Hybrid Rye for Forage

Becca Stokes, PhD
Livestock Nutritionist
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

Yield of hybrid and population rye varieties from 5 Minnesota locations in 2016-2018
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

May 31st Silage Yields

Tons/acre (adjusted to 65% moisture)

KWS Daniello, KWS Propower, KWS Seraphino, KWS Trebiano, KWS Tayo, KWS Progas, Presto, KWS Bono, NT13416, Trical 718, NT09404, KWS Bininto, Flex-719, Cainer 154, NT07403, Trical 813, NT14433, NT15408, Pika, NT05421, NE441T, NT16402
## Hybrid Rye – Wisconsin Silage Yields

### June 10th – Silage Yields

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Tons/acre (adjusted to 65% moisture)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trical718</td>
<td>4.80</td>
</tr>
<tr>
<td>KWS Propower</td>
<td>4.70</td>
</tr>
<tr>
<td>KWS Trebianio</td>
<td>4.60</td>
</tr>
<tr>
<td>KWS Progias</td>
<td>4.50</td>
</tr>
<tr>
<td>KWS Bono</td>
<td>4.40</td>
</tr>
<tr>
<td>KWS Daniello</td>
<td>4.30</td>
</tr>
<tr>
<td>Presto</td>
<td>4.20</td>
</tr>
<tr>
<td>NT13416</td>
<td>4.10</td>
</tr>
<tr>
<td>KWS Sorafino</td>
<td>4.00</td>
</tr>
<tr>
<td>Flex719</td>
<td>3.90</td>
</tr>
<tr>
<td>NT09404</td>
<td>3.80</td>
</tr>
<tr>
<td>KWS Tayo</td>
<td>3.70</td>
</tr>
<tr>
<td>KWS Bimbito</td>
<td>3.60</td>
</tr>
<tr>
<td>Pika</td>
<td>3.50</td>
</tr>
<tr>
<td>NT14433</td>
<td>3.40</td>
</tr>
<tr>
<td>Trical613</td>
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</tr>
<tr>
<td>NT05421</td>
<td>3.20</td>
</tr>
<tr>
<td>Gainer154</td>
<td>3.10</td>
</tr>
<tr>
<td>NT07403</td>
<td>3.00</td>
</tr>
<tr>
<td>NE441T2</td>
<td>2.90</td>
</tr>
<tr>
<td>NT15406</td>
<td>2.80</td>
</tr>
<tr>
<td>NT16402</td>
<td>2.70</td>
</tr>
</tbody>
</table>
Table 1: Analysis of variance showing P values for the effect of variety on rye forage dry yield at various sampling dates.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>April 2</th>
<th>April 9</th>
<th>April 16</th>
<th>April 23</th>
<th>April 30</th>
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<tbody>
<tr>
<td>Block</td>
<td>3</td>
<td>0.1559</td>
<td>0.6399</td>
<td>0.6086</td>
<td>0.0973</td>
<td>0.5349</td>
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<tr>
<td>Variety</td>
<td>2</td>
<td>0.2296</td>
<td>0.7660</td>
<td>0.8218</td>
<td>0.0819</td>
<td>0.2673</td>
</tr>
<tr>
<td>Coefficient of Variation</td>
<td>12.3</td>
<td>37.6</td>
<td>24.3</td>
<td>14.4</td>
<td>15.7</td>
<td></td>
</tr>
</tbody>
</table>

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 – Texas and Colorado

Silage Yields

Hybrid Rye Yielded 7.4% more than triticale or wheat

Tons/acre (adjusted to 68% moisture)

- Gilcrest, CO Field #1
- Gilcrest, CO Field #2
- XIT, TX
- Hartley, TX

- KWS Hybrid Rye
- Triticale
- Wheat
## Hybrid Rye – Texas and Colorado

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

*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

Silage Yields

Hybrid Rye Yielded 26% more than VNS Rye
## Hybrid Rye – Wisconsin

<table>
<thead>
<tr>
<th>Forage type</th>
<th>Plot</th>
<th>NDFD</th>
<th>Crude protein, %</th>
<th>Milk (lbs/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KWS Progas</td>
<td>West</td>
<td>60.81</td>
<td>7.4</td>
<td>3520</td>
</tr>
<tr>
<td>VNS Rye</td>
<td>West</td>
<td>60.78</td>
<td>7.8</td>
<td>3004</td>
</tr>
<tr>
<td>KWS Progas</td>
<td>East</td>
<td>59.97</td>
<td>8.4</td>
<td>4376</td>
</tr>
<tr>
<td>VNS Rye</td>
<td>East</td>
<td>61.16</td>
<td>9.1</td>
<td>3142</td>
</tr>
</tbody>
</table>

