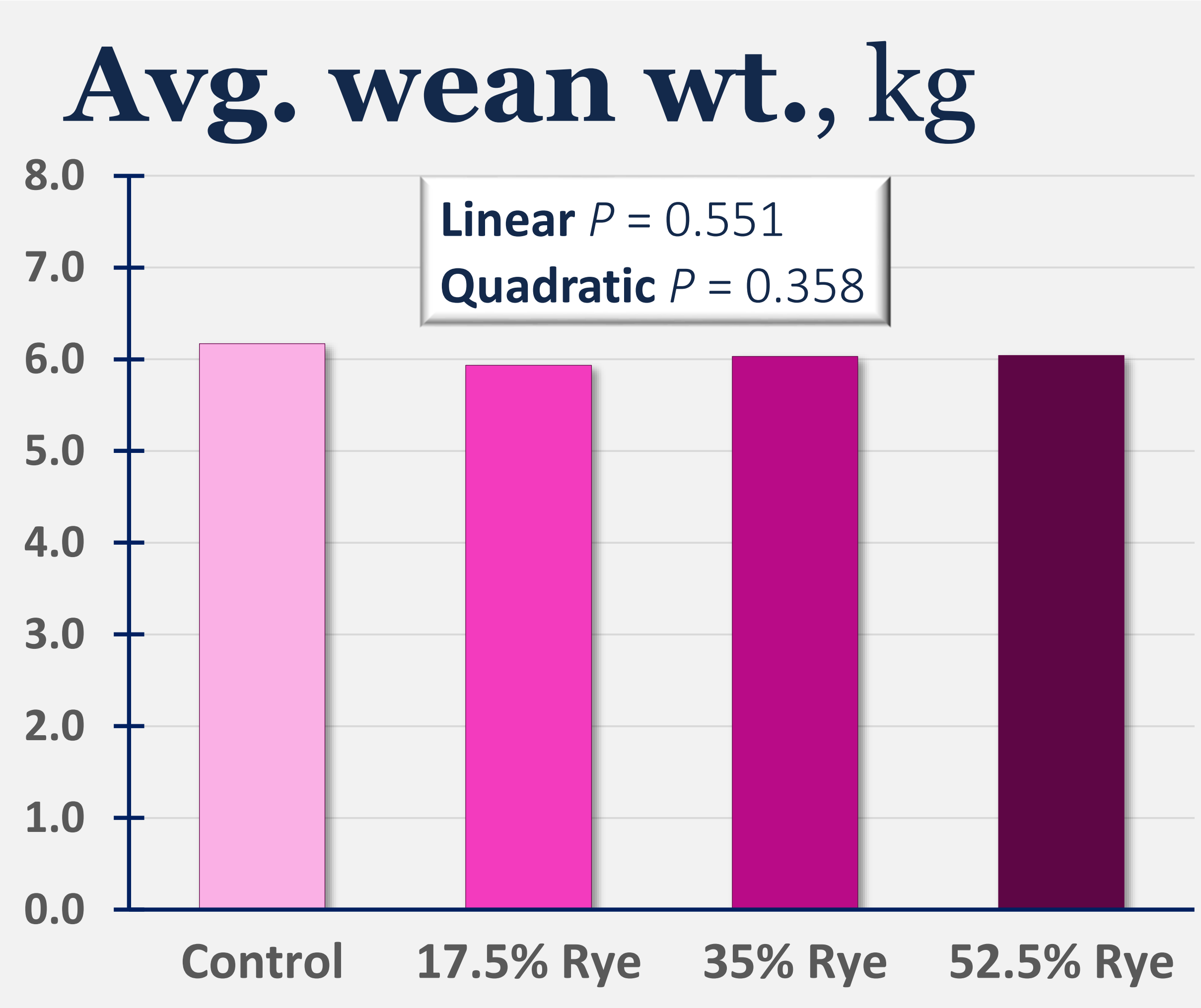
Litter wean wt., kg
Linear P = 0.631
Quadratic P = 0.023
100
90
80
70
60
50
40
30
20
10
0
Control
17.5% Rye
35% Rye
52.5% Rye



