Published December 8, 2014

Effects of feeding schedule on body condition, aggressiveness, and reproductive failure in group-housed sows[1,2]

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ABSTRACT: A total of 208 sows and 288 gilts (PIC line C29) were used to determine the influence of feeding frequency (2 vs. 6 times/d, floor fed) on performance and welfare measurements on a commercial sow farm. Treatments consisted of feeding similar amounts of feed to each sow (2.5 kg) or gilt (2.05 kg) over 2 (0700 and 1530) or 6 times daily (0700, 0730, 0800, 1530, 1600, and 1630). There were 8 sows or 12 gilts in each pen. Gilts and sows were moved to pens 1 to 4 d after breeding. In sows, there were no differences ($P > 0.10$) in ADG, backfat change, or variation in BW. There was a trend ($P < 0.08$) for sows fed twice daily to farrow more total pigs born, but number born alive or other reproductive performance traits were not different ($P > 0.10$) among treatments. Sows fed 6 times per day had increased vocalization during the morning ($P < 0.07$) and afternoon ($P < 0.01$) feeding periods compared with sows fed twice daily. Sows fed twice daily had more skin ($P < 0.01$) and vulva ($P < 0.04$) lesions as well as a small increase in feet and leg ($P < 0.01$) and hoof ($P < 0.02$) problems. In this commercial facility, the standard management protocol required moving gilts to a different gestation facility on d 42. On d 42, two pens of gilts with similar breeding dates and treatment were combined and moved to another facility with larger pens until farrowing. Gilts fed 6 times daily had a tendency for greater ADG ($P < 0.07$) from d 0 to 42 and a tendency for greater ($P < 0.09$) backfat on d 42. After movement to the larger groups from d 42 to farrowing, ADG was similar ($P > 0.10$) for gilts fed 2 or 6 times daily. Gilts fed twice daily had lower BW variation at d 42 ($P < 0.04$) and tended to at farrowing ($P < 0.10$). In gilts, there were no differences ($P > 0.10$) for reproductive performance, skin and vulva lesions, and feet and leg scores. In conclusion, there were few growth, farrowing, or aggression differences among gilts fed 2 or 6 times daily. This suggests that either feeding method is suitable for group-housed gilts. Among sows, feeding frequency resulted in few growth or farrowing performance differences. Feeding 6 times daily resulted in a small but significant reduction in skin and vulva lesions and structural problem scores while increasing vocalization. Increasing the feeding frequency from 2 to 6 times daily does not appear to have a negative or positive impact on performance or welfare of group-housed gilts and sows.

Key words: feeding frequency, feeding system, gestation, sow, welfare

J. Anim. Sci. 2007. 85:3462–3469
doi:10.2527/jas.2007-0345

INTRODUCTION

In many commercial swine facilities, sows are individually housed in gestation stalls; however, animal welfare concerns may lead to increased usage of group housing. The welfare concerns are evident by ballot measures in Arizona and Florida banning gestation crates and decisions by Smithfield Foods Inc. (Smith, 2007) and Maple Leaf Foods (Arnot and Gauldin, 2007) to replace sow stalls with group housing. Because group housing allows for increased freedom of movement and social interaction, it is perceived to be more welfare-friendly than housing sows in stalls (Trottier and Johnston, 2001). Group housing is also thought to decrease chronic stress experienced by sows (Barnett et al., 1987) and speed the farrowing process (Ferket and Hacker, 1985). The social interactions, however, can also lead to greater aggressive behavior. Dominant sows, high on the social order, consume

[1]Contribution no. 07-267-J of the Kansas Agric. Exp. Sta., Manhattan 66506.
[2]The authors thank the National Pork Board for partial financial support and to Keesecker Agri-business for use of the facilities, animals, and labor.
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Received June 12, 2007.
Accepted August 18, 2007.

more feed than desired at the expense of less dominant sows, which is likely to result in high fear and distress in the less dominant sows (Gonyou, 2001).

The ability to properly feed gestating sows in group housing has been one of the biggest detriments of group housing. Several approaches to feed group housed sows have been attempted, including feeding stalls within a pen, electronic sow feeders, trickle feeding, and ad libitum feeding of high fiber diets (Trottier and Johnston, 2001). A recent approach used on some farms is multiple feedings (5 or 6 meals) spread over the feeding period each day (personal observations). The theory behind multiple feedings is that offering feed more frequently may result in dominant sows eating their allowance and then giving timid sows more opportunity to eat later in the feeding period, resulting in less variation.