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 protein – late May early June (15-20% protein)
  - Haylage
  - Double 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**: Cut at Milky Stage and No Later!
- **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
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
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 ileal digestibility

Used for:
AMINO ACIDS
STARCH
Procedure for measuring **total tract digestibility**

Used for:
- ENERGY
- MINERALS
- FIBER

<table>
<thead>
<tr>
<th>1 day</th>
<th>5</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADAPTATION</td>
<td>COLLECTION</td>
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</tbody>
</table>
Apparent and standardized ileal digestibility of AA and starch in hybrid rye, barley, wheat, and corn fed to growing pigs

Molly L. McGhee and Hans. H. Stein

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

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doi: 10.1093/jas/sky206
SID = 64%  
0.41% Lysine  
0.26% SID Lysine
Digestible Lysine (SID)

- Hybrid Rye: 62% b
- DH Barley: 77% a
- Wheat: 79% a
- Corn: 78% a

Undigested

Total [Lys] in grain

$P < 0.05$
**Digestible Methionine (SID)**

<table>
<thead>
<tr>
<th></th>
<th>Methionine, %</th>
<th>Undigested</th>
<th>Digested</th>
<th>Total [Met] in grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid Rye</td>
<td>76% &lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DH Barley</td>
<td>86% &lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>89% &lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>91% &lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P < 0.05*
Digestible Threonine (SID)

<table>
<thead>
<tr>
<th>Grain</th>
<th>Undigested</th>
<th>Digested</th>
<th>Total [Thr] in grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid Rye</td>
<td>0.25</td>
<td>0.39</td>
<td>0.64 b</td>
</tr>
<tr>
<td>DH Barley</td>
<td>0.25</td>
<td>0.56</td>
<td>0.81 a</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.25</td>
<td>0.55</td>
<td>0.80 a</td>
</tr>
<tr>
<td>Corn</td>
<td>0.25</td>
<td>0.57</td>
<td>0.82 a</td>
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Digestible Tryptophan (SID)

<table>
<thead>
<tr>
<th>Grain</th>
<th>Undigested</th>
<th>Digested</th>
<th>Total [Trp] in grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid Rye</td>
<td>0.08</td>
<td>0.04</td>
<td>0.12</td>
</tr>
<tr>
<td>DH Barley</td>
<td>0.06</td>
<td>0.08</td>
<td>0.14</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.08</td>
<td>0.10</td>
<td>0.18</td>
</tr>
<tr>
<td>Corn</td>
<td>0.08</td>
<td>0.08</td>
<td>0.16</td>
</tr>
</tbody>
</table>

P < 0.05

\[ \text{Digestible Tryptophan} (\text{SID}) = \text{Digested} / \text{Total [Trp]} \]

- Hybrid Rye: 72% b
- DH Barley: 88% a
- Wheat: 90% a
- Corn: 89% a
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

Molly L. McGhee and Hans H. Stein
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 65.0%, 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

EXP. 2

Phosphorus Digestibility
STTD = 49%

0.29% Phosphorus
0.14% STTD P

WHAT IF WE ADD PHYTASE?
STTD = 49%  63%

WHAT IF WE ADD PHYTASE?
Digestible Phosphorus (STTD)

<table>
<thead>
<tr>
<th>Grain</th>
<th>Undigested</th>
<th>Digested</th>
<th>Total [P] in grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rye</td>
<td>49%</td>
<td></td>
<td>37%</td>
</tr>
<tr>
<td>Barley</td>
<td>45%</td>
<td></td>
<td>63%</td>
</tr>
<tr>
<td>Wheat</td>
<td>37%</td>
<td></td>
<td>17%</td>
</tr>
<tr>
<td>Corn</td>
<td>25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sorghum</td>
<td>17%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Digestible Phosphorus (STTD)

