RESEARCH REPORT
ANIMAL WELFARE

Title: **Investigation into the effects of feeding schedule on body condition, aggressiveness, and reproductive failure in group housed sows NPB #05-060**

Investigator: M. D. Tokach

Institution: Kansas State University

Co-Investigators: J. D. Schneider, S.S. Dritz, R. D. Goodband, J. L. Nelssen, and J. M. DeRouchey

Date Received: July 17, 2006

Abstract

A total of 208 sows and 288 gilts (PIC Line C29) were used to determine the influence of feeding frequency (two versus six times per day) in gestation 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. Treatments consisted of feeding similar amounts of feed to each sow or gilt over two (07:00 and 15:30) or six times per day (07:00, 07:30, 08:00, 15:30, 16:00, and 16:30 hours, respectively). There were 8 sows or 12 gilts in each pen. Gilts and sows were moved to pens after breeding.

In gestating sows, there were no differences ($P > 0.10$) between treatments in ADG, backfat change, or variation in body weight. There was a trend ($P < 0.08$) for sows fed twice a day to farrow more total number born, but number born alive or other reproductive performance were not different ($P > 0.10$) among treatments. Sows fed 6 times a day had increased vocalization during the morning ($P < 0.07$) and afternoon ($P < 0.01$) feeding periods compared with sows fed twice a day; however, sows fed twice a day had more skin ($P < 0.01$) and vulva ($P < 0.04$) lesions as well as a small, but significant, increase in feet/leg ($P < 0.01$) and hoof ($P < 0.02$) problems.

In this commercial facility, their standard management protocol required moving gilts to a different gestation facility. 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. From d 0 to 42, gilts fed six times a day had greater ADG ($P < 0.07$), and d 42 backfat ($P < 0.09$). After movement to the larger groups from d 42 to farrowing, ADG was similar ($P > 0.10$) for gilts fed twice or six times per day. Gilts fed twice a day had lower weight variation at both d 42 ($P < 0.04$) and at farrowing ($P < 0.10$). In gilts, there were no differences ($P > 0.10$) for reproductive performance, skin and vulva lesions, and leg/feet and hoof scores.

In conclusion, there was few growth, farrowing, or aggression differences among gilts fed either two or six times per day. 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 six times per day did result in a small but significant reduction in skin and vulva lesions and structural problem scores while increasing vocalization. Increasing the feeding frequency from two to six times per day does not appear to have a dramatic negative or positive impact on performance or welfare of group housed gilts and sows.

Introduction

In many commercial swine facilities, sows are individually housed in gestation stalls; however, animal welfare concerns and equipment replacement costs may lead to increased usage of group housing strategies during gestation. Because housing sows in groups allows for an increase in freedom of movement and social interaction, it is perceived to be more welfare-friendly than individually housing sows in stalls (Lewis and Southern, 2001). This approach is also thought to decrease chronic stress experienced by sows (Barnett et al., 1987) and speed the farrowing process (Ferket and Hacker, 1985). However, the social interactions between animals also can lead to greater aggressive behavior among sows. The condition commonly known as “boss sow” syndrome 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. Not only does this form of aggression lead to timid sows consuming less feed than desired as they fail to compete with dominant sows, but also it 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 an ongoing challenge for swine producers and is one of the biggest detriments of group housing systems. Several different approaches to feed group housed sows have been attempted, including feeding sows every other day, using feeding stalls within a pen, using electronic sow feeders, trickle feeding, and ad libitum feeding of high fiber diets. A recent approach used on some swine farms is multiple feedings per day, where pens of sows are fed small amounts of feed spread throughout the day (over 5 or 6 meals). The theory behind multiple feedings is that offering feed more frequently may result in dominate sows eating their allowance early in the day and possibly giving timid sows more opportunity to eat later in the day, resulting in less variation. Although this procedure appears to be popular among some producers, we are unaware of any research that validates this concept.

