Value of U.S. Sorghum in Swine Diets

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Overview

- Why include sorghum in swine diets?
- Use throughout different stages of production
- Current research
- Available resources
- Questions

Why Include Sorghum in Swine Diets?

Advantages

- Excellent energy source
- Can completely replace corn
- High digestible phosphorus content
- Ideal fatty acid profile

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Keys to Utilizing Sorghum

- Lower energy value compared with corn (98 to 99%)
- Proper grinding and processing
- Capitalize on:
  - Standardized ileal digestible amino acid profile
  - Phosphorus content

Nutrient Composition of Corn

	Sorghum	Corn	Sorghum:corn
Energy, kcal/kg			
Digestible[2]	3,400	3,391	**100%**
Metabolizable[2]	3,314	3,308	**100%**
NE[2]	2,616	2,651	**99%**
Crude protein, %	9.2	8.3	111%
Calcium, %	0.03	0.03	100%
Phosphorus, %	0.27	0.26	104%
Digestible P, %	0.108	0.088	**128%**
SFA, %	13.88	13.59	102%
MUFA, %	30.07	26.39	114%
PUFA, %	41.52	45.61	91%

[1]All values are derived from NRC (2012) unless otherwise indicated; [2]INRA 2014

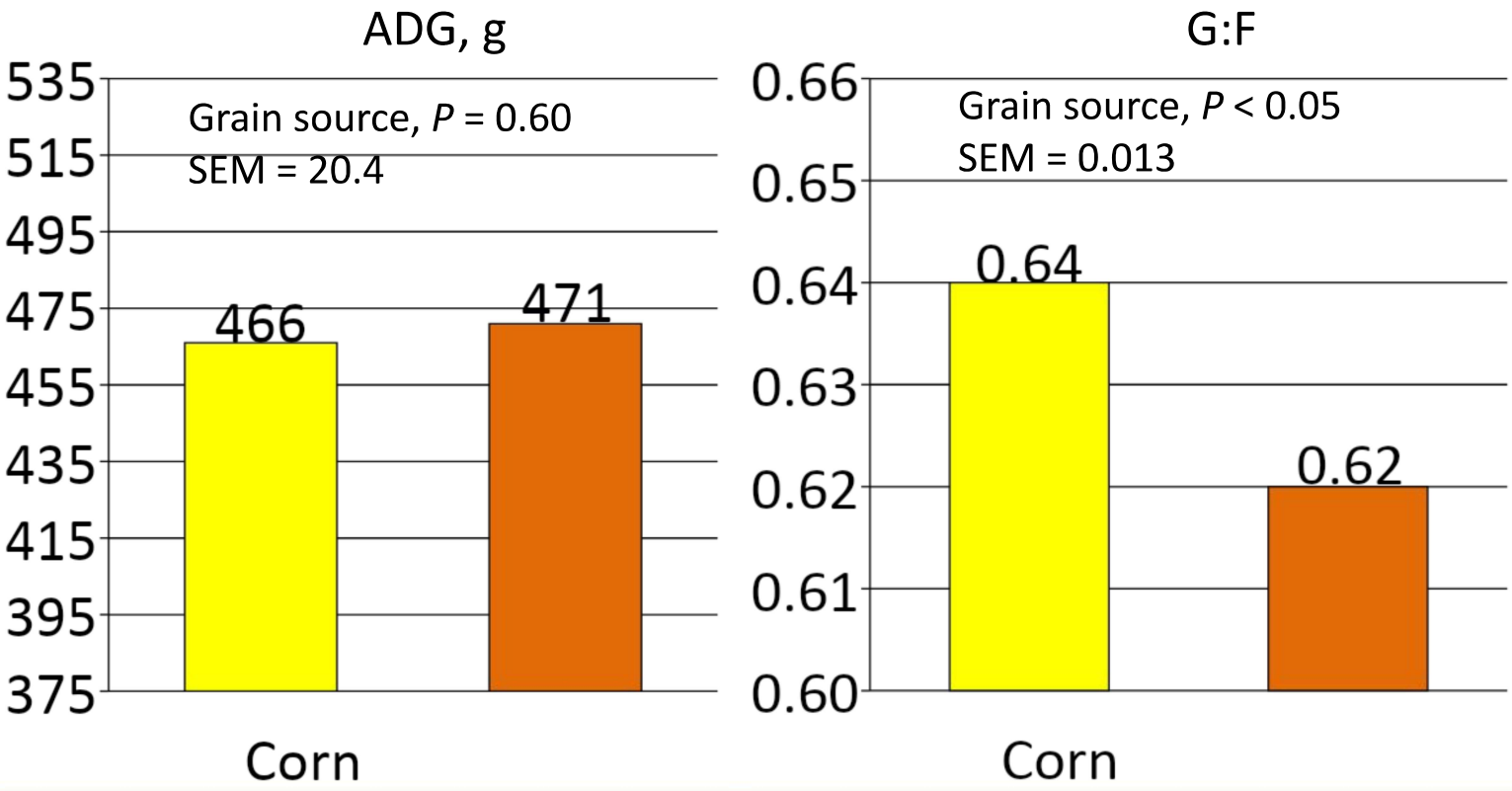
Sorghum in Different Production Phases

Sorghum in Nursery Diets

Study	ADG	ADFI	G:F	Reference
1	90	91	99	Richert et al. (1992) Exp. 1
2	113	112	101	Richert et al. (1992) Exp. 2
3	80	84	95	Healy et al. (1994) Hard
4	84	88	95	Healy et al. (1994) Soft
5	111	104	108	Hongtrakul et al. (1998)
6	103	105	99	Jones et al. (2000) Mill-run
7	105	105	100	Jones et al. (2000) Red
8	103	101	102	Jones et al. (2000) White
9	96	103	93	Fialho et al. (2004)
10	101	99	102	Sotak et al. (2011; Exp. 1)
11	102	107	96	Sotak et al. (2011; Exp. 2)
12	100	100	99	Jordan et al. (2014)
Average	99	100	99	