<table>
<thead>
<tr>
<th></th>
<th>Undigested</th>
<th>Digested</th>
<th>Total [P] in grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rye -</td>
<td>49%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rye +</td>
<td>63%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barley -</td>
<td>45%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barley +</td>
<td>68%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat -</td>
<td></td>
<td>37%</td>
<td></td>
</tr>
<tr>
<td>Wheat +</td>
<td></td>
<td>58%</td>
<td></td>
</tr>
<tr>
<td>Corn -</td>
<td>25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn +</td>
<td>63%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sorghum -</td>
<td>17%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sorghum +</td>
<td></td>
<td>54%</td>
<td></td>
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</table>
Intrinsic phytase

<table>
<thead>
<tr>
<th></th>
<th>Phytase Units (FTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid 1</td>
<td>3,000</td>
</tr>
<tr>
<td>Hybrid 2</td>
<td>3,200</td>
</tr>
<tr>
<td>Hybrid 3</td>
<td>2,300</td>
</tr>
<tr>
<td>Barley</td>
<td>490</td>
</tr>
<tr>
<td>Wheat</td>
<td>580</td>
</tr>
<tr>
<td>Corn</td>
<td>50</td>
</tr>
<tr>
<td>Sorghum</td>
<td>80</td>
</tr>
</tbody>
</table>
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
3,800 kcal/kg
56% starch
18% dietary fiber
Starch (AID)

P < 0.05

Starch, %

<table>
<thead>
<tr>
<th>Grain</th>
<th>Undigested</th>
<th>Digested</th>
<th>Total [Starch] in grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rye 1</td>
<td>91%&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rye 2</td>
<td>96%&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barley</td>
<td>94%&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>98%&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>95%&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sorghum</td>
<td>96%&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Total dietary fiber (ATTD)

Total dietary fiber, %

<table>
<thead>
<tr>
<th>Grain</th>
<th>Undigested</th>
<th>Digested</th>
<th>Total [TDF] in grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rye</td>
<td>68%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barley</td>
<td>56%</td>
<td>10%</td>
<td>66%</td>
</tr>
<tr>
<td>Wheat</td>
<td>58%</td>
<td>22%</td>
<td>80%</td>
</tr>
<tr>
<td>Corn</td>
<td>58%</td>
<td>10%</td>
<td>68%</td>
</tr>
<tr>
<td>Sorghum</td>
<td>58%</td>
<td>10%</td>
<td>68%</td>
</tr>
</tbody>
</table>

$P < 0.05$
Metabolizable energy, kcal/kg DMB

- **Rye**: 3,499 (c)
- **Barley**: 3,342 (d)
- **Wheat**: 3,641 (ab)
- **Corn**: 3,732 (a)
- **Sorghum**: 3,573 (bc)

*P < 0.05*
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 $\cong$ barley $\cong$ sorghum

(Less than corn and wheat)
EXP. 4

Sow performance

OCTOBER 2018 – AUGUST 2019
Hybrid rye for sows

Satiety

Growth

Stress

Immune function

Health

Nutrition

Milk production

Laxation

Illinois
Sow dietary treatments

FORMULATED FOR GESTATION + LACTATION

Control: Corn/SBM

- Corn
- SBM
- Other
- SB hulls, SB oil, vitamins, minerals
Sow dietary treatments
FORMULATED FOR GESTATION + LACTATION

- SB hulls, SB oil, vitamins, minerals
- Corn
- SBM
- Other
- Hybrid Rye

Replaces 25% of corn with hybrid rye
Sow dietary treatments
FORMULATED FOR GESTATION + LACTATION

- SB hulls, SB oil, vitamins, minerals
- Corn
- SBM
- Hybrid Rye

Replaces 50% of corn with hybrid rye
Sow dietary treatments
FORMULATED FOR GESTATION + LACTATION

Hybrid Rye
SB hulls, SB oil, vitamins, minerals

Other
SBM
Corn

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

- **BREED**
- **ALLOT**
- **BUMP FEED**
- **MOVE TO LACTATION**
- **FARROW**
- **SAMPLE**
- **WEAN**

- 0 days of gestation
- 7 days of gestation
- 90 days of gestation
- 105 days of gestation
- ~115 days of gestation
- 13 days of lactation
- 21 days of lactation
**GESTATION DATA**