Our objective was to determine whether feeding group-housed gestating sows multiple times per day reduces variation in sow BW, backfat thickness, aggressiveness, and feet and leg problems compared with twice daily feeding.

MATERIALS AND METHODS

The experimental protocol was approved by the Kansas State University Institutional Animal Care and Use Committee.

A total of 496 group housed gilts and sows were used to determine the influence of feeding frequency (2 vs. 6 times per day) on performance and welfare measurements. The experiment was conducted on a commercial sow farm in northeast Kansas that typically housed gestating sows and gilts in pens. Sows and gilts were managed differently in the experiment, and thus procedures and data are presented separately.

A total of 208 sows were randomly allotted to treatments (13 pens per treatment) in a balanced incomplete block design. After weaning, sows were moved to a breeding facility. Sows (average of 3 parities) received boar exposure and were housed in crates until detection of estrus, then received AI twice. The following day, 24 to 40 sows were randomly allotted by parity and assigned to a pen (5 × 3 m; 8 sows per pen) with 50% slotted and 50% solid concrete flooring (there was no slope to the solid portion of the floor). Sows were weighed and backfat was measured at the P2 position (6 cm from the midline at the last rib) at the time of allotment and before introduction into the farrowing house. Standard farrowing records (total born, total born alive, number born mummified, and number born stillborn) were recorded by farm personnel.

Two hundred eighty-eight gilts were allotted to treatments at breeding, with 12 replicates (pens) per treatment, in a balanced incomplete block design. Replacement gilts were selected for breeding and transported to a breeding facility. Upon arrival, gilts were housed in groups, with boar exposure until estrus detection. Gilts then received AI twice and then were moved to pens (5 × 3 m, 50% slotted and 50% solid concrete flooring) over approximately 4 d until there were 12 gilts in each pen. Gilts were housed in this facility until d 42 of gestation. At this time, gilts of similar breeding dates and treatment were combined and moved to another facility with larger pens until farrowing. Thus, the 12 replicates per treatment were combined to give 6 replications per treatment after d 42 of gestation. Because of removals and combining of gilts with similar breeding dates, pen size ranged from 17 to 23 gilts per pen. Gilts were weighed and backfat measured at the P2 position at allotment, on d 42, and before farrowing. Each pen in the experiment contained half-solid and half-slatted flooring with a deep pit. Pen partitions (approximately 1 m high) were solid concrete on the 2 sidewalls and rear of the pen, with a gate at the front of the pen. In each pen, there was 1 nipple waterer to allow ad libitum access. Standard farrowing records were recorded by farm personnel.

A grain sorghum-soybean meal-based gestation diet was fed to all sows and gilts, but with 2 or 6 feedings per day (Table 1). Feed drops were set to provide 2.50 kg of feed/sow daily and 2.05 kg of feed/gilt daily. All feed for sows and gilts was dropped onto the solid concrete portion of the floor. Feed drops were sched-

Table 1. Composition of the diet (as-fed basis)

Item, %	
Ingredient	
Sorghum	83.50
Soybean meal (46.5% CP)	13.00
Monocalcium P (21% P)	2.30
Limestone	1.05
Salt	0.50
Trace mineral premix[1]	0.15
Vitamin premix[2]	0.25
Sow add pack[3]	0.25
Total	100.00
Calculated analysis	
ME, kcal/kg	3,256
CP, %	13.50
Total lysine, %	0.60
Total threonine, %	0.55
Total tryptophan, %	0.16
TSAA, %	0.51
Analyzed composition	
CP, %	14.61
Total lysine, %	0.62
Total threonine, %	0.52
Total tryptophan, %	0.17
TSAA, %	0.49

[1]Premix provided potency levels of following nutrients per kilogram: copper at 11 g, iodine at 198 mg, iron at 110 g, manganese at 26 g, selenium at 198 mg, and zinc at 110 g.

[2]Premix provided potency levels of following nutrients per kilogram: vitamin A at 4,400,000 IU, vitamin D at 660,000 IU, vitamin E at 17,600 IU, vitamin K at 1,760 mg, vitamin B_{12} at 15 mg, niacin at 19,800 mg, pantothenic acid at 11,000 mg, and riboflavin at 3,300 mg.

