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Summary

A total of 557 mixed parity sows (PIC 1050) were used to evaluate the effect of lactation feeder design on sow farrowing and litter growth performance during summer conditions. The experiment was conducted at a commercial sow farm located in northwest Texas with two sequential farrowing groups with approximately 279 sows per group. On d 112 to 114 of gestation, sows were moved to the farrowing house and randomly allotted to 1 of 3 feeder types based on parity and caliper score. Each of the three feeder types were equipped with the SowMax ad-lib sow feed hopper (Hog Slat). Feeder types consisted of: 1) a dry lactation feeder with a nipple drinker located next to the feeder; 2) a wet/dry lactation feeder with a divider to separate feed and water; or 3) the wet/dry lactation feeder without a divider. The three feeder types were placed in groups of three continuous stalls with the same sequence from the front to the end of all rooms to balance environmental effects. Sows were weighed before entering the farrowing house and at weaning. Sows were provided approximately 4 lb per day of a common lactation diet pre-farrowing. After farrowing, sows were provided ad libitum access to lactation feed. The weaning age averaged 20.9 d. There was no evidence of difference ($P > 0.10$) in sow weight or caliper score at entry, weaning, or overall BW change. Additionally, there was no evidence of difference ($P > 0.10$) in total litter or piglet birth BW, total pigs born, or percentage of pigs born alive. However, sows fed with the dry lactation feeder had decreased ($P < 0.001$) total daily feed disappearance, and average daily feed disappearance compared to sows fed with either wet/dry feeder. There was no evidence of difference ($P > 0.10$) for litter or pig weaning weight, or litter average daily gain. As a result, litter feed efficiency was improved ($P = 0.027$) in sows fed with the dry feeder compared to either wet/dry feeder. Sows fed with the dry feeder had decreased ($P \leq 0.006$) total lactation feed cost and feed cost per piglet weaned compared to either wet/dry feeder. For feeder cleaning criteria, dry feeders had increased ($P = 0.001$) washing time and washing cost compared to either wet/dry feeder. In summary, using the dry feeder design reduced feed disappearance with no effects on sow and litter performance compared to either wet/dry feeder, thus

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improving litter feed efficiency and reducing feed cost per sow and litter presumably through less feed wastage.

Introduction

During lactation, maximizing sow feed intake is critical to prevent body reserve mobilization and sustain milk production for litter growth. However, sow farms located in hot and humid climates have difficulties maintaining high levels of lactation feed intake, especially during the summer months, which may lead to poorer performance.[4] Several factors may affect sow feed intake, one is feeder type and design. While there are numerous types of lactation feeders on the market, a good feeder design can help improve sow feed intake and reduce feed wastage. In finishing pigs, wet/dry feeders have been shown to increase ADFI and ADG, but there is limited research on the effects of wet/dry feeder implementation in lactation.[5] Therefore, the objective of this experiment was to evaluate the effect of different lactation feeder designs on sow farrowing performance, litter growth performance, and feeder cleaning criteria.

Materials and Methods

The Kansas State University Animal Care and Use Committee approved the protocol used in this experiment. The experiment was conducted at a commercial sow farm located in northwest Texas.

Animals and treatments

There were 72 stalls per room. A total of four farrowing rooms (288 stalls; 96 stalls per lactation feeder treatment) were used for each group. The trial was conducted in two sequential farrowing groups for a total of 576 sows enrolled on test.

The first group of sows (PIC 1050) farrowed between June 7 and June 17, 2023, and piglets were weaned between June 29 and July 4, 2023. The second group of sows farrowed between July 4 and July 13, 2023, and piglets were weaned between July 27 and August 1, 2023. On d 112 to 114 of gestation, sows were moved to the farrowing house, and randomly allotted to 1 of 3 feeder types based on parity and caliper score. Each of the three feeder types were equipped with the SowMax ad-lib sow feed hopper (SKU: 7150890500; Hog Slat). Feeder types consisted of: 1) dry lactation feeder with a separate nipple drinker available outside of the feeder (Hog Slat, Newton Grove, NC); 2) wet/dry lactation feeder with a divider to separate feed and water (Hog Slat), or 3) the wet/dry lactation feeder without a divider (Hog Slat; Figure 1). The wet/dry feeders had a nipple drinker located near the bottom of the feeder to allow sows free access to water.