**Initial BW, kg**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Initial BW, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>200</td>
</tr>
<tr>
<td>17.5% Rye</td>
<td>210</td>
</tr>
<tr>
<td>35% Rye</td>
<td>220</td>
</tr>
<tr>
<td>52.5% Rye</td>
<td>230</td>
</tr>
</tbody>
</table>

*Linear* $P = 0.532$

*Quadratic* $P = 0.166$

**Day 105 BW, kg**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Day 105 BW, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>300</td>
</tr>
<tr>
<td>17.5% Rye</td>
<td>310</td>
</tr>
<tr>
<td>35% Rye</td>
<td>320</td>
</tr>
<tr>
<td>52.5% Rye</td>
<td>330</td>
</tr>
</tbody>
</table>

*Linear* $P = 0.536$

*Quadratic* $P = 0.192$
GESTATION DATA

**Sow ADG, kg**

- **Linear** $P = 0.817$
- **Quadratic** $P = 0.623$

**Sow ADFI, kg**

- **Linear** $P = 0.812$
- **Quadratic** $P = 0.466$
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

**Farrow BW, kg**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>17.5% Rye</th>
<th>35% Rye</th>
<th>52.5% Rye</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quadratic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Linear $P = 0.613$

Quadratic $P = 0.507$

**Wean BW, kg**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>17.5% Rye</th>
<th>35% Rye</th>
<th>52.5% Rye</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quadratic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Linear $P = 0.989$

Quadratic $P = 0.861$
**SOW LACTATION DATA**

### ADG, kg

- **Linear** $P = 0.474$
- **Quadratic** $P = 0.476$

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>17.5% Rye</th>
<th>35% Rye</th>
<th>52.5% Rye</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADG, kg</td>
<td>-1.1</td>
<td>-0.9</td>
<td>-0.7</td>
<td>-0.5</td>
</tr>
</tbody>
</table>

### ADFI, kg

- **Linear** $P = 0.520$
- **Quadratic** $P = 0.134$

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>17.5% Rye</th>
<th>35% Rye</th>
<th>52.5% Rye</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADFI, kg</td>
<td>5.0</td>
<td>5.2</td>
<td>5.4</td>
<td>5.6</td>
</tr>
</tbody>
</table>
**Total born, pigs**

- Linear: \( P = 0.401 \)
- Quadratic: \( P = 0.334 \)

**Live born, pigs**

- Linear: \( P = 0.593 \)
- Quadratic: \( P = 0.324 \)
**PIGLET DATA**

**Weaned, pigs**
- Linear $P = 0.904$
- Quadratic $P = 0.113$

**Mortality, %**
- Linear $P = 0.363$
- Quadratic $P = 0.052$

### Weaned, pigs
- Control
- 17.5% Rye
- 35% Rye
- 52.5% Rye

### Mortality, %
- Control
- 17.5% Rye
- 35% Rye
- 52.5% Rye
PIGLET DATA

**Total litter wt., kg**

- Linear $P = 0.048$
- Quadratic $P = 0.072$

**Live litter wt., kg**

- Linear $P = 0.253$
- Quadratic $P = 0.189$
**PIGLET DATA**

**Litter wean wt., kg**

![Bar chart showing litter wean weight in kg for different rye concentrations.](image)

- **Linear** $P = 0.631$
- **Quadratic** $P = 0.023$

**Litter ADG, kg**

![Bar chart showing litter average daily gain in kg for different rye concentrations.](image)

- **Linear** $P = 0.490$
- **Quadratic** $P = 0.006$
**PIGLET DATA**

**Avg. live wt., kg**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>17.5% Rye</th>
<th>35% Rye</th>
<th>52.5% Rye</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Linear</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P</strong></td>
<td>0.511</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quadratic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P</strong></td>
<td>0.521</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Avg. wean wt., kg**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>17.5% Rye</th>
<th>35% Rye</th>
<th>52.5% Rye</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Linear</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P</strong></td>
<td>0.551</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quadratic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P</strong></td>
<td>0.358</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Avg. pig ADG, kg**

- Linear: $P = 0.228$
- Quadratic: $P = 0.198$

**Est. milk/d, kg**

- Linear: $P = 0.488$
- Quadratic: $P = 0.035$
Results: Lactation

Linear
- TOTAL LITTER WEIGHT, kg
- LITTER WEAN WEIGHT, kg
- LITTER ADG, kg

Quadratic
- 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