Objective

The objective of this study was to determine whether feeding group-housed gestating sows multiple times per day reduces variation in sow body weight, backfat thickness, aggressiveness, and feet and leg problems compared with twice per day feeding.

Procedures

A total of 496 group-housed gilts and sows were used to determine the influence of feeding frequency (two versus six 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 for them.

A total of 208 sows were randomly allotted to treatments (13 pens/treatment) in a balanced incomplete block design. Average sow parity was 3.9 with a range from parity 2 to 9. After weaning sows were moved to a breeding facility. Sows received boar exposure and were housed in crates until detection of estrus, then inseminated twice. The following day, 24 to 40 sows were randomly allotted by parity and assigned to a pen (16 × 10 ft; 8 sows/pen). Sows were weighed and backfat measured at the P2 position at the time of allotment and before introduction into the farrowing house. Standard farrowing records were recorded by farm personnel.

Two hundred eighty-eight gilts were allotted to treatments at breeding with 12 replicates 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 were then inseminated twice and then were moved to pens (16 × 10 ft) over approximately 4 d until there was 12 gilts 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 where combined to give 6 replications per treatment after d 42 of gestation. Gilts were weighed and backfat measured at the P2 position at allotment, on d 42, and before farrowing. Standard farrowing records were recorded by farm personnel.

A grain sorghum-soybean meal gestation diet was fed to all sows and gilts, but with either 2 or 6 feedings per day. Feed drops were set to provide 5.5 lb of feed per sow per day and 4.5 lb of feed per gilt per day. All feed for sows and gilts was dropped onto the solid concrete portion of the partially slatted floor. Feed drops were scheduled to drop twice (07:00 and 15:30) or six times per day (07:00, 07:30, 08:00, 15:30, 16:00, and 16:30 hours, respectively). Feed drops were set at the beginning of the trial and adjusted if a sow or gilt was removed from the trial. To accommodate the amount of feed needed per day, there were two feed drops per sow pen. For the gilts, there were three feed drops per pen from d 0 to 42 and five feed drops per pen from d 42 to farrowing. Feed drops used in the current trial were the Accu-Drop Feed Dispenser provided by Automated Production Systems (Assumption, IL).

Sow and gilt aggressiveness during gestation period was determined by visually scoring lesions on the total body and vulva. Total body lesion scores were determined from a scale: 1 = no blemishes to some reddening or calluses, 2 = less then 10 scratches or 5 small cuts, 3 = more then 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: 1 = no obvious wounds, 2 = slight laceration, 3 = severe lacerations observed, and 4 = sow with 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: 1 = no lameness observed in front or rear legs, 2 = animals with slight structural and/or movement

problems, and 3 = sows/gilts with severe structural problems and unable to get up or walk. Hoof integrity scores were determined on a scale: 1 = no obvious lesions or cracks, 2 = animals with slight lesions on their foot pad and/or between toes, and 3 = sows with severe hoof cracking and lesions on the foot pad and/or between toes. Lesion scores were recorded on day 1 (before mixing) and every 14 days until farrowing.

Vocalization of sows was recorded using an Extech Model 407764 (Waltham, MA) 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 responds in 500 ms) to monitor a sound source that has a reasonably consistent noise level or to average quickly changing levels. Decibel readings at 1 min intervals are determined by using a sound level meter. The sound meters were placed approximately 0.15 m from the feed drop and 1 m above the feeding area. A directional cone was attached to the microphone to decrease extraneous noise from adjacent pens. Vocalization was not measured in gilts due to the combining of pens and movement to another facility on d 42. Chi-square analysis was used to determine differences in the proportion of gilts and sows removed from the trial. All other data reported was analyzed using the MIXED procedure of SAS (2001).

Results

Feeding frequency did not influence ($P > 0.93$; Table 1) total sow removal or the proportion of sows removed for reproductive failure. Although relatively few sows were removed for structural problems, they were all on the twice per day feeding frequency leading to a higher ($P < 0.07$) removal rate for structural problems for sows fed twice per day than sows fed six times per day. In gilts, there was no influence ($P > 0.31$) of feeding frequency on removal from the trial because of reproductive failure or structural problems.