Sorghum in Nursery Diets

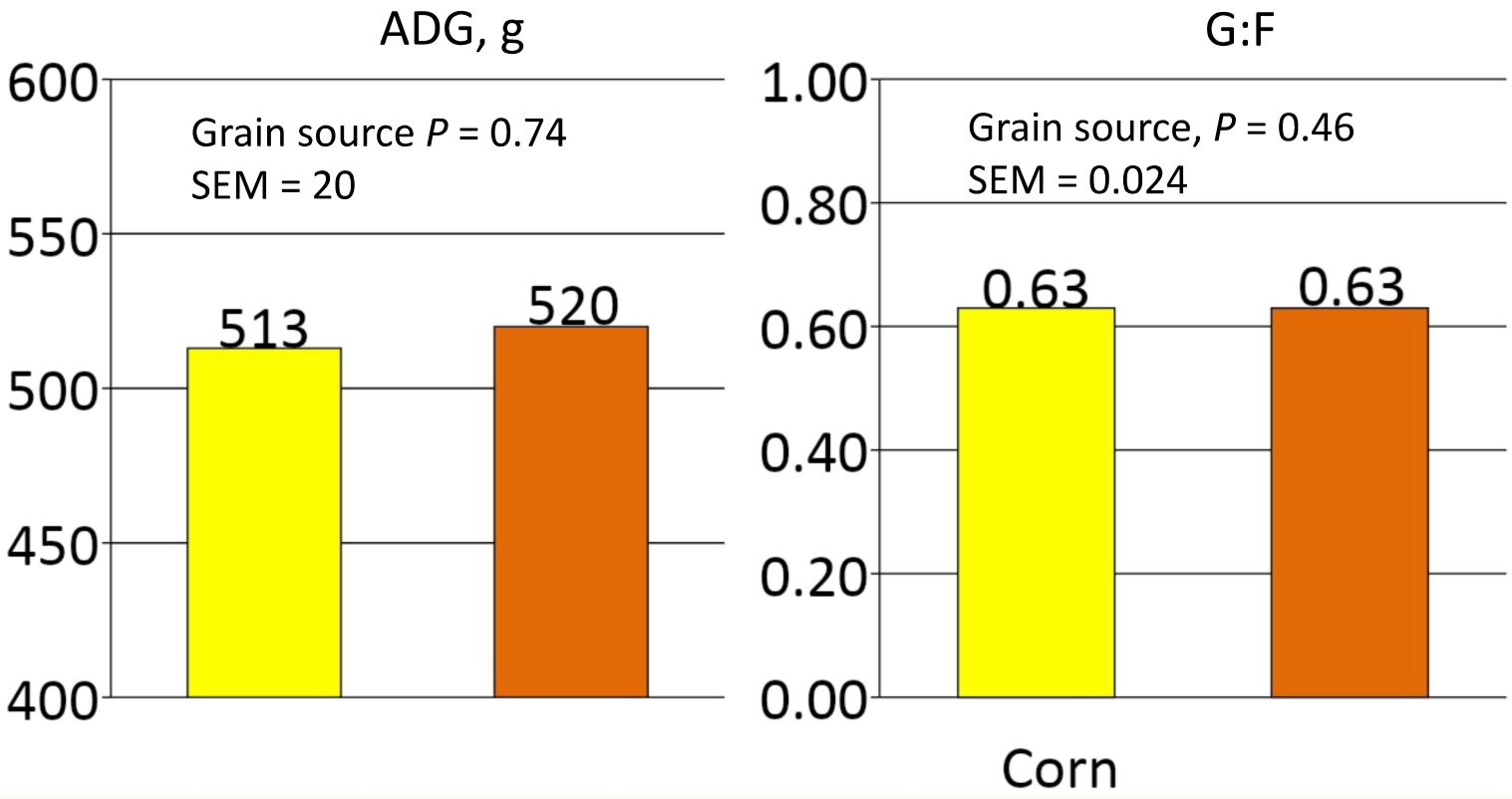
Experiment 1



Sotak et al., 2014

Sorghum in Nursery Diets

Experiment 2



Sorghum in Growing-Finishing Diets

TABLE 5. RELATIVE VALUE (%) OF SORGHUM VERSUS CORN IN FINISHING PIGS

STUDY	ADG	ADFI	F/G	REFERENCE
1	104	109	96	BRAND ET AL. (1990) VARIETY 1
2	102	108	95	BRAND ET AL. (1990) VARIETY 2
3	98	104	95	HANCOCK ET AL. (1992)
4	100	100	100	CABRERA ET AL. (1993) SOFT SORGHUM
5	104	107	97	CABRERA ET AL. (1993) HARD SORGHUM
6	106	106	100	JOHNSTON ET AL. (1998)
7	104	109	95	SHELTON ET AL. (2004) WAXY SORGHUM
8	106	114	93	SHELTON ET AL. (2004) NON-WAXY SORGHUM
9	104	100	104	ISSA (2009)
10	99	100	100	SEABOARD FARMS (2010)
11	106	105	101	BENZ ET AL. (2011)
12	103	103	100	PAULK ET AL. (2015)
13	96	101	97	JORDAN ET AL. (2014)
AVERAGE	102	105	98	
CROMWELL (1985 REVIEW)	98	102	97	10 EXP SUMMARY

Goodband et al., 2016

Sorghum in Growing-Finishing Diets

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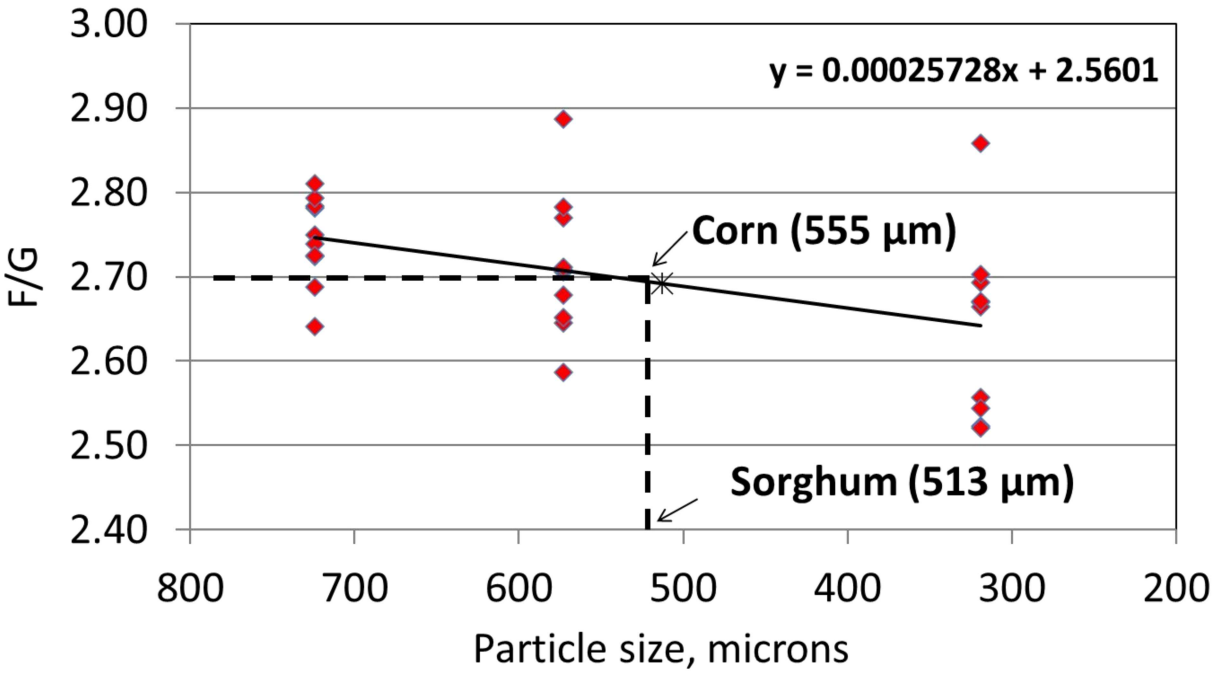

Paulk et al., 2015

Sorghum in Growing-Finishing Diets

	Sorghum			Corn		
AA	Total	SID %	SID	Total	SID %	SID
Ile	0.36	78	**0.281**	0.28	82	**0.230**
Lys	0.20	74	0.148	0.25	74	0.185
Met	0.16	79	0.126	0.18	83	0.149
Thr	0.30	75	**0.225**	0.28	77	**0.216**
Trp	0.07	74	**0.052**	0.06	80	**0.048**
Val	0.46	77	**0.354**	0.38	82	**0.312**

NRC, 2012

Sorghum in Growing-Finishing Diets

		SORGHUM	
INGREDIENT, %	CORN	OPTION 1[1]	OPTION 2[2]
SORGHUM	- - -	79.35	78.20
CORN	77.27	---	---
SOYBEAN MEAL, (46.5% CP)	20.06	17.81	18.25
CHOICE WHITE GREASE	- - -	---	0.70
MONOCALCIUM P, 21% P	0.60	0.53	0.53
LIMESTONE, GROUND	1.03	1.08	1.08
SALT	0.35	0.35	0.35
L-LYSINE-HCl	0.290	0.385	0.385
DL-METHIONINE	0.030	0.090	0.095
L-THREONINE	0.060	0.085	0.085
L-TRYPTOPHAN	0.005	0.013	0.013
VITAMIN PREMIX	0.15	0.15	0.15
TRACE MINERAL PREMIX	0.15	0.15	0.15
TOTAL	100	100	100

STANDARDIZED ILEAL DIGESTIBLE AMINO ACIDS, %			
LYSINE	0.90	0.89	0.90
ISOLEUCINE:LYSINE	62	63	63
LEUCINE:LYSINCE	143	153	152
METHIONINE:LYSINE	29	32	32
MET & CYS:LYSINE	56	56	56
THREONINE:LYSINE	61	61	61
TRYPTOPHAN:LYSINE	18	18	18
VALINE:LYSINE	70	70	70
TOTAL LYSINE, %	1.02	0.99	1.00
NET ENERGY, KCAL/LB	1,132	1,119	1,132
CRUDE PROTEIN, %	16.3	16.4	16.5
CALCIUM, %	0.55	0.55	0.55
TOTAL P, %	0.47	0.45	0.45
DIGESTIBLE P, %	0.25	0.25	0.25

