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Evaluation of U.S. Grain Sorghum in Lactation Diets on Sow and Litter Performance

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Summary

A total of 568 sows (Line 1050, PIC) were used to evaluate the effects of U.S. grain sorghum compared with corn in lactation diets on sow and litter performance. Sows, in four separate farrowing groups (approximately 142 ± 1 sows per group), were moved into the farrowing house and blocked by parity on d 112 ± 1 of gestation. Sows were assigned to one of three dietary treatments, consisting of diets with 0, 50, or 100% of the corn replaced with sorghum. Diets were formulated to be balanced for amino acids, minerals, and energy. Corn and sorghum were given the same NE loading value (1,212 kcal/lb). Sows were fed 4 lb of their assigned treatment diet before farrowing, then were given *ad libitum* access until weaning (approximately d 19 of lactation). Replacing corn with sorghum in the diet did not affect sow weight, backfat, or caliper score change from entry to weaning. Feeding sows sorghum did not affect sow ADFI, litter feed conversion ratio, or wean-to-estrus interval. There were no differences in total born or total born alive. However, there was a decrease (quadratic, $P = 0.003$) in the percentage of stillborn pigs with increasing sorghum in the diet. Also, the percentage of mummies increased and then decreased (quadratic, $P = 0.001$) as sorghum inclusion increased. There were no differences after cross-fostering (d 1) or at weaning for litter size and litter weight. Preweaning mortality tended to decrease then increase (quadratic, $P = 0.080$) with increasing sorghum in the diet. Additionally, as sorghum increased, preweaning removals increased (linear, $P = 0.046$); however, no differences were observed in total removals and mortality. In conclusion, U.S. grain sorghum can replace corn in lactation diets with little impact on sow or litter performance.

Introduction

There are limited studies evaluating the use of sorghum in sow lactation diets. Due to the lack of information, many production systems rarely utilize sorghum in lactation diets, and its inclusion is typically limited to situations where a significant economic advantage exists compared with corn. Hesitation surrounding the use of alternative grains relative to corn may stem from uncertainty regarding their potential effects on

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sow productivity and litter performance. While some older research has evaluated sorghum as a primary energy source in lactation diets, additional commercial research is needed to better understand the effects of modern sorghum varieties compared with corn in lactation diets. Therefore, the objective of this study was to determine the effects of sorghum relative to corn in sow lactation diets on sow and litter performance.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. This study was conducted at a commercial sow farm in northwest Texas (JBS Live Pork, Dalhart, TX). Sows were housed in individual farrowing stalls measuring 81 × 60 in, including sow and piglet area. Each stall was equipped with a SowMax feed hopper (HogSlat, Newton Grove, NC). Two feeder configurations were used: a dry and wet-dry feeder (HogSlat, Newton Grove, NC). All stalls were equipped with a supplementary piglet water nipple 6.5 in above the floor. The dry feeder included a sow water nipple located 16 in above the floor, whereas the wet-dry feeder included a water nipple located 12 in above the floor, with an additional water source provided in the feed pan. Dietary treatments were evenly distributed across feeder configurations.

Animals and diets

A total of 568 sows (Line 1050, PIC) and litters were used across four farrowing groups (approximately 142 ± 1 sows per farrowing group). Sows were moved into the farrowing house on d 112 ± 1 of gestation. Treatment diets were assigned at entry into farrowing and fed through weaning. Treatments consisted of diets with 0, 50, or 100% of the corn replaced with U.S. grain sorghum (Table 1). There were 189 or 190 sows for each dietary treatment. No creep feed was offered to piglets throughout lactation. Diets were fed in mash form and formulated to be balanced for amino acids, minerals, and energy using NRC (2012) nutrient loading values for ingredients. Corn and sorghum were given the same estimated NE value of 1,212 kcal/lb. Both grains were ground to a target particle size of 500 μm. Particle size was measured when new grain batches were ground (Table 2). All diets were manufactured, and particle size was analyzed at the JBS Dalhart Feed Mill.

Upon entry into the farrowing house and at weaning, sow weight, caliper score, and backfat depth were measured. Caliper scores were taken at the last rib. Backfat depth was measured at the last rib, 2.5 in from the midline on the left side of the sow (Renco Lean Meter, S.E.C. Repro Inc., Golden Valley, MN). Cross-fostering occurred across dietary treatments to equalize litter size within 24 h of farrowing. Piglets were weighed as a litter on d 1 post cross-fostering and the day prior to weaning. Starting on d 3 of lactation, piglets that were unthrifty, unable to compete with littermates, or gaunt were removed and classified as a fall-behind pigs. All pigs removed and mortalities were weighed and recorded.