In sows, increasing feeding frequency from two to six times a day had no effect ($P > 0.10$) on overall gain, ADG, and backfat change (Table 2). Initial and final P2 backfat were not different ($P > 0.10$) among sows fed two or six times a day. Backfat gain (3.3 mm) was similar ($P > 0.10$) for sows on both feeding treatments.

Sow weight variation increased from the beginning of gestation (CV of 10 and 12%, respectively) to the end of gestation (CV of 15 and 17%, respectively), but was not influenced ($P > 0.10$) by treatment.

In gilts, increasing the feeding frequency from twice to six times a day did not affect weight gain from d 0 to 42 of gestation; however, there was a trend ($P < 0.12$; Table 3) for gilts fed six times a day to have a greater ADG and therefore gain more weight from d 0 to 42 (33 vs. 25 lb) when compared with gilts fed twice a day. There were no differences in weight gain from d 42 of gestation until farrowing. Thus, final weight was similar for the two feeding frequencies.

There was no difference ($P > 0.10$) in initial weight variation for gilts; however, d 42 weight variation was greater ($P < 0.04$) for gilts fed six times a day. The increased variation at d 42 was maintained until farrowing with greater variation in final weight ($P < 0.10$) for gilts fed six times per day.

From d 0 to 42, gilts fed six times a day gained P2 backfat (0.37 mm) while gilts fed twice per day lost backfat (0.28 mm) resulting in 1 mm difference ($P < 0.09$) on day 42. From day 42 to the end of gestation, all gilts lost approximately 1 mm, but the difference observed on day 42 was maintained until the end of the gestation period.

Among sows or gilts there were no difference ($P > 0.10$; Table 4) in number born alive, stillbirths, or mummies when feeding either twice or six times a day during gestation. Sows fed twice per day tended ($P > 0.08$) to have higher total born, but this did not result in higher born alive.

In sows, aggressiveness, as determined by visual scores of skin and vulva lesions, was more pronounced ($P < 0.01$ and 0.04, respectively) when fed twice a day versus gestating sows fed six times a day (Table 5). Gestating sows fed six times a day experienced less ($P < 0.01$ and 0.02, respectively) structural problems with feet and legs and hoofs as measured by higher visual scores. It must be noted; however, that all scores were low indicating relatively few structural problems for either treatment. In gilts there were no differences ($P > 0.10$) observed for skin or vulva lesions or leg and hoof scores during the d 0 to 42 period or from d 42 to farrowing. Vocalization was greater in the two hour period around the morning ($P < 0.07$) and afternoon ($P < 0.01$) feeding periods for sows fed six times a day versus sows fed twice a day (Table 6). As demonstrated in Figures 1 and 2, vocalization increased with each feeding and returned to baseline values. Sows fed six times per day had three

distinct vocalization peaks during each feeding period indicating that they were more active over the feeding period.

Discussion

Feeding frequency did not affect ADG, backfat change, or weight variation of group housed gestating sows. In gilts, feeding six times per day tended to increase ADG and backfat from d 0 to 42. The increased backfat was maintained until farrowing, but final weight was similar at the end of gestation. The lack of differences in final weight was not surprising because gilts and sows on both treatments were fed the same total quantity of feed each day. The greater feeding frequency (six times per day) was hypothesized to reduce variation in weight 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, which should have induced a greater sense of satiety by the time when the second and third feeding occurred. In reality, variation in final weight increased numerically in both sows and gilts when feeding frequency was increased suggesting that more aggressive sows may have been able to consume more total feed instead of less.

There were no differences in reproductive performance for sows or gilts fed either treatment; except for a trend for sows fed twice a day to farrow more total number of pigs. Feeding frequency was not expected to have a large impact on reproductive performance.