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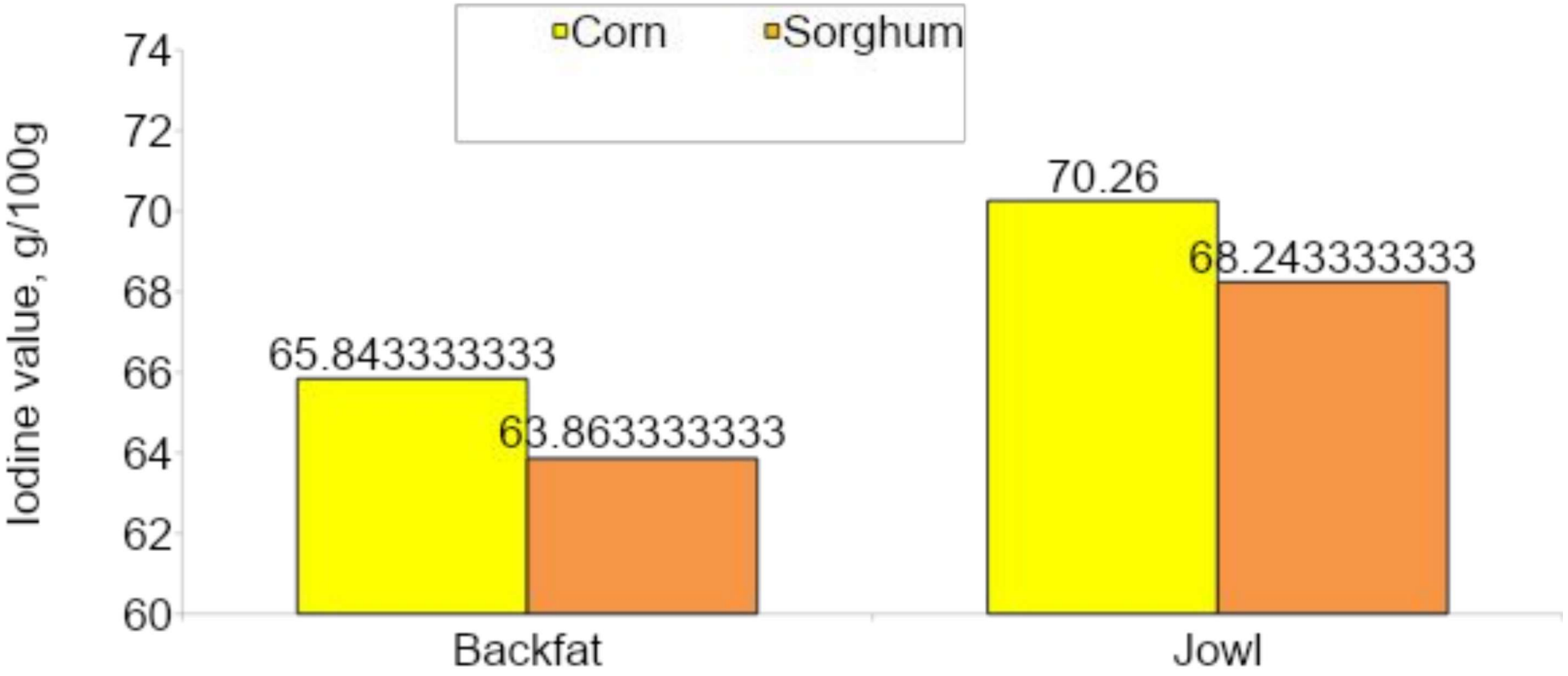


Benz et al., 2010

Sorghum in Sow Diets

Item	Louis et al., 1991	Johnston et al., 1998	Sotak et al., 2012	Average
Sow performance				
Lactation ADFI	90	102	104	99
Lactation weight change	90	62	74	75
Wean to estrous interval	94	111	NA	103
Litter performance				
Litter size born alive	108	102	99	103
Litter size at weaning	103	99	99	100
Litter BW at birth	99	101	99	100
Litter BW at weaning	93	98	98	96
Litter BW gain	92	97	94	94

Current Research

Grinding and Pelleting Sorghum

Overall objective

- Feed manufacturing characteristics of corn, non-waxy red, waxy red, and waxy white sorghum

Experiment 1: Consistent Hammermill Settings

- Objective 1: Grinding corn and sorghum
- Objective 2: Pelleting corn and sorghum-based diets

Experiment 2: Consistent Particle Size (dgw)

- Objective 3: Flowability and distribution of grain
- Objective 4: Pelleting corn and sorghum-based diets

Grinding and Pelleting Sorghum

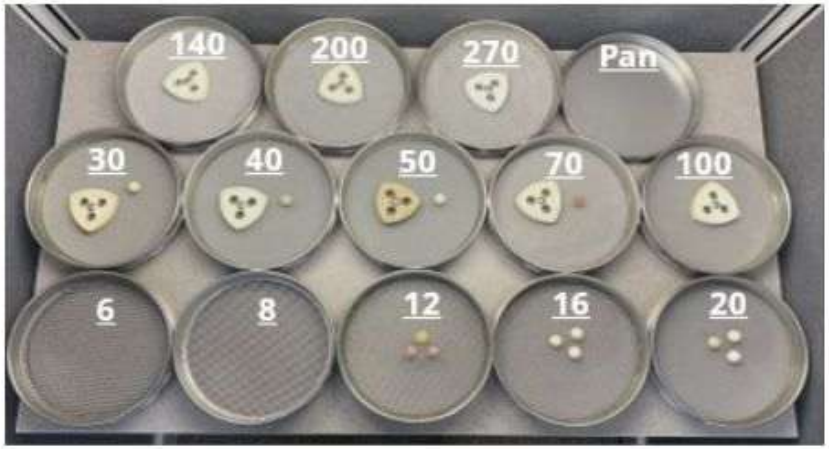
Grinding

Pelleting

Grinding and Pelleting Sorghum

Weigh 100g sample

Add 0.5g sieve agent

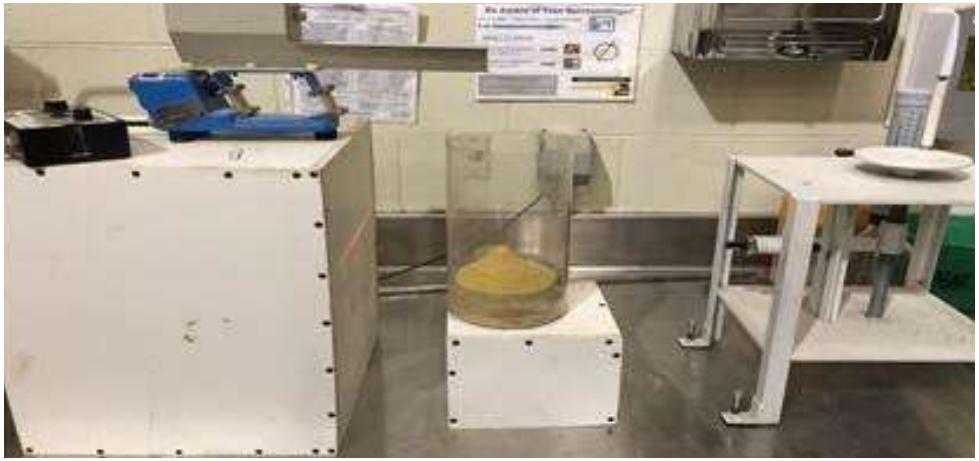


10 minutes

Grinding and Pelleting Sorghum

Angle of repose determined using a vibratory conveyor

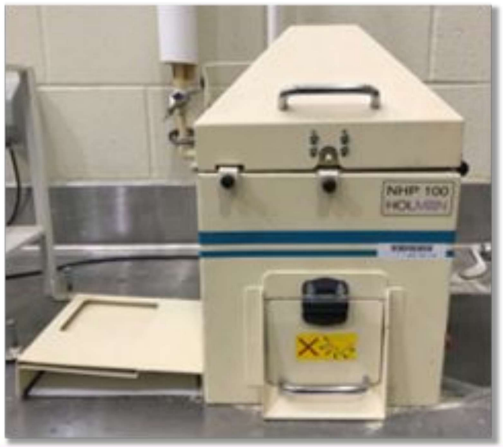
- Grain slowly free falls to build pile
- Measurement mound height with laser alignment for accuracy
- Height of grain pile, used to determine AoR value



Grinding and Pelleting Sorghum

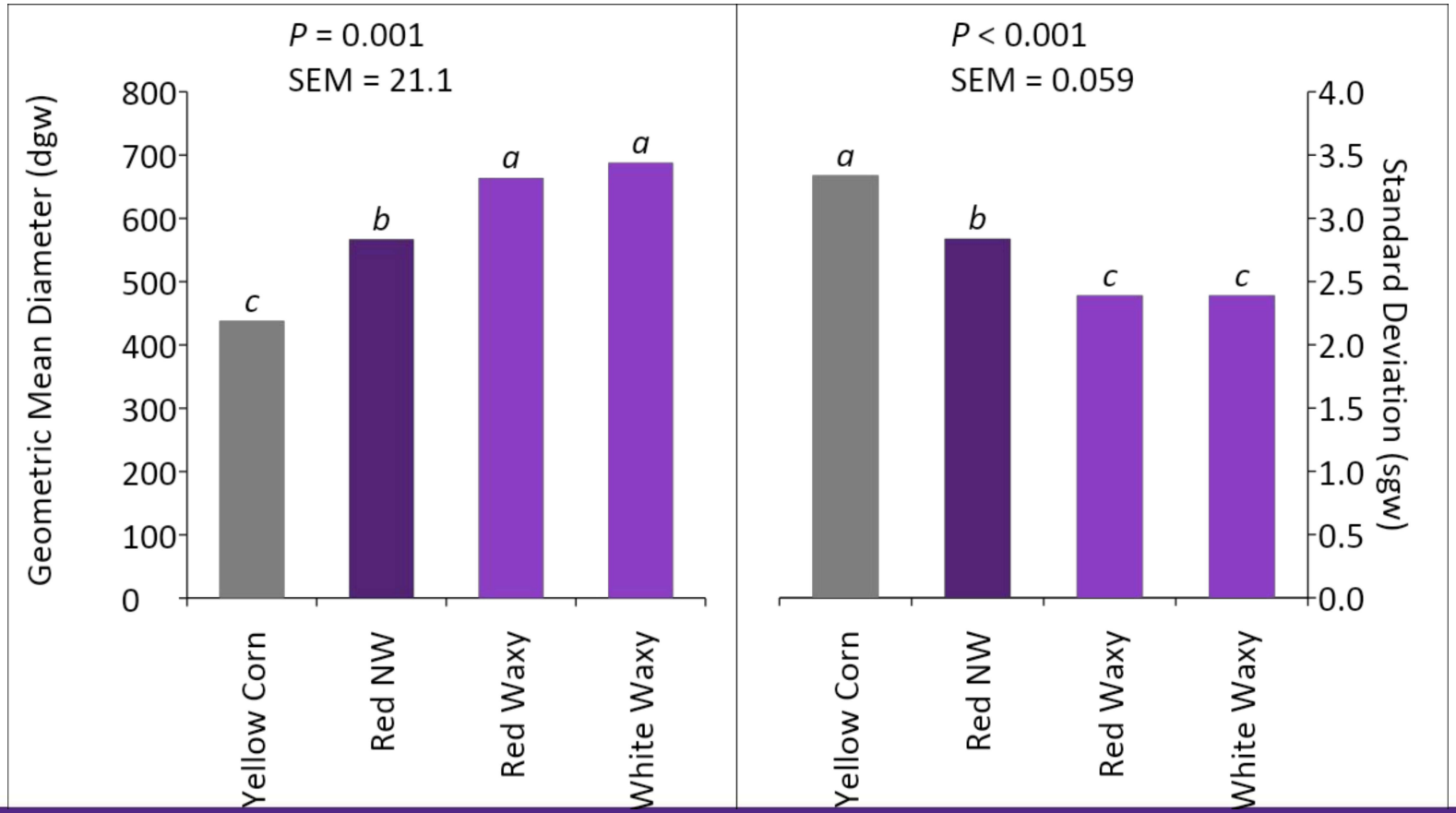
- Pellet durability tested with 30-second Homen 100
- Pellets screened before and after test with #6 screen