The same commercial lactation feed was fed to all sows (Table 1). Pre-farrowing, sows were provided approximately 2.0 lb in the morning and the afternoon, for a total of 4.0 lb per day, of the lactation diet. After farrowing, sows were provided *ad libitum* access to the lactation feed with individual hoppers, and each feed addition was weighed and electronically recorded. Feed addition to each feeder was registered to the stall (location

[4] Rao, Z. X., K. F. Coble, M. D. Tokach, J. C. Woodworth, J. M. DeRouchey, R. D. Goodband, and J. T. Gebhardt. 2023. Effect of different sow lactation feeder types and drip cooling on sow body weight, litter performance, and feeder cleaning criteria. Transl. Anim. Sci. 7:1-9. doi:10.1093/tas/taxd040.
[5] Greiner, L. L, D. C. Humphrey, S. Becker, C. S. Hagen, and K. Holtz. 2022. Evaluation of Novel Wet/Dry Feeder in Finishing Pigs. J. Anim. Sci. 100(Suppl. 2):45-46. doi:10.1093/jas/skac064.071.

pen) with the date and weight recorded for calculating feed disappearance. Prior to each feed addition all feeders were checked for old/moldy feed, and this feed was removed. Viable piglets were individually tagged with an RFID tag within 24 h of birth. The average weaning age was 20.9 d.

Data and sample collection

Feed, sow and litter data were recorded and stored using the LeeO system (Prairie Systems, Spencer, IA). A walk-on platform scale was used to weigh sows before entering the farrowing house and at weaning. Sow caliper score was taken between days 109 and 111 of gestation. Caliper scores 6-12, 12-17, and 17-22 correspond to body condition scores of 1, 2, and 3, respectively. Each sow stall was tagged with an RFID tag and identified as a location pen in the LeeO system. For sow data, the information (sow ID, parity, and breeding date) for each sow was exported from the CloudFarms® system and then imported into the LeeO system. When sows were moved into the farrowing stall, they were also registered in pens in the LeeO system.

For litter performance, piglets were registered under the sow and crate, and weighed individually at birth and at weaning. Non-viable piglets (low birth weight or dead before tagging), stillborn, and mummies were recorded but not weighed. Any cross-fostering and mortalities throughout the lactation period were recorded.

After weaning, 3 farm employees were designated to wash feeders, and cleaning times for several feeders per feeder type were recorded. The number of feeders used was 59, 57, and 57 for the dry feeder, wet/dry feeder with a divider, and wet/dry feeder without a divider, respectively. For economic data, the lactation feed cost was $330/ton, litter value was $0.70/lb of litter weight, and the labor cost for washing was $23/hr.

Statistical analysis

For sow BW data, the number of sows used for the dry feeder, the wet/dry feeder with a divider, and the wet/dry feeder without a divider was 143, 154, and 143, respectively, with an average parity of 1.9. Sows not included in the analysis of BW data were because of missing data points for their weaning weight. This was due to either culling or mortality prior to weaning. For feed disappearance, the number of sows used for the dry feeder, the wet/dry feeder with a divider, and the wet/dry feeder without a divider was 169, 170, and 170, respectively. Sows not included in the analysis of feed disappearance were a result of culling, mortality, or movement to another stall prior to weaning. For litter performance data, the number of sows used for the dry feeder, the wet/dry feeder with a divider, and the wet/dry feeder without a divider was 158, 161, and 157, respectively. Sows not included in the analysis of litter data were a result of missing data points for litter birth weight, weaning weight, culling, or mortality prior to weaning.

Data were analyzed as a randomized complete block design for one-way ANOVA in the R Studio program. The lmer function from the lme4 package was used for lactating sow BW, feed disappearance, and litter growth performance. The glmer function (Poisson distribution) from the lme4 package was used for total born and litter size. The glmmTMB function (beta-binomial distribution) from the glmmTMB package was used for the percentage of mortality and pigs weaned. Sow (litter) was considered as the experimental unit. Farrowing room was the blocking factor for sow and litter data. Lactation feeder design was used as the fixed effect. Sow entry weight was used as a covariate for sow weaning weight and weight change data. Parity category (P1, P2, or P3+) was used as a covariate for litter weights and growth performance data. A Tukey/Sidak multiple comparison adjustment was used to control type I error rate. All results were considered significant at $P \leq 0.05$ and marginally significant at $0.05 < P \leq 0.10$.