[3]Sow add pack provided potency levels of the following nutrients per kilogram: biotin at 88 mg, folic acid at 660 mg, pyridoxine at 1,980 mg, choline at 220,000 mg, carnitine at 19,800 mg, and chromium at 79 mg.

uled to be twice (0700 and 1530) or 6 times (0700, 0730, 0800, 1530, 1600, and 1630) per day. The time intervals were chosen because Woodworth (2002) determined that blood glucose and insulin peaked at approximately 30 min after consumption of a meal. Therefore, it was hypothesized that if the more dominant sows consumed the first meal, they should have a greater sense of satiety by the time the second and third feeding occurred. Feed drops were set at the beginning of the experiment and adjusted if a sow or gilt was removed from the study. To accommodate the amount of feed needed per day, there were 2 feed drops per sow pen. For the gilts from d 0 to 42, there were 3 feed drops per pen and 5 feed drops per pen from d 42 to farrowing. Feed drops used were the Accu-Drop Feed Dispenser (Automated Production Systems, Assumption, IL). These volumetric feed drops were calibrated at the beginning of and every week during the study to ensure the specific amounts of feed were provided.

Sow and gilt aggressiveness during gestation was determined by visually scoring lesions on the total body and vulva every 14 d. All visual scores were adapted from Zurbrigg (2006). Total body lesion scores on every animal were determined from a scale as follows: 1 = no blemishes to some reddening or calluses, 2 = less than 10 scratches or 5 small cuts, 3 = more than 10 scratches or 5 small cuts, and 4 = most or whole area covered with scratches/wounds with little or no untouched skin. Visual scoring of the vulva was determined from a scale as follows: 1 = no obvious wounds, 2 = slight laceration, 3 = severe lacerations, and 4 = severe laceration and portions of the vulva absent. Structural integrity for sows and gilts was performed by visual scoring of the feet and legs. Visual scores for mobility were determined from a scale as follows: 1 = no lameness observed in front or rear legs, 2 = animals with slight structural or movement problems, or both, and 3 = sows/gilts with severe structural problems and unable to get up or walk. Hoof integrity scores were determined on a scale as follows: 1 = no obvious lesions or cracks, 2 = slight lesions on the foot pad, between toes, or both, and 3 = severe hoof cracking and lesions on the foot pad, between toes, or both. Lesion scores were recorded on d 1 (before mixing) and every 14 d until farrowing.

Behaviors were video recorded for 96 h consecutively between d 50 and 60 of gestation. Sow behavior was observed using the Observer 5.1 behavior program (Noldus, Leesburg, VA), which allowed the duration of behaviors to be averaged for each observation to determine the percentage of time spent conducting each behavior. The analyses of behaviors were averaged over the 24-h behavior observation period. Behavior videos were blocked by time, and 4 of the 13 pens per treatment were randomly selected for observations. The recorded behaviors were adapted from those of Dailey and McGlone (1997) and were drinking, eating, oral-nasal-facial (**ONF**), sitting, standing, lying, and antagonistic (behavior indicative of social conflict). The total active behaviors were calculated by subtracting lying behavior from the sum of all behaviors. Standing behavior was defined as having taken place when the animal adopted an upright position with all legs supporting the body. Lying was defined to involve contact of the body with the ground and the legs not supporting the body. Sitting behavior was defined as when the hindquarter portion of the body was in contact with the ground and support of BW was by the front legs. Feeding behavior was when the pig was standing with its head down on the solid concrete floor. Drinking behavior was defined as when pigs pressed their nose against the nipple waterer. Antagonistic behavior was defined as physical encounters between at least 2 pigs. Oral-nasal-facial behavior was defined as belly-nosing, rubbing, sniffing, or licking of pen mates.

Vocalization of sows around the time of feeding was assumed to be an indicator of social conflict or stress (Grandin, 1998). Vocalization was recorded using an Extech (Waltham, MA) model 407764 data logging sound level meter. The data logger was set to a frequency weighting A mode, which responds like the human ear (boosting and cutting the noise amplitude over the frequency spectrum). The A weighting mode is typically used for environmental measurements, OSHA regulatory testing, law enforcement, and workplace design. The meter was also set to slow mode (meter responding in 500 ms) to monitor a sound source that had a reasonably consistent noise level or to average quickly changing levels. Decibel readings at 1-min intervals were determined by using a sound level meter (Extech, Waltham, MA). The sound meters were placed approximately 0.15 m from the feed drop and 1 m above the feeding area. A directional cone (10 cm high by 8 cm diameter) was attached to the microphone to decrease extraneous noise from adjacent pens. Recordings began 30 min before feed was dropped and continued until 30 min after the last feeding. Vocalization was not measured in gilts due to the combining of pens and movement to another facility on d 42.