$$\text{PDI}, \% = \frac{\text{Initial pellet weight(g)}}{\text{Final pellet weight (g)}} \times 100$$



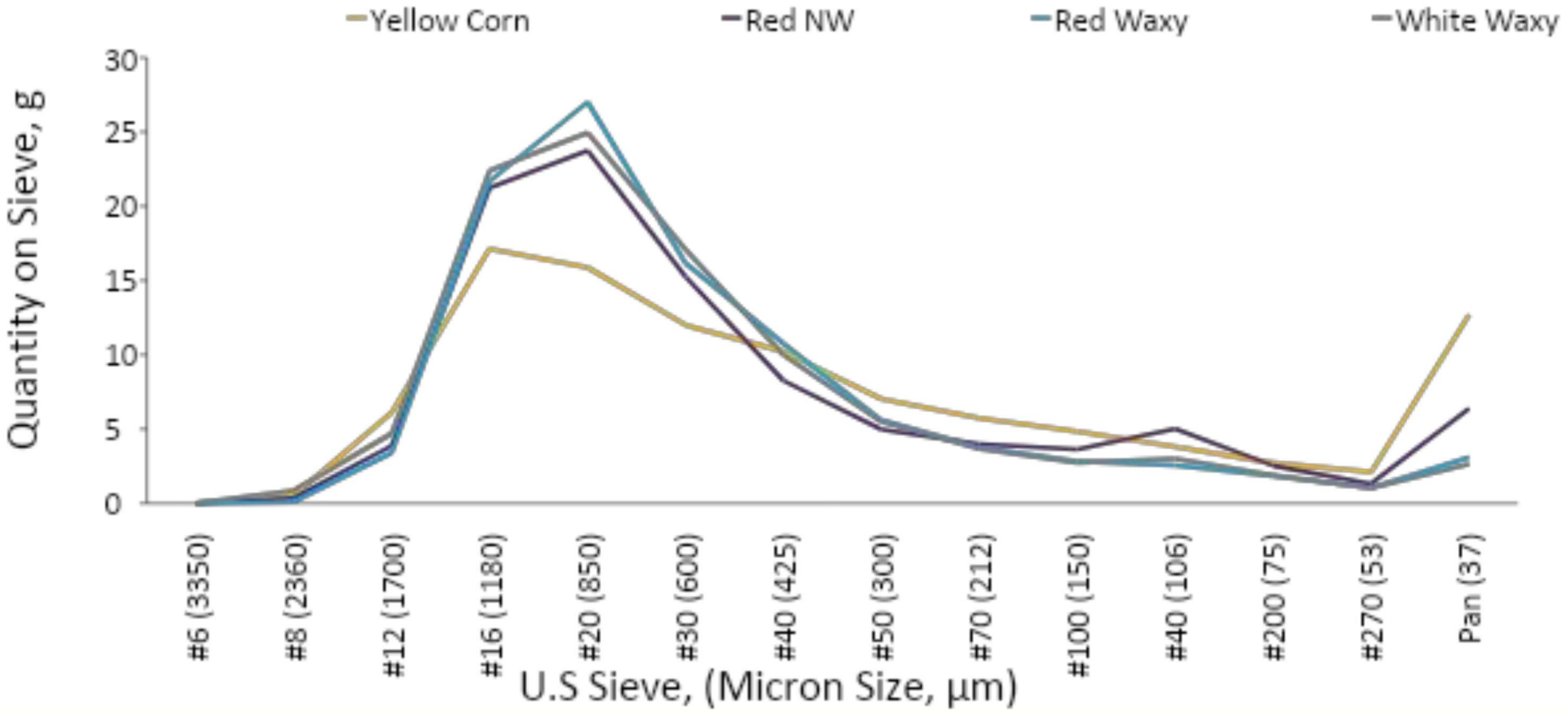
Tekpro Limited, North Walsham, UK; Schofield, AFIA, 2005