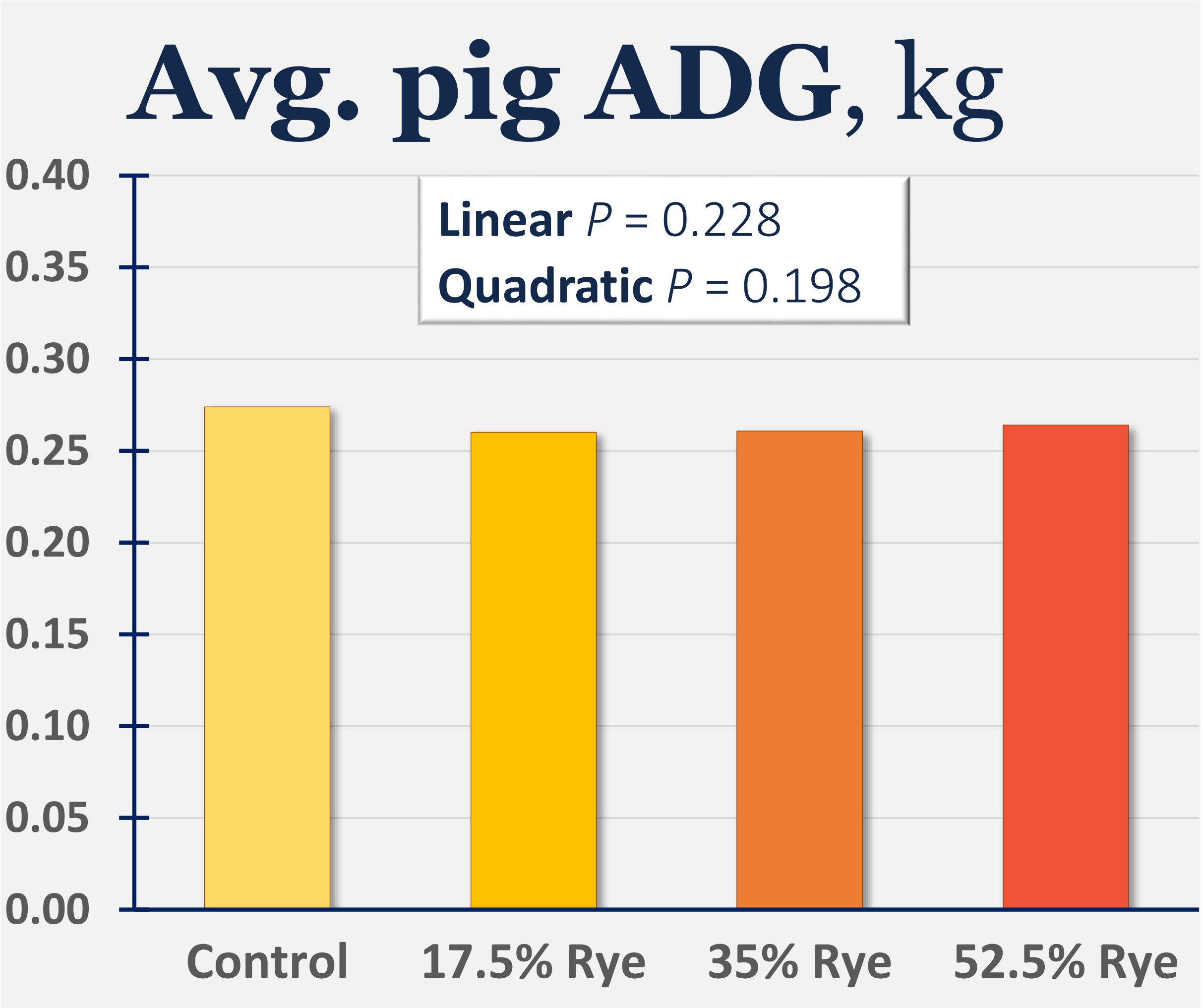
Litter ADG, kg
Linear P = 0.490
Quadratic P = 0.006
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Control
17.5% Rye
35% Rye
52.5% Rye