Statistical Analysis

Chi-squared analysis was used to determine differences in the proportion of gilts and sows removed from the study. Data were analyzed as a randomized incomplete block design using the MIXED procedure (SAS Inst. Inc., Cary, NC). Blocks were based on breeding time, and pen served as the experimental unit for performance and welfare response criteria. Blocks in the vocalization and behavior observations were based on time of recording. The model included the fixed effect of treatment and the random effect of block.

RESULTS

Feeding frequency did not influence ($P > 0.93$; Table 2) total sow removal or the proportion of sows removed

Table 2. Effect of feeding frequency on removal of gestating gilts and sows[1]

Item	Frequency of feeding per day: 2	6	*P*-value
Reason for sow removal, no.			
Not pregnant	11	17	0.93
Structural problems[2]	4	0	0.07
Total	15	17	0.97
Reason for gilt removal, no.			
Not pregnant	23	19	0.31
Structural problems[2]	0	0	0.99
Total	23	19	0.31

[1]Data were analyzed using χ^2.
[2]Culled for lameness and structural incorrectness.

for reproductive failure (not pregnant). Although relatively few sows were removed for structural problems (n = 4), they were all on the twice daily feeding frequency. This led to a greater ($P = 0.07$) removal rate for structural problems for sows fed twice daily than sows fed 6 times per day. In gilts, there was no influence ($P > 0.31$) of feeding frequency on removal from the study because of reproductive failure or structural problems.

In sows, increasing feeding frequency from 2 to 6 times daily had no effect ($P > 0.32$) on overall BW gain, ADG, and backfat change (Table 3). Initial and final P2 backfat were not different ($P > 0.80$) among sows fed 2 or 6 times daily. Backfat gain (3.3 mm) was similar ($P = 0.96$) for sows on both feeding treatments. Sow BW variation (within pen) increased from the beginning of gestation (CV of 11 and 12%, for sows fed 2 vs. 6 times daily, respectively) to the end of gestation

Table 3. Effect of feeding frequency on performance of gestating sows[1]

Item	Frequency of feeding per day: 2[2]	6[3]	SE	*P*-value[4]
Gestation period				
Initial weight, kg	229	233	5.66	0.67
Final weight, kg	276	276	4.90	0.99
Gain, kg	47	44	2.73	0.36
ADG, kg	0.50	0.46	0.04	0.34
ADFI, kg	2.50	2.50	0.01	0.23
CV of initial weight, %	10.62	12.27	1.09	0.31
CV of final weight, %	14.85	17.22	1.52	0.20
Initial backfat, mm	16.04	15.96	0.32	0.85
Final backfat, mm	19.35	19.32	0.35	0.95
Backfat change, mm	3.30	3.32	0.38	0.96

[1]Each value is the mean of 13 replications (pens) with 8 sows per pen.
[2]Received feed at 0700 and 1530 daily.
[3]Received feed at 0700, 0730, 0800, 1530, 1600, and 1630 daily.
[4]Data were analyzed as a balanced incomplete block design with day on trial as a covariate.

Table 4. Effect of feeding frequency on performance of gestating gilts

Item	Frequency of feeding per day: 2[1]	6[2]	SE	*P*-value[3]
Gestation d 0 to 42[4]				
Initial weight, kg	174	177	2.13	0.31
Final weight, kg	186	191	2.49	0.17
Gain, kg	12	15	1.49	0.12
ADG, kg	0.27	0.36	0.03	0.07
ADFI, kg	2.05	2.05	0.01	0.23
CV of initial weight, %	10.35	10.66	0.84	0.72
CV of final weight, %	10.26	12.48	0.89	0.04
Initial backfat, mm	18.93	19.53	0.37	0.14
Final backfat, mm	18.75	19.72	0.50	0.09
Backfat change, mm	–0.28	0.37	0.48	0.22
Gestation d 42 until farrowing[5]				
Initial weight, kg	188	193	4.07	0.24
Final weight, kg	214	216	4.89	0.62
Gain, kg	26	24	3.50	0.45
ADG, kg	0.47	0.42	0.06	0.53
ADFI, kg	2.05	2.05	0.01	0.23
CV of initial weight, %	10.21	13.47	0.85	0.02
CV of final weight, %	10.39	15.12	2.20	0.10
Initial backfat, mm	18.96	20.12	0.57	0.06
Final backfat, mm	18.01	19.20	0.50	0.04
Backfat change, mm	–0.97	–1.13	0.51	0.76