Results and Discussion

There was no evidence of difference ($P > 0.10$) in sow weight or caliper score at entry or weaning, or BW change during lactation (Table 2). There was no evidence of difference ($P > 0.10$) in total litter or piglet birth BW, total pigs born, or percentage of pigs born alive. However, sows fed with the dry lactation feeder had decreased ($P < 0.001$) total daily feed disappearance, and average daily feed disappearance compared to those fed with either wet/dry feeder. There was no evidence of difference ($P > 0.10$) for litter or pig weaning weight, or litter average daily gain. As a result, litter feed efficiency was improved ($P = 0.027$) in sows fed with the dry feeder compared to those fed with either wet/dry feeder type. In addition, sows fed with the dry feeder had reduced ($P \leq 0.006$) total lactation feed cost and feed cost per piglet weaned compared to sows fed with either wet/dry feeder. For feeder cleaning criteria, dry feeders had increased ($P = 0.001$) washing time and washing cost compared to either wet/dry feeder.

In summary, the lack of differences in litter growth performance and sow weight change suggests that sows had similar true lactation feed intake, regardless of feeder design. However, the increased feed disappearance observed when sows were fed with either wet/dry feeder design appears to be due to increased feed wastage. This difference could be explained by additional daily removal of wet feed from either of the wet/dry feeder designs. Although we did not record the amount of wasted feed, wet/dry feeders had a greater frequency of old/wet feed removal through daily observation, compared to the dry feeder. Therefore, sows fed using the wet/dry feeders (with or without the divider) had greater total feed disappearance, which was likely due to increased feed waste compared to sows fed using the dry feeder. As a result, sows fed using the dry feeder had reduced lactation feed coast and reduced feed cost per pig weaned.

Table 1. Diet composition (as-fed basis)[1]

Item	Lactation diet
Ingredients, %	
Sorghum	64.21
Soybean meal	25.50
Corn DDGS	5.00
Corn oil	1.50
Limestone	1.55
Monocalcium P (21% P)	0.70
Sodium chloride	0.55
Lysine, 60%[2]	0.44
Methionine hydroxy analogue[3]	0.08
L-Thr	0.08
VTM Premix w/ Phytase	0.25
Choline Chloride	0.11
Phytase[4]	0.04
Total	100.00
Calculated analysis	
Standardized ileal digestibility AA, %	
Lys	1.05
Ile:Lys	68
Leu:Lys	148
Met:Lys	30
Met and Cys:Lys	53
Thr:Lys	64
Trp:Lys	20.0
Val:Lys	75
His:Lys	39
Total Lys, %	1.18
NE, kcal/lb	1,162
SID Lys:NE, g/Mcal	4.10
CP, %	19.4
Ca, %	0.80
P, %	0.54
STTD P, %	0.43

[1]Feed was manufactured by a commercial feed mill (JBS, Dalhart, TX).
[2]BioLys (Evonik Industries AG, Essen Germany).
[3]MHA (Novus International, Inc. Chesterfield, MO).
[4]OptiPhos Plus 2500 G (Huvepharma, Peachtree City, GA), provided 409 FTU/lb of diet, for an estimated release of 0.11% STTD P.