Daily feed additions were recorded for each sow using a scale cart and the LeeO system (Prairie Systems, Spencer, IA). Each farrowing stall had an RFID tag and was identified as a location pen in the LeeO system. When sows were moved into the farrowing stall, they were registered to the pen in the LeeO system. Uneaten feed refusal was removed from the feed pan at weaning, weighed, and subtracted from the recorded feed disappearance for each sow. The dry matter (DM) content of the recovered feed was analyzed to calculate feed removed on a DM basis, and diet DM was subsequently used

to convert feed removed back to an as-fed basis for accurate adjustment. Additionally, feeder measurements were taken at farrowing and weaning to account for feed remaining in the feeder. The feeder measurement at farrowing was added to the sow's total intake, whereas the feeder measurement at weaning was subtracted from the sow's total intake. After weaning, the sow's wean-to-estrus interval was recorded.

Statistical analysis

Performance data were analyzed as a generalized block design using R software, version 4.4.1 (R Core Team, Vienna, Austria). Sow was considered the experimental unit. Treatment served as a fixed effect with random effects of block (sow parity nested within group) and group. Pre-wean mortality was analyzed using a binomial distribution. Results were considered significant at $P \leq 0.05$ and marginally significant at $0.05 < P \leq 0.10$.

Results and Discussion

There were no differences in sow body weight, backfat, or caliper score at entry or weaning, or the change from entry to weaning (Table 3). No differences were observed for sow ADFI from farrowing to weaning. Additionally, there were no differences (in sow wean-to-estrus interval between inclusion levels.

For litter performance, there were no differences in total born or total born alive (Table 4). The percentage of stillborn piglets decreased (quadratic, $P = 0.003$) with increasing sorghum, with a small reduction at the 50% inclusion level and a greater reduction at the 100% inclusion level. The percentage of mummies increased (quadratic, $P = 0.001$) with increasing sorghum, with a higher incidence at the 50% level and lower values at both the 0% and 100% inclusion levels. However, because sows were allotted to dietary treatment on d 112 of gestation, the observed difference in mummies is likely due to chance. There were no differences in litter size on d 1 or at weaning. There were also no differences observed for litter weight, mean piglet weight, litter ADG, or piglet ADG from d 1 to weaning.

There was a tendency for a quadratic effect ($P = 0.080$) in preweaning mortality, with the lowest value in sows fed the 50% sorghum inclusion level. Additionally, there was an increase (linear, $P = 0.046$) in preweaning removals as sorghum increased in the diet. However, there was no difference in total preweaning removals and mortality. In conclusion, there were no differences in sow performance or litter growth when U.S. grain sorghum replaced either 50 or 100% of the corn in the diet.

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Table 1. Composition of lactation diets (as-fed basis)[1]

	Sorghum:corn[2]		
Item	0	50	100
Ingredient, %			
Sorghum	---	34.10	68.15
Corn	68.02	34.03	---
Soybean meal, 48% CP	26.17	26.09	26.08
Soybean oil	1.50	1.50	1.50
Monocalcium phosphate, 21% P	0.63	0.59	0.55
Limestone	1.80	1.82	1.83
Salt	0.60	0.60	0.60
Lysine, 62.4%[3]	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	---
VTM premix w/ phytase	0.25	0.25	0.25
Feed mitigant[4]	0.27	0.27	0.27
Phytase[5]	0.04	0.04	0.04
Choline chloride	0.11	0.11	0.11
Total	100	100	100
Calculated analysis			
SID AA, %			
Lys	1.05	1.05	1.05
Ile:Lys	62	64	67
Leu:Lys	133	140	147
Met:Lys	30	31	32
Met and Cys:Lys	54	54	54
Thr:Lys	64	64	64
Trp:Lys	20	20	20
Val:Lys	72	72	72
His:Lys	41	40	39
Total Lys, %	1.18	1.18	1.17
NE, kcal/lb	1,132	1,133	1,133
SID Lys:NE, g/Mcal	4.21	4.20	4.20
CP, %	17.8	18.7	19.6
Ca, %	0.87	0.87	0.87
P, %	0.48	0.48	0.48
STTD P, %	0.38	0.38	0.38

[1] Feed was manufactured by a commercial feed mill (JBS, Dalhart, TX).

[2] Dietary treatment is indicated by sorghum as a percentage to corn as the diet cereal grain.

[3] BioLys (Evonik Industries AG, Essen, Germany).