[1]Received feed at 0700 and 1500 daily.
[2]Received feed at 0700, 0730, 0800, 1530, 1600, and 1630 daily.
[3]Data was analyzed as a balanced incomplete block design with day on trial as a covariate.
[4]Each value is the mean of 12 replications with 12 gilts per pen.
[5]Each value is the mean of 6 replications with 17 to 23 gilts per pen.

(CV of 15 and 17%, respectively), but was not influenced ($P > 0.20$) by treatment.

In gilts, increasing the feeding frequency from twice to 6 times daily did not affect BW gain ($P = 0.12$) from d 0 to 42 of gestation (Table 4). However, there was a trend ($P = 0.07$) for gilts fed 6 times daily to have a greater ADG and therefore gain more weight from d 0 to 42 (12 vs. 15 kg) when compared with gilts fed twice daily. There were no differences ($P = 0.45$) in BW gain from d 42 of gestation until farrowing. Thus, final BW was similar ($P = 0.62$) for the 2 feeding frequencies.

There was no difference ($P = 0.72$) in initial BW variation for gilts; however, d-42 weight variation was greater ($P = 0.04$) for gilts fed 6 times daily. The greater variation may be because of the increase in ADG for gilts fed 6 times daily. A trend ($P = 0.10$) for increased variation at transfer at d 42 was also observed in final BW before farrowing.

From d 0 to 42, gilts fed 6 times daily gained P2 backfat (0.37 mm), whereas gilts fed twice daily lost backfat (0.28 mm), resulting in a 1-mm difference ($P = 0.09$) on d 42. From d 42 to the end of gestation, all gilts lost approximately 1 mm, but the difference observed on d 42 was maintained until the end of the gestation period. Among sows or gilts there was no

Table 5. Effect of feeding frequency on reproductive performance of gestating gilts and sows[1]

Item	Frequency of feeding per day: 2	6	SE	*P*-value
Sow farrowing record				
No. of sows	89	87	—	—
Total number born	14.64	13.58	0.38	0.08
Number born alive	11.98	11.32	0.39	0.26
Stillbirths	1.78	1.64	0.18	0.58
Mummies	0.89	0.62	0.15	0.21
Gilt farrowing record				
No. of gilts	124	121	—	—
Total number born	14.22	14.39	0.39	0.75
Number born alive	11.15	11.37	0.31	0.62
Stillbirths	1.80	1.46	0.16	0.17
Mummies	1.28	1.56	0.27	0.42

[1]Reproductive performance was recorded by farm personnel and accessed via the PigChamp (Ames, IA) database.

Table 6. Effect of feeding frequency on aggressiveness and soundness scores in gestation[1]

Item	Frequency of feeding per day: 2	6	SE	*P*-value
Sows[2]				
Aggressiveness				
Skin[3]	1.51	1.34	0.04	<0.01
Vulva[3]	1.08	1.03	0.02	0.04
Structure				
Feet and leg[4]	1.21	1.12	0.03	<0.01
Hoof[4]	1.05	1.01	0.01	0.02
Gilts				
d 0 to 42[5]				
Aggressiveness				
Skin[3]	1.36	1.37	0.03	0.82
Vulva[3]	1.06	1.06	0.01	0.94
Structure				
Feet and leg[4]	1.03	1.03	0.01	0.75
Hoof[4]	1.01	1.00	0.01	0.24
d 42 to farrowing[6]				
Aggressiveness				
Skin[3]	1.22	1.27	0.04	0.22
Vulva[3]	1.12	1.12	0.01	0.92
Structure				
Feet and leg[4]	1.09	1.11	0.01	0.12
Hoof[4]	1.04	1.04	0.01	0.86

[1]Aggressiveness and structure scores were taken at d 0 and every 14 d thereafter until sows and gilts were moved into the farrowing house. Sows and gilts were scored individually and then an average pen score was calculated.
[2]Each value is the mean of 13 replications (pens) with 8 sows per pen.
[3]Skin and vulva lesion scores ranged on a scale of 1 to 4.
[4]Feet and leg and hoof scores ranged on a scale of 1 to 3.
[5]Each value is the mean of 12 replications with 12 gilts per pen.
[6]Each value is the mean of 6 replications with 17 to 23 gilts per pen.

difference ($P > 0.17$; Table 5) in number of pigs born alive, stillbirths, or mummies when feeding twice or 6 times daily during gestation. However, there was a trend ($P = 0.08$) for sows fed 6 times daily to have more total pigs born than those fed 2 times daily.