Grinding and Pelleting Sorghum



Friesen et al., 2025

Grinding and Pelleting Sorghum



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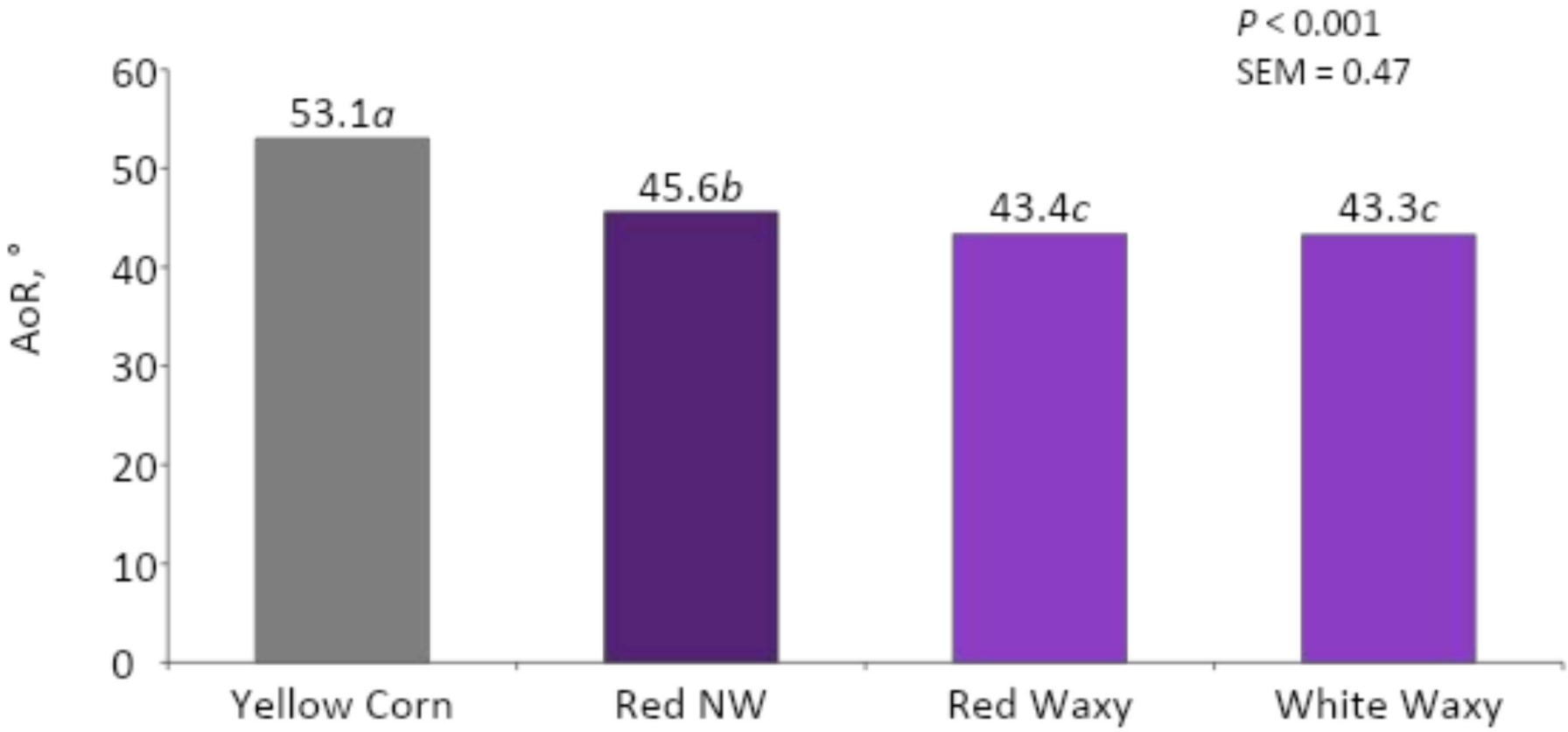
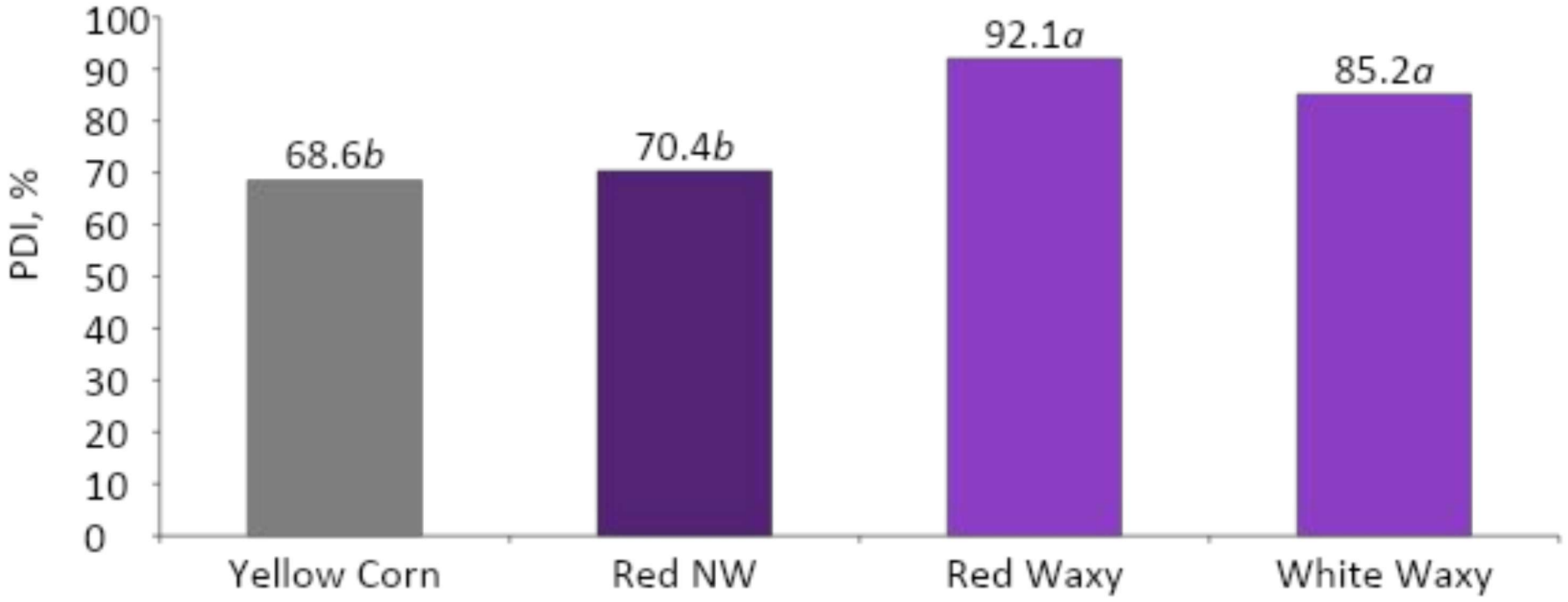
Grinding and Pelleting Sorghum



Friesen et al., 2025

Grinding and Pelleting Sorghum

P = 0.006
SEM = 4.15



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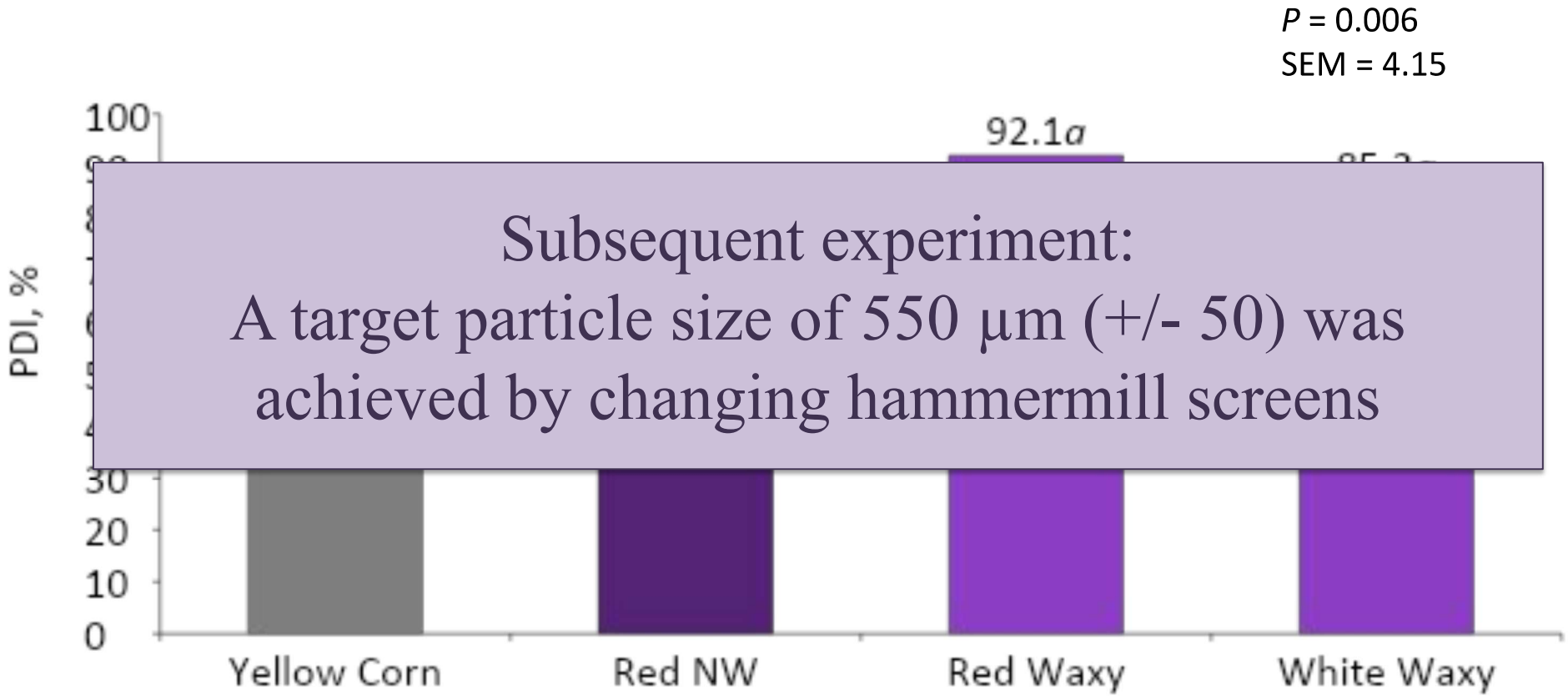
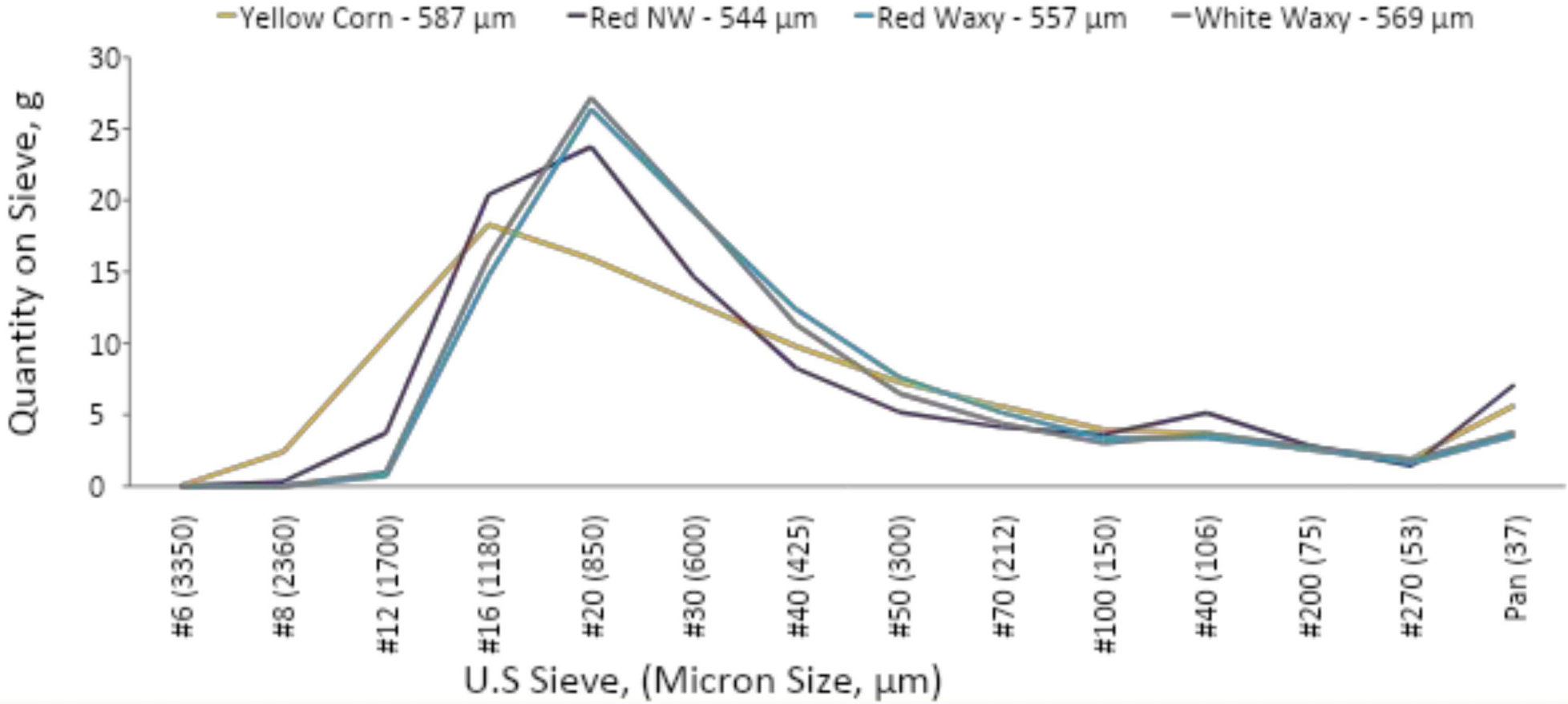