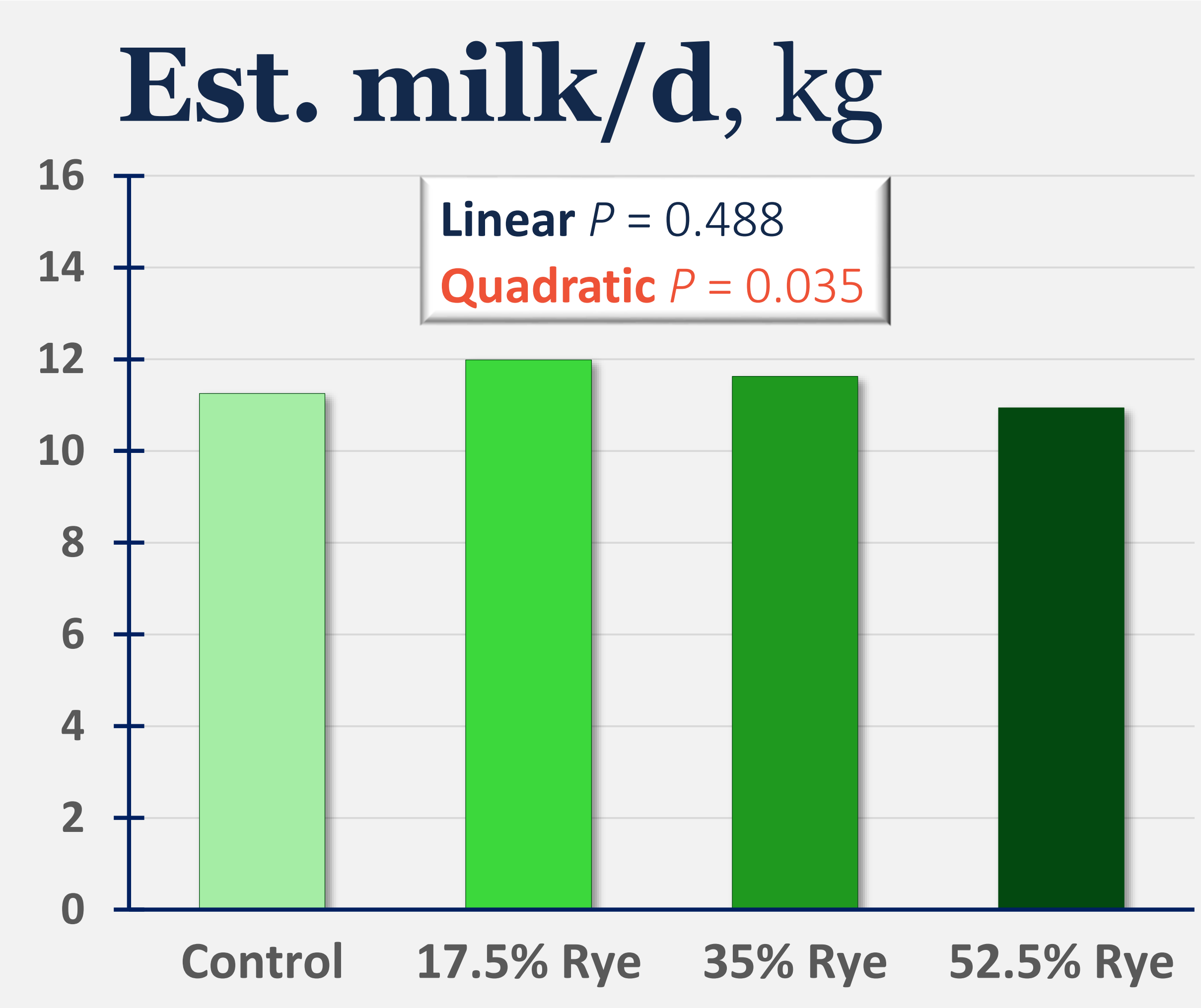
PIGLET DATA


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





ILLINOIS

Results: Lactation

Linear
- TOTAL LITTER WEIGHT, kg

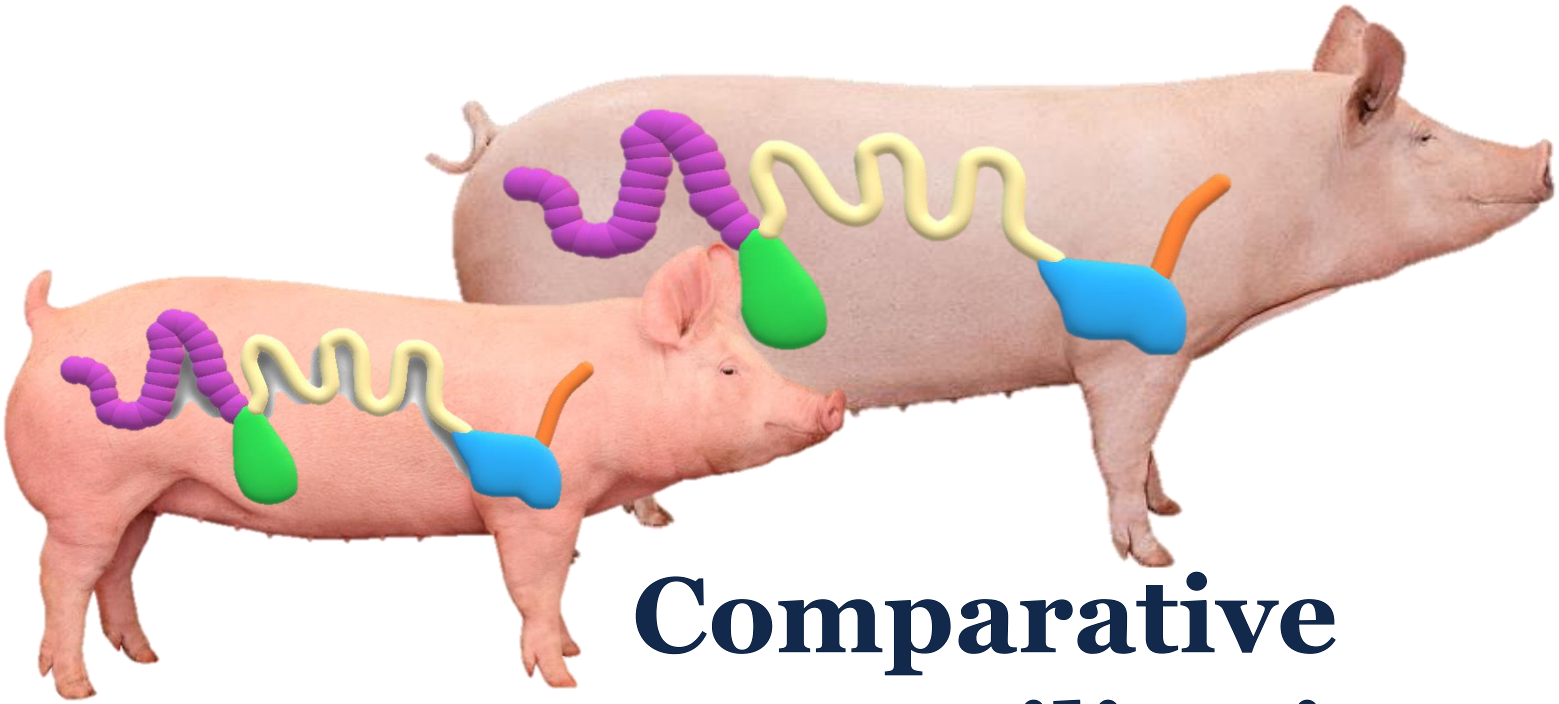
Quadratic
- LITTER WEAN WEIGHT, kg
- LITTER ADG, kg
- ESTIMATED MILK PRODUCTION, kg

Preliminary recommendation: **35% hybrid rye in lactation diets results in no reduction in performance.**

52.5% hybrid rye resulted in slight reductions in litter weight gain.