In sows, aggressiveness, as determined by visual scores of skin and vulva lesions, was greater ($P < 0.04$) when fed twice daily vs. gestating sows fed 6 times daily (Table 6). Gestating sows fed 6 times daily experienced less ($P < 0.02$) structural problems with feet and legs and hoofs as measured by greater visual scores. It must be noted, however, that all the above scores were low, indicating relatively few skin and vulva lesions or structural problems for either treatment. In gilts there were no differences ($P > 0.12$) observed for skin or vulva lesions or leg and hoof scores during the d 0 to 42 period or from d 42 to farrowing. Increasing the feeding frequency from 2 to 6 times daily increased the time spent standing ($P = 0.02$), feeding ($P = 0.02$), and the overall activity level ($P = 0.07$) of sows (Table 7). Vocalization was greater in the 2-h period around the morning ($P = 0.07$) and afternoon ($P = 0.01$) feeding periods for sows fed 6 times daily vs. sows fed twice daily (Table 8). As demonstrated in Figures 1 and 2, vocalization increased with each feeding and returned to baseline values. Sows fed 6 times daily had 3 distinct vocalization peaks during each feeding period, indicating that they were more active over the feeding period.

DISCUSSION

Because group housing allows sows to exhibit increased social behavior and locomotion, and provides separate lying and dunging areas, it is often cited as being more favorable for the welfare status of the animal (van Putten and van de Burgwal, 1990). However, Kirkden and Pajor (2006) suggested that the increased social contact and space offered by a group pen was not important to previously stall-housed gestating sows. There also are major disadvantages to a group-housed system, such as increased BW variation between sows of different social hierarchy, the high incidence of

Table 7. Effect of feeding frequency on the percentage of time spent conducting each behavior (percentage of time in a 24-h period) for gestating sows[1,2]

Behavior	Frequency of feeding per day: 2	6	SE	*P*-value
Agonistic	0.02	0.02	0.01	0.99
Active	4.43	5.13	0.25	0.07
Oral-nasal-facial	2.53	2.63	0.17	0.65
Lie	95.58	94.88	0.25	0.07
Stand	1.05	1.51	0.09	0.02
Sit	0.55	0.57	0.09	0.84
Drink	0.06	0.07	0.01	0.49
Feed	0.23	0.36	0.03	0.02

[1]Behavior observations were recorded for 4 consecutive days in each treatment.
[2]Active behavior was determined by subtracting lying behavior from the sum of all behaviors.

Table 8. Effect of feeding frequency on decibel level measured over a 2-h period for gestating sows[1]

	Frequency of feeding per day			
Decibel level, dB	2	6	SE	*P*-value
Feeding time				
AM	8,458	8,540	41.4	0.07
PM	8,348	8,906	41.4	0.01

[1]Area under the curve is the sum of the decibel level each min measured over a 2-h sampling period.

lameness, and increase in skin and vulva damage (Task Force Report, 2005). Douglas et al. (1998) stated that feeding regimen strongly influenced indicators of feeding motivation and arousal. The conventional diet in modern North American farms is concentrated in nutrients, and although it is sufficient for good health and performance, it might not fulfill other needs of the sow because the small amount of food is unlikely to give a feeling of satiety (Lawrence et al., 1988). Also, sows normally eat as a group, but the amount of floor space available for feeding often decreases as the number of sows increase in a group setting. When the area of feeding is restricted, pigs tend to eat more quickly (Gonyou and Lou, 1996). This eating behavior may lead to sow frustration and cause an increase of aggressiveness among "boss sows". This dominant status may be advantageous for sows in group housing pens. Brouns and Edwards (1994) reported that sows at the bottom of the hierarchy gained less BW than high ranking group members when fed once a day.