Subsequent experiment:
A target particle size of 550 µm (+/- 50) was achieved by changing hammermill screens

Grinding and Pelleting Sorghum



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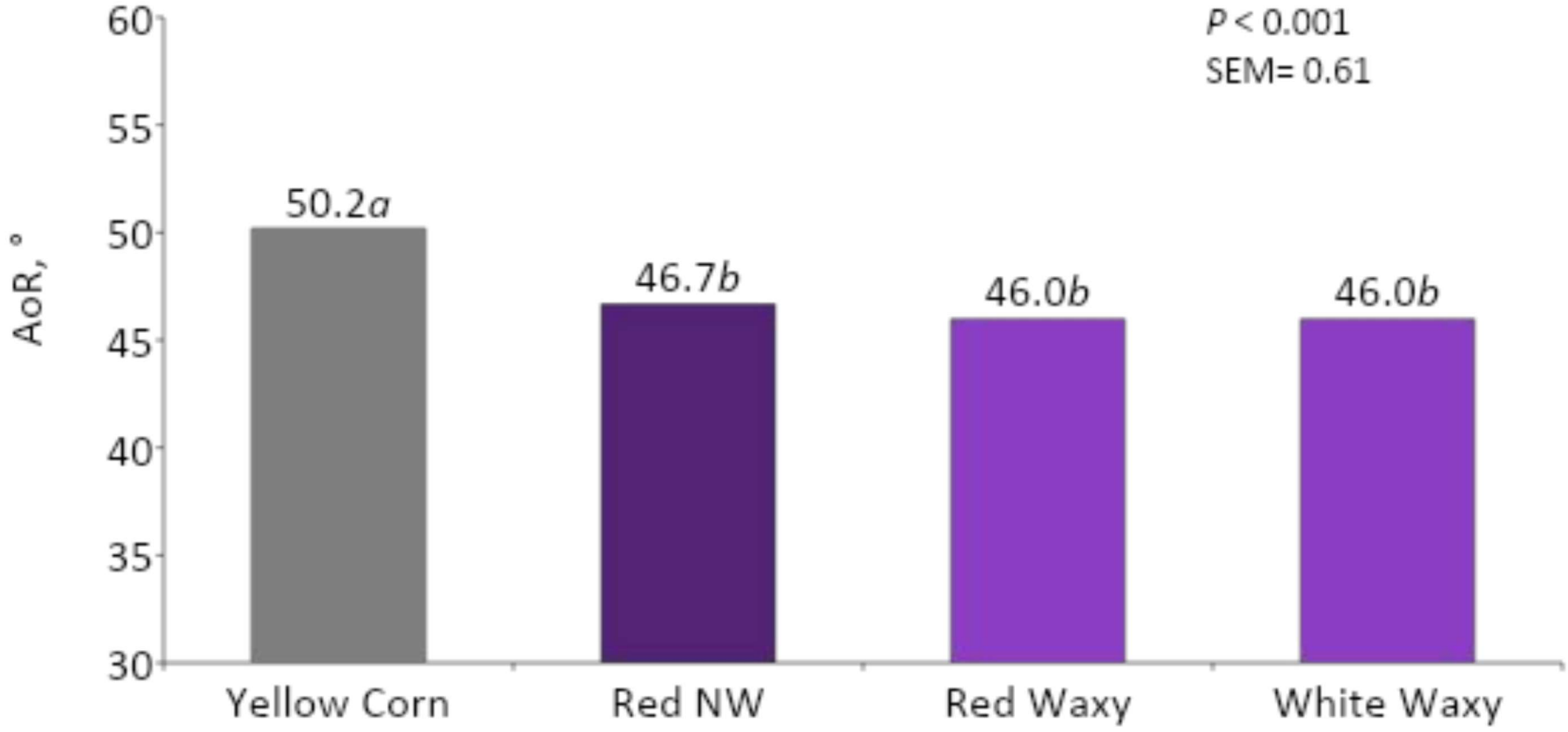