Table 2. The effect of lactation feeder design on sow and litter performance

Feeder Type:	Dry	Wet/dry			
Divider:		Yes	No	SEM	P =
Sow body weight					
Sows, n	154	143	143		
Entry	516.3	516.3	515.3	11.09	0.960
d 1[2]	433.4	434.4	432.2	2.02	0.733
Weaning[3]	430.3	435.8	433.4	3.34	0.398
Weight change					
Entry-weaning[3]	-85.6	-80.1	-82.5	3.24	0.398
Weight change, %[3]	-16.6	-15.2	-15.8	0.60	0.241
d 1 - weaning[2,3]	-2.7	1.7	1.5	3.73	0.562
Weight change, %[2,3]	-0.4	1.1	1.0	0.90	0.362
Sow caliper score					
Entry	14.6	14.7	14.7	0.18	0.889
Weaning	12.5	12.8	12.7	0.19	0.526
Change (entry to wean)	-2.0	-1.8	-2.1	0.21	0.500
Feed disappearance					
Sows, n	170	169	170		
Lactation feed disappearance, lb	261.9[b]	283.5[a]	287.8[a]	6.62	< 0.001
Average daily feed disappearance, lactation, lb	12.4[b]	13.5[a]	13.7[a]	0.37	< 0.001
Total feed disappearance, lb	279.3[b]	302.5[a]	306.3[a]	7.59	< 0.001
Litter performance					
Sows, n	161	158	157		
Total born, n	16.6	16.6	16.8	0.34	0.852
Live born, %	91.3	91.0	90.8	0.66	0.827
Viable born, %	88.8	88.3	88.7	0.65	0.820
Nonviable born, %[5]	2.4	2.7	2.1	0.31	0.380
Stillborn, %	5.7	6.1	6.4	0.51	0.580
Mummified, %	3.0	2.9	2.8	0.34	0.914
Litter size after cross-fostering, n	14.8	14.8	14.8	0.31	0.979
Litter birth weight, lb[4]	46.6	45.9	46.3	0.96	0.754
Pig birth weight, lb[4]	3.1	3.1	3.1	0.08	0.937
Lactation length, d	21.0	20.8	20.8	0.57	0.894
Litter weaning weight, lb[4]	167.6	169.5	171.0	3.08	0.506
Pig weaning weight, lb[4]	13.0	13.0	13.0	0.18	0.995
Litter weight gain, lb[4]	121.0	123.6	124.8	2.96	0.369
Litter average daily gain, lb[4]	5.78	5.94	6.01	0.15	0.182
Litter feed efficiency[4,6]	2.22[b]	2.34[ab]	2.37[a]	0.06	0.027
No. weaned	12.9	13.0	13.2	0.29	0.799
Weaned, %	86.8	88.5	88.9	0.81	0.135
Pre-weaned mortality, %[7]	13.2	11.5	11.1	0.81	0.135

continued

Table 2. The effect of lactation feeder design on sow and litter performance

Feeder Type:	Dry	Wet/dry			
Divider:		Yes	No	SEM	*P* =
Economics, $[8]					
Litter value[4]	117.3	118.6	119.7	2.16	0.506
Total lactation feed cost[4]	46.08[b]	49.92[a]	50.46[a]	1.25	< 0.001
Litter value over lactation feed cost[4]	71.82	70.30	69.59	2.06	0.561
Feed cost per pig weaned[4]	3.63[b]	3.85[s]	3.89[a]	0.095	0.006
Feed cost per lb of litter weight gain[4]	0.39	0.41	0.41	0.010	0.112
Washing time per feeder, s	45.9[a]	40.0[b]	40.3[b]	4.67	0.001
Washing cost per feeder	0.28[a]	0.25[b]	0.25[b]	0.029	0.001
Sow subsequent performance					
Sows, n	157	151	139		
Bred by 7 d, %	73.2	74.3	78.7	6.99	0.524
Bred by 14 d, %	76.1	76.6	81.7	6.76	0.446
Bred by 30 d, %	85.1	85.4	89.0	4.09	0.534

[a,b] Means within a row with different superscripts differ ($P \leq 0.05$)

[1]A total of 557 mixed parity sows (average parity 1.9; PIC 1050) that were bred to PIC 337 boars were used. Sow caliper score was taken between d 109 and 111 of gestation and sows were allotted to treatment based on parity and caliper score.

[2]Day 1 weight estimated as: entry weight – (litter birth weight + estimated weight of conceptus). Conceptus weight estimated using the equation proposed in NRC 2012.

[3]Entry BW was used as a covariate.

[4]Parity category (P1, P2, or P3+) was used as a covariate.

[5]Nonviable pigs consisted of those born with an injury, a deformity, or under 1.5 lb BW.

[6]Litter feed efficiency = Lactation feed disappearance ÷ total litter weight gain.

[7]Pre-weaned mortality, % of litter size = [(dead after cross-fostering) ÷ (litter size at 24 h)] × 100%

[8]Lactation feed cost was $330/ton, and the labor cost for washing was $23/h. Litter value = litter weaning weight × $0.70/lb.

Figure 1. Sow lactation feeders. Dry feeder, wet/dry feeder with divider, and wet/dry feeder without divider (from left to right). All feeders were equipped with the SowMax ad-lib sow feed hopper which has a rod that can be pushed sideways, opening a gap on the sides of the hopper to allow feed to drop.