In this study, feeding frequency did not affect ADG, backfat change, or BW variation of group-housed gestating sows. In gilts, feeding 6 times daily tended to increase ADG and backfat from d 0 to 42. In a companion study using finishing pigs as a model, we also observed an increase in ADG with multiple feedings (6 vs. 2 times daily; Schneider, 2007). The increase in ADG may be related to spreading out the nutrient load by increasing the feeding frequency, which has been shown to improve nutrient utilization (Jenkins et al., 1989). The increased backfat was maintained until farrowing, but final BW was similar at the end of gestation. The lack of differences in final BW was not surprising because gilts or sows on their respective treatments were fed the same total quantity of feed each day. The greater feeding frequency (6 times per day) was hypothesized to reduce variation in BW gain; however, this did not occur. The more aggressive "boss" sows were expected to consume a greater portion of feed at the first morning and afternoon feedings and then allow more submissive sows to consume more feed at the second and third feedings. After the initial morning and afternoon meal, sows that consumed feed should have had a spike in blood glucose and insulin (Woodworth, 2002), which should have induced a greater sense of satiety by the time when the second and third feeding occurred.

There were no differences in reproductive performance for sows or gilts fed either treatment except for a trend ($P = 0.08$) for sows fed twice per day to farrow more total number of pigs (but born alive was not different). Feeding frequency was not expected to have a large impact on reproductive performance because increasing the feeding frequency was not thought to dramatically increase stress, which may negatively affect reproductive performance (Norman et al., 1994; Varley and Stedman, 1994).

Sows fed 6 times daily had lower skin and vulva lesion scores and leg/feet and hoof scores than sows

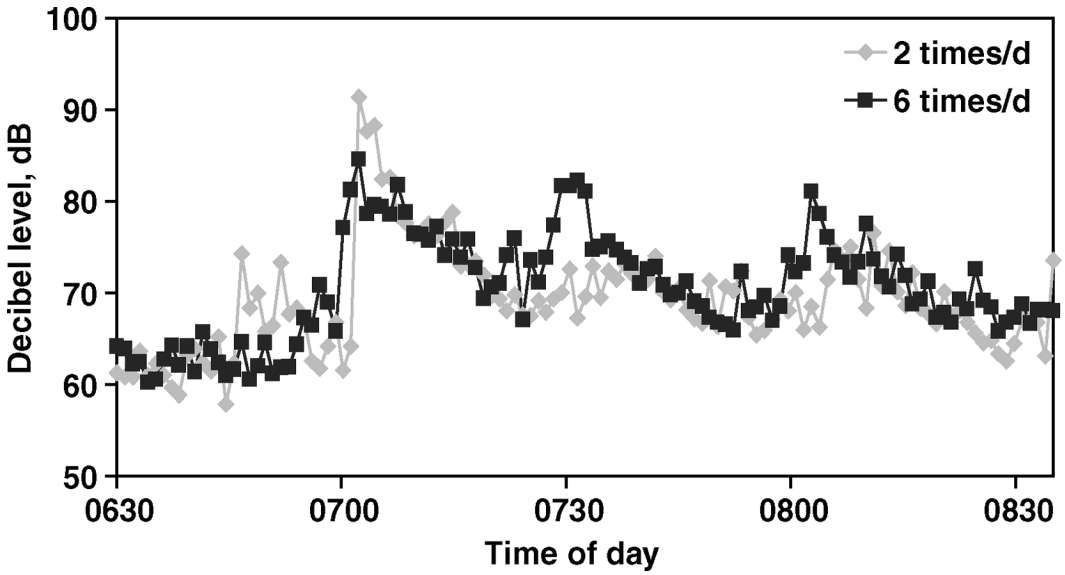

Figure 1. Diagram of the decibel levels measured in a 2-h period over the morning feeding period for gestating sows. Feed drops were scheduled to drop 2 (0700 and 1530) or 6 times per day (0700, 0730, 0800, 1530, 1600, and 1630).