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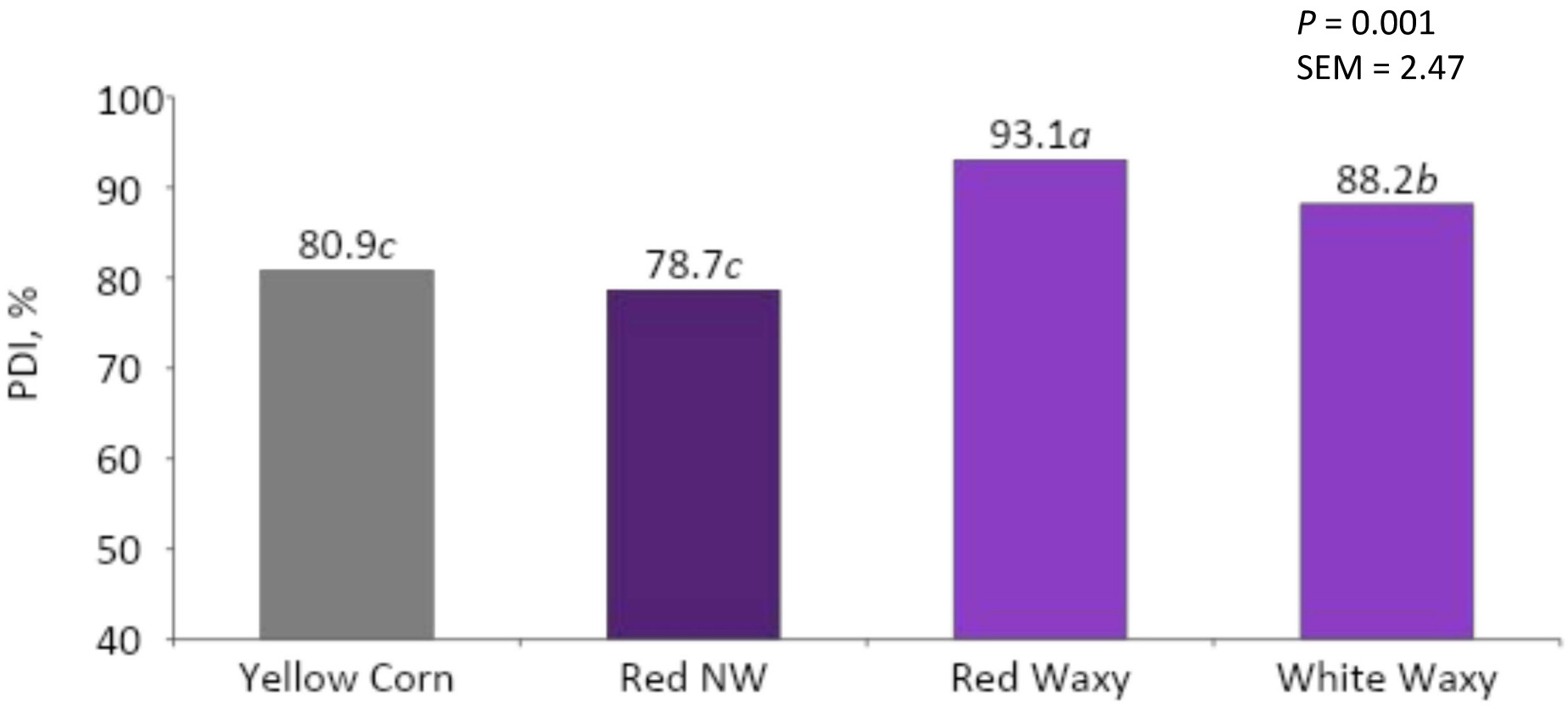
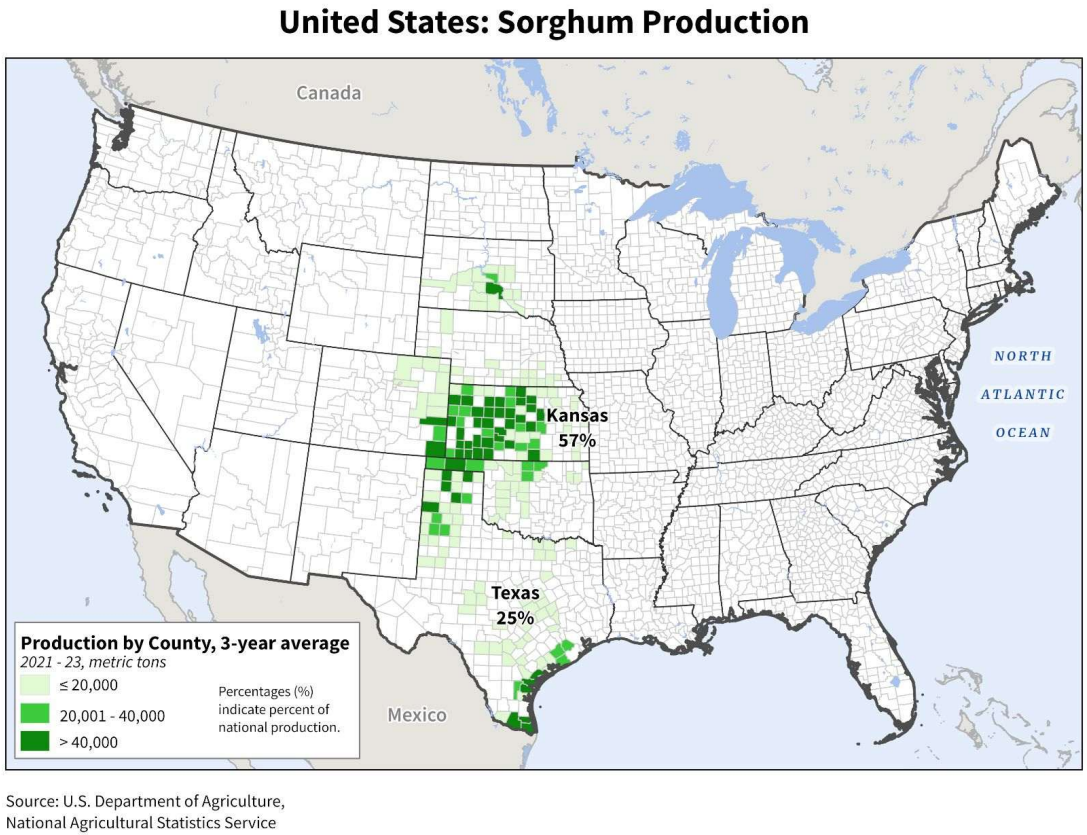


Friesen et al., 2025

Sorghum in Sow Lactation Diets



Source: U.S. Department of Agriculture, National Agricultural Statistics Service

Sorghum in Sow Lactation Diets

- A total of ~ 600 sows and their litters are being used in a lactation study at a JBS Live Pork Farm (Dalhart, TX)
- 296 total crates (148 crates per room); will be used during two farrowing rotations

100% Corn

50% Corn:50% Sorghum

100% Sorghum

Lactation Diets			
Ingredient, %	0% Sorghum	50% Sorghum	100% Sorghum
Sorghum	---	34.10	68.15
Corn	68.02	34.03	---
Soybean meal	26.17	26.09	26.08
Corn oil	1.50	1.50	1.50
Monocalcium phosphate, 21%	0.63	0.59	0.55
Limestone	1.80	1.82	1.83
Sodium chloride	0.60	0.60	0.60
Biolys Dry 80 (62.4%)	0.40	0.41	0.42
DL-Met	0.07	0.09	0.10
L-Thr	0.12	0.11	0.10
L-Trp	0.02	0.01	---
L-Val	0.03	0.01	---
Vitamin and trace mineral premix	0.25	0.25	0.25
Feed additives	0.27	0.27	0.27
Phytase	0.04	0.04	0.04
Choline chloride dry 60%	0.11	0.11	0.11

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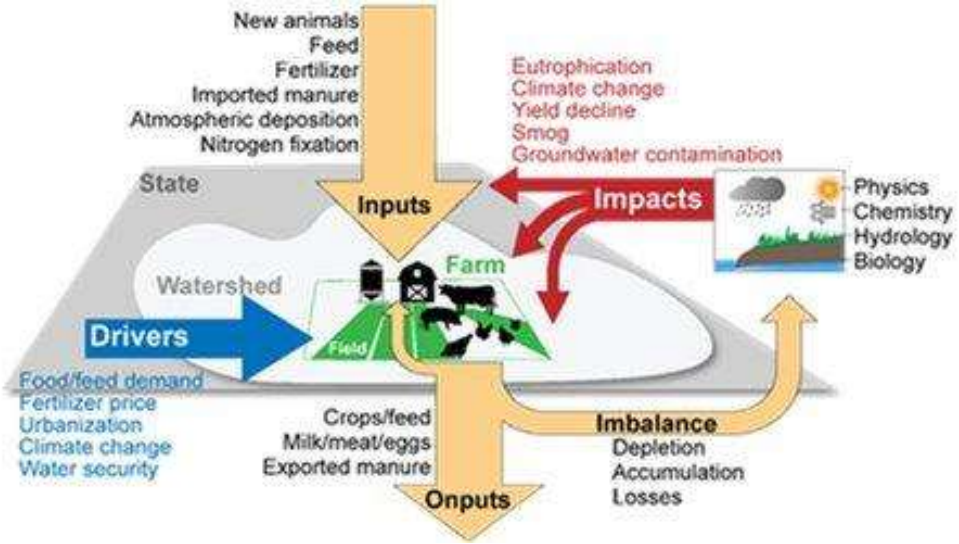
Sorghum in Sow Lactation Diets

K-STATE Research and Extension

SORGHUM CHECKOFF

Privett et al., 2025

Life Cycle Assessment



SORGHUM CHECKOFF

IOWA STATE UNIVERSITY

IFEEDER® Institute for Feed Education & Research

UNIVERSITY OF MINNESOTA

KANSAS STATE UNIVERSITY

NC STATE UNIVERSITY

pork checkoff

K-STATE Research and Extension

Continuous Progress

Improved sorghum varieties

– improvements in plant genetics

Feed processing

– importance of particle size

Amino acids

– balancing of SID amino acids in diet formulation

Phosphorus

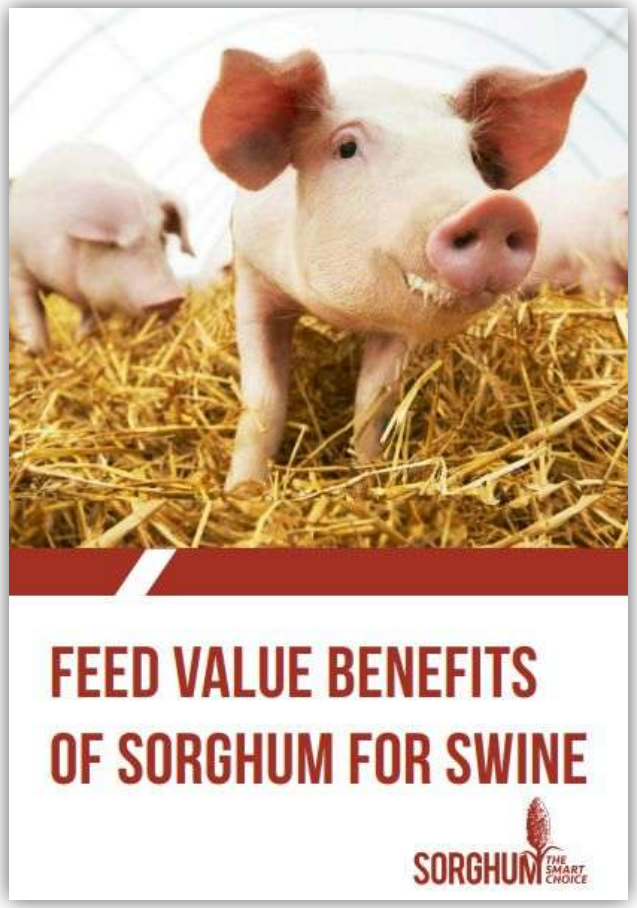
– opportunity to use less inorganic P

Continuous Progress

Advantages:

- Energy value
- Phosphorus content
- Amino acid profile
- Fatty acid profile
- Environmental sustainability

Resources


FEED VALUE BENEFITS
OF SORGHUM FOR SWINE
SORGHUM
THE SMART CHOICE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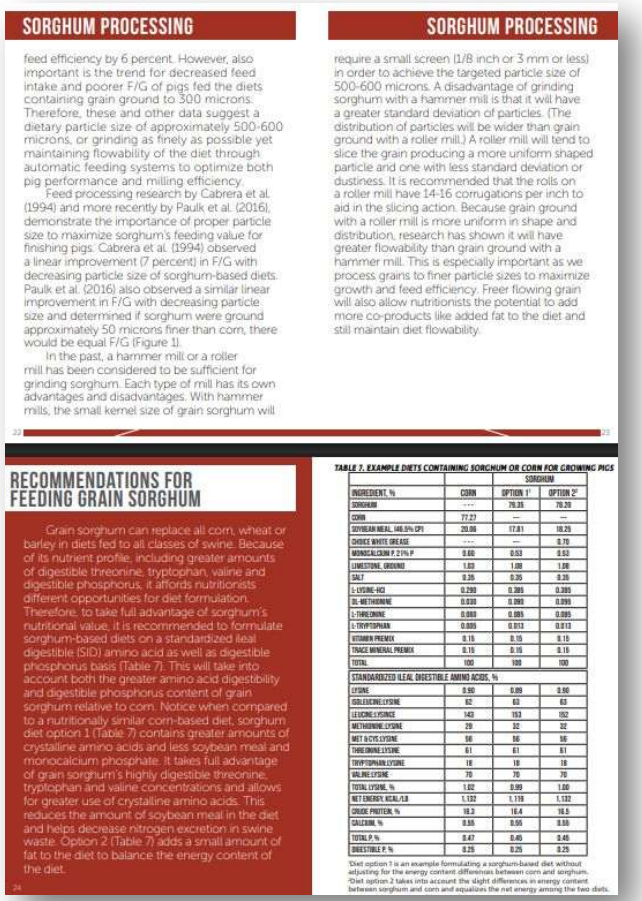
INTRODUCTION
Grain sorghum is a feedstuff with an excellent nutritional value for swine and can be used as the primary grain source in all swine diets. Numerous feeding trials in the last 20 years with nursery and finishing pigs and gestating and lactating sows have demonstrated the value of feeding sorghum relative to corn and other grains. When processed correctly and balanced for digestible amino acid and digestible phosphorus concentrations, sorghum can be an economical replacement for corn, wheat or barley in swine diets. In the past, research demonstrated sorghum grain contained 96 percent the energy content of corn (Cromwell et al., 1985).
However, new reference values indicate today's sorghum varieties will contain approximately 98-99 percent the energy content of corn (INRA, 2014). The increased energy values correspond with more recent studies that have observed 98-103 percent the feeding value of corn. In addition, its greater digestible phosphorus content also requires less supplemental inorganic phosphorus sources (monocalcium- or dicalcium-phosphate) than corn-based diets and reduces phosphorus excretion in swine waste, a benefit for the environment. Grain sorghum contains slightly less oil than corn. However, sorghum has more saturated fatty acids and less polyunsaturated fatty acids than corn. From a carcass fat quality prospective, this is positive as pigs fed sorghum will deposit a firmer carcass fat, providing an advantage relative to corn for bacon processors and in many fresh pork markets.
Only recently has research been conducted with sorghum dried distillers grains with solubles (DDGS). But like corn DDGS, the nutritional value of sorghum DDGS will depend on its oil concentration. As more and more ethanol plants are further extracting the oil in production of DDGS, comparisons among pigs fed sorghum vs. corn DDGS must be carefully made as the two sources might contain different oil concentrations. However, data indicates a similar growth rate can be achieved with diets containing low concentrations of sorghum DDGS as with diets containing corn DDGS. Similar to the comparison between their parent grains, sorghum DDGS may have a slightly lower oil content than corn DDGS, but again, may vary based on the oil extraction procedures at the ethanol plant.
Grain sorghum provides an excellent opportunity for swine producers or feed suppliers to lower feed costs. As our understanding of feed processing and the nutrient profile of grain sorghum increases, greater opportunities for expanded grain sorghum use exist to capitalize on its full potential in swine diets.


SORGHUM PROCESSING
feed efficiency by 6 percent. However, also important is the trend for decreased feed intake and poorer F/G of pigs fed the diets containing grain ground to 300 microns. Therefore, these and other data suggest a dietary particle size of approximately 500-600 microns, or grinding as finely as possible yet maintaining flowability of the diet through automatic feeding systems to optimize both pig performance and milling efficiency.
Feed processing research by Cabrera et al. (1994) and more recently by Paulk et al. (2016), demonstrate the importance of proper particle size to maximize sorghum's feeding value for finishing pigs. Cabrera et al. (1994) observed a linear improvement (7 percent) in F/G with decreasing particle size of sorghum-based diets. Paulk et al. (2016) also observed a similar linear improvement in F/G with decreasing particle size and determined if sorghum were ground approximately 50 microns finer than corn, there would be equal F/G (Figure 1).
In the past, a hammer mill or a roller mill has been considered to be sufficient for grinding sorghum. Each type of mill has its own advantages and disadvantages. With hammer mills, the small kernel size of grain sorghum will require a small screen (1/8 inch or 3 mm or less) in order to achieve the targeted particle size of 500-600 microns. A disadvantage of grinding sorghum with a hammer mill is that it will have a greater standard deviation of particles. (The distribution of particles will be wider than grain ground with a roller mill.) A roller mill will tend to slice the grain producing a more uniform shaped particle and one with less standard deviation or dustiness. It is recommended that the rolls on a roller mill have 14-16 corrugations per inch to aid in the slicing action. Because grain ground with a roller mill is more uniform in shape and distribution, research has shown it will have greater flowability than grain ground with a hammer mill. This is especially important as we process grains to finer particle sizes to maximize growth and feed efficiency. Freer flowing grain will also allow nutritionists the potential to add more co-products like added fat to the diet and still maintain diet flowability.
SORGHUM PROCESSING
RECOMMENDATIONS FOR FEEDING GRAIN SORGHUM
Grain sorghum can replace all corn, wheat or barley in diets fed to all classes of swine. Because of its nutrient profile, including greater amounts of digestible threonine, tryptophan, valine and digestible phosphorus, it affords nutritionists different opportunities for diet formulation. Therefore, to take full advantage of sorghum's nutritional value, it is recommended to formulate sorghum-based diets on a standardized ileal digestible (SID) amino acid as well as digestible phosphorus basis (Table 7). This will take into account both the greater amino acid digestibility and digestible phosphorus content of grain sorghum relative to corn. Notice when compared to a nutritionally similar corn-based diet, sorghum diet option 1 (Table 7) contains greater amounts of crystalline amino acids and less soybean meal and monocalcium phosphate. It takes full advantage of grain sorghum's highly digestible threonine, tryptophan and valine concentrations and allows for greater use of crystalline amino acids. This reduces the amount of soybean meal in the diet and helps decrease nitrogen excretion in swine waste. Option 2 (Table 7) adds a small amount of fat to the diet to balance the energy content of the diet.
TABLE 7. EXAMPLE DIETS CONTAINING SORGHUM OR CORN FOR GROWING PIGS
INGREDIENT, %
CORN
SORGHUM
OPTION 1
OPTION 2
SORGHUM
CORN
SOYBEAN MEAL, (46.5% CP)
CHOICE WHITE GREASE
MONOCALCIUM P, 21% P
LIMESTONE, GROUND
SALT
L-LYSINE-HCl
DL-METHIONINE
L-THREONINE
L-TRYPTOPHAN
VITAMIN PREMIX
TRACE MINERAL PREMIX
TOTAL
STANDARDIZED ILEAL DIGESTIBLE AMINO ACIDS, %
LYSINE
ISOLEUCINE:LYSINE
LEUCINE:LYSINE
METHIONINE:LYSINE
MET & CYS:LYSINE
THREONINE:LYSINE
TRYPTOPHAN:LYSINE
VALINE:LYSINE
TOTAL LYSINE, %
NET ENERGY, KCAL/LB
CRUDE PROTEIN, %
CALCIUM, %
TOTAL P, %
DIGESTIBLE P, %
*Diet option 1 is an example formulating a sorghum-based diet without adjusting for the energy content differences between corn and sorghum.
*Diet option 2 takes into account the slight differences in energy content between sorghum and corn and equalizes the net energy among the two diets.

Swine Extension

The Kansas State University Swine Extension program takes practical swine nutrition research and works with producers to facilitate rapid adoption of technology by the industry. The program also works with producers in the area of environmental management of swine facilities.

Upcoming Events

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Thank you!

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