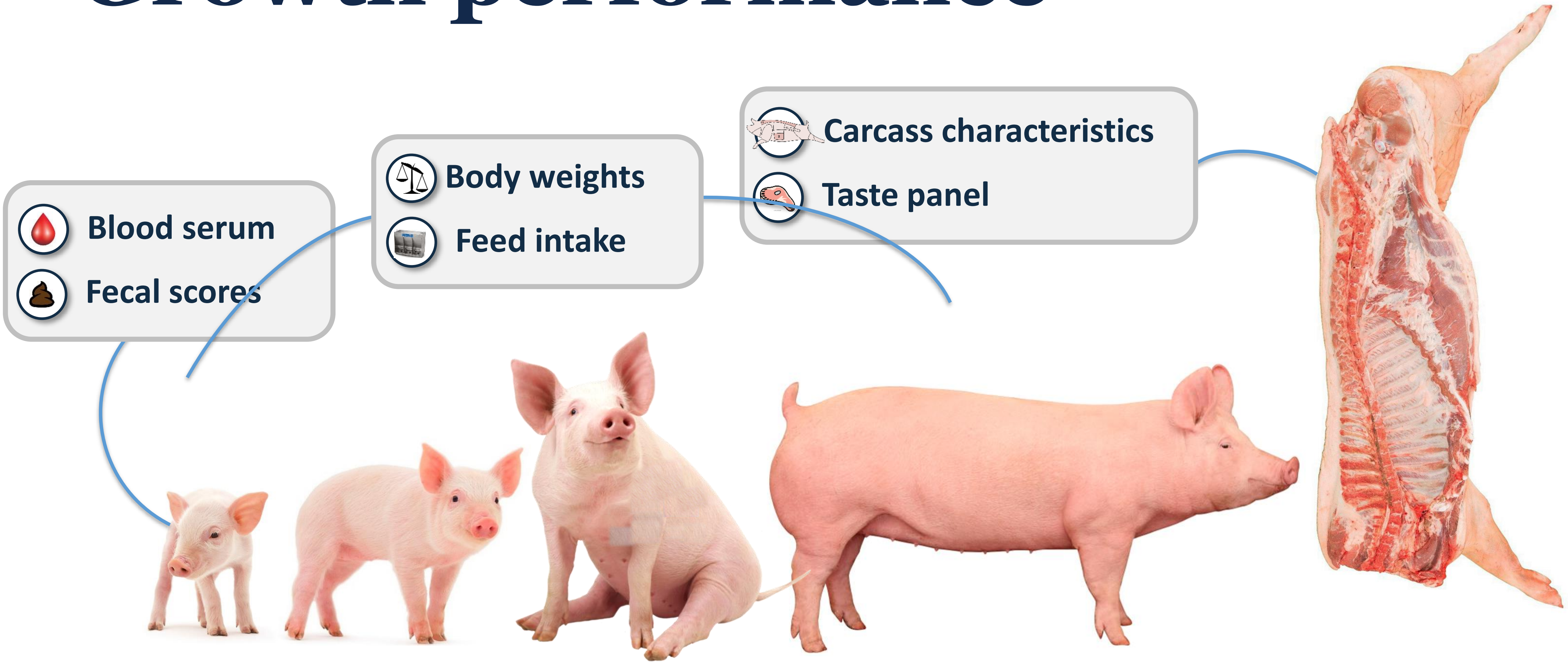
Upcoming research

Taste preference



Comparative energy utilization

Growth performance



HANS H. STEIN MONOGASTRIC NUTRITION LABORATORY

www.nutrition.ansc.illinois.edu

Molly McGhee
mmcghee2@illinois.edu