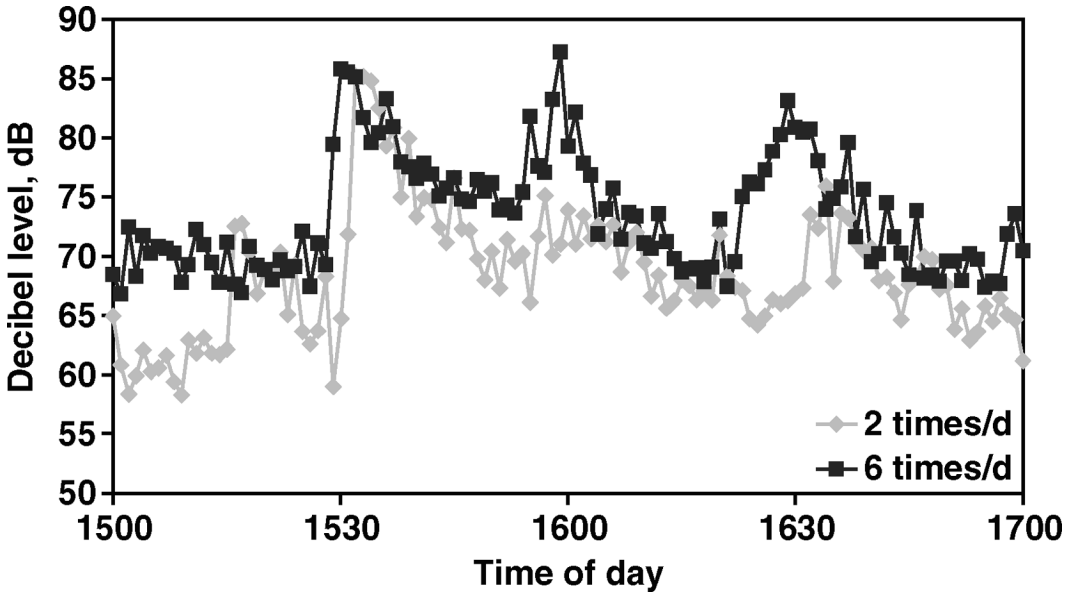

Figure 2. Diagram of the decibel levels measured in a 2-h period over the afternoon feeding period for gestating sows. Feed drops were scheduled to drop 2 (0700 and 1530) or 6 times per day (0700, 0730, 0800, 1530, 1600, and 1630).

fed twice daily; however, there were no differences in gilts. Lower skin and vulva lesions are an indication that fewer fights and subsequent injuries occurred in the sows fed 6 times per day. However, the differences between treatments were relatively small. The low skin and vulva lesion scores are most likely results from the stable pen environment and established social order after mixing (Mendl, 1995). We speculated sows fed 6 times per day were expected to have fewer hoof lesions because there should have been less feed impacted in hooves of sows fed 6 times daily because of the lower amount of feed on the concrete at any one time. Sows fed 6 times per day were more active during the feeding period, as measured by vocalization and video observation vs. sows fed twice per day. The increase in activity level in sows fed 6 times daily was related to the increase in time spent standing and feeding and the reduction in time spent lying. Although the behavior observation data associated with increasing feeding time is limited, Hulbert and McGlone (2006) did not find a difference in any behavior observed in sows when fed from a drop or trickle feeding system. Conversely, Hessel et al. (2006) used a scan sampling method (every 5 min over a 24-h period) of growing pigs and reported an increase in the percentage of time spent feeding when feeding frequency was increased from 3 to 9 meals per day. However, when using a continuous observation method for a 2-h period over the morning feeding period there was no difference in the percentage of time spent feeding. Furthermore, Hessel et al. (2006) explained that continuous observations are more precise than a time sampling methods for a short-term behavior such as feeding. Thus, the welfare criteria demonstrate both positive (lower lesion and structural problem scores in sows) and negative (increased vocalization) responses to increasing the feeding frequency.

Determining the welfare status of gestating sows can be challenging because of complexities between different gestation housing environments and challenges quantifying measures of welfare. A common problem with group housing of gestating sows is a condition commonly known as "boss sow" syndrome. This occurs when dominant sows that are high on the social order consume more feed than desired at the expense of other sows in the group. In this project, we increased the feeding frequency from 2 to 6 times per day and spaced the feedings at a designed interval in an attempt to induce the sense of satiety of the aggressive sows and reduce variation in sow BW gain within each pen. Increasing feeding frequency did not improve overall BW gain, BW variation, reproductive performance, or overall removal rate of group housed gestating sows or gilts. There was a small reduction in skin and vulva lesions and structural scores, but an increase in vocalization for sows fed 6 times daily. Thus, increasing the feeding frequency from 2 to 6 times per day does not appear to have a dramatic negative or positive impact on performance or welfare of group-housed gilts and sows.

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