[4] Guardian, Alltech, Nicholasville, KY.

[5] OptiPhos Plus 2500 G (Huvepharma, Peachtree City, GA) provided 944 FTU/lb of diet for an estimated release of 0.12% STTD P.

Table 2. Average particle size of grain sources and complete diets

	Grain		Diet sorghum:corn[1]		
Item	Sorghum	Corn	0	50	100
Particle size, μm[2]	442	504	597	580	571

[1] Dietary treatment is indicated by sorghum as a percentage to corn as the diet cereal grain.

[2] Particle size was determined using the Kansas State University 13-sieve system with a flow agent and a 15-min run time, following standard sieving procedures. Values represent the mean of six analyses over the duration of the experiment.

Table 3. Evaluation of increasing sorghum in lactation diets on sow lactation performance[1]

	Sorghum:corn[2]				*P* =	
Item	0	50	100	SEM	Linear	Quadratic
Count, n	190	189	189	---	---	---
Parity	2.5	2.5	2.5	0.51	0.692	0.920
Lactation length, d	19.3	19.2	19.3	0.84	0.682	0.423
Sow BW, lb						
Entry	621.6	622.7	622.2	26.84	0.913	0.882
Wean	537.5	543.3	540.2	28.47	0.657	0.399
Change (entry to wean)	-84.7	-79.5	-82.2	3.37	0.494	0.201
Sow backfat, mm						
Entry	16.9	16.9	16.8	1.09	0.536	0.893
Wean	13.6	13.9	13.6	0.64	0.948	0.306
Change (entry to wean)	-3.4	-3.1	-3.2	0.55	0.576	0.335
Sow caliper score, units						
Entry	17.6	17.7	17.6	0.35	0.655	0.728
Wean	16.1	16.4	16.4	0.41	0.261	0.576
Change (entry to wean)	-1.4	-1.3	-1.3	0.17	0.316	0.722
Sow ADFI, lb						
Farrow to wean	14.6	14.7	14.7	0.59	0.850	0.760
Entry to wean	11.9	11.8	11.8	0.55	0.830	0.957
Litter FCR[3]	2.69	2.84	2.89	0.099	0.121	0.647
Wean-to-estrus interval, d	5.6	5.5	5.7	0.14	0.364	0.182

[1] A total of 568 mixed-parity sows (Line 1050, PIC, Hendersonville, TN) and litters were used. Litters were cross-fostered to equalize litter size up to 24 h after farrowing.

[2] Dietary treatment is indicated by sorghum as a percentage to corn as the diet cereal grain.

[3] Litter feed conversion ratio (FCR) calculated as total sow feed intake during lactation divided by total litter weight gain.

Table 4. Evaluation of sorghum inclusion level in lactation diets on litter performance[1]

	Sorghum:corn[2]				*P* =	
Item	0	50	100	SEM	Linear	Quadratic
Total born, n	17.1	16.6	16.8	0.46	0.497	0.321
Total born alive, n	15.8	15.3	15.7	0.43	0.968	0.204
Stillborn, %	5.0	4.7	3.5	2.89	< 0.001	0.003
Mummy, %	2.0	2.5	2.1	1.44	0.453	0.001
Litter size, n						
d 1	14.9	14.9	14.8	0.36	0.769	0.978
Weaning	13.1	13.1	12.9	0.31	0.547	0.660
Litter weight, lb						
d 1	49.4	50.3	49.2	0.72	0.792	0.255
Weaning	156.4	154.8	151.9	8.80	0.174	0.831
Mean piglet BW, lb						
d 1	3.3	3.4	3.3	0.10	0.903	0.223
Weaning	12.0	11.8	11.8	0.91	0.431	0.757
Litter ADG, lb						
d 1 to weaning	5.84	5.75	5.63	0.209	0.204	0.910
Piglet ADG, lb						
d 1 to weaning	0.44	0.44	0.43	0.025	0.338	0.864
Mortality, d 1 to weaning, %	7.6	6.4	7.3	0.52	0.606	0.080
Removals, d 1 to weaning, %	4.4	5.1	5.6	0.49	0.046	0.797
Removals and mortality, d 1 to weaning, %	12.0	11.5	12.8	0.75	0.362	0.202

[1] A total of 568 mixed-parity sows (Line 1050, PIC, Hendersonville, TN) and litters were used. Litters were cross-fostered to equalize litter size up to 24 h after farrowing.

[2] Dietary treatment is indicated by sorghum as a percentage to corn as the diet cereal grain.