Sows fed six times per day had lower skin and vulva lesion scores and leg/feet and hoof scores than sows fed twice per day; 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 six times per day; however, the differences between treatments were relatively small. Sows fed six times per day were expected to have fewer hoof lesions because there should have been less impacted feed in hooves of sows fed six times per day because of the lower amount of feed on the concrete at any one time. Sows fed six times a day were more active during the feeding period, as measured by vocalization, versus sows fed twice a day. 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.

Lay Interpretation

Determining the welfare status of gestating sows can be challenging because of the 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 two to six times per day and spaced the feedings at a designed interval in an attempt to induce the sense of satiety of the boss sows and reduce variation in sow weight gain within each pen. Increasing feeding frequency did not improve overall weight gain, weight 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 six times per day. In summary, increasing the feeding frequency from two to six times per day does not appear to have a dramatic negative or positive impact on performance or welfare of group housed gilts and sows.

Contact: Mike Tokach, 246 Weber Hall, Kansas State University, Manhattan, KS 66502; 785-532-2032; mtokach@ksu.edu

References:

Barnett, J. L., P. H. Hemsworth, C. G. Winfield, and V. A. Fahmy. 1987. The effects of pregnancy and parity number on behavioral and physiological responses related to the welfare status of individual and group housed pigs. Appl. Anim. Behav. Sci., 17:229

Ferket, L.L., and R.R. Hacker. 1985. Effect of forced exercise during gestation on reproductive performance of sows. Can. J. Anim. Sci., 65:851

Gonyou, H.W. 2001. Group housing of sows: The potential for the future. Focus on the future conference. Feb. 2001. Alberta, Canada.

Lewis, A.J., and L. L. Southern. 2001. Swine Nutrition (2nd Ed.). CRC Press LLC, New York.

SAS. 2001. SAS User's Guide: Statistics. SAS Inst. Inc., Cary, NC.

Table 1. Effect of Feeding Frequency on Removal of Gestating Gilts and Sows[a]

	Frequency of Feeding per Day		Chi-Square
Item	2	6	P-value (P <)
Reason for sow removal			
Open	11	17	0.93
Structural problems	4	0	0.07
Total	15	17	0.97
Reason for gilt removal			
Open	23	19	0.31
Structural problem	0	0	0.99
Total	23	19	0.31

[a]Data was analyzed as a chi-square.

Table 2. Effect of Feeding Frequency on Performance of Gestating Sows[a]

	Frequency of Feeding per Day[bcd]			
Item	2	6	SE	P-value (P <)
Gestation period				
Initial weight, lb	504	512	12.28	0.66
Final weight, lb	602	600	10.72	0.90
Gain, lb	98	88	6.96	0.32
ADG, lb	1.03	0.93	0.07	0.30
ADFI, lb	5.50	5.50	0.01	0.22
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

[a]Each value is the mean of 13 replications with 8 sows per pen.
[b]Data was analyzed as a balanced incomplete block design with days on trial as a covariate.
[c]Pens that were fed twice daily received feed at 07:00 and 15:30 hours; Pens that were fed six times a day received feed at 07:00, 07:30, 08:00, 15:30, 16:00, and 16:30 hours, respectively.
[d]Feed drops were adjusted if sow was removed from trial.

Table 3. Effect of Feeding Frequency on Performance of Gestating Gilts[ab]

Item	Frequency of Feeding per Day[cde] 2	6	SE	P-value (P <)
Gestation d 0 to 42				
Initial weight, lb	382	389	4.70	0.31
Final weight, lb	409	421	5.48	0.17
Gain, lb	25	33	3.28	0.12
ADG, lb	0.60	0.79	0.07	0.07
ADFI, lb	4.50	4.50	0.01	0.23
CV of initial weight, %	10.35	10.66	0.63	0.72
CV of final weight, %	10.26	12.48	0.65	0.04
Initial backfat, mm	18.93	19.53	0.28	0.14
Final backfat, mm	18.75	19.72	0.45	0.09
Backfat change, mm	-0.28	0.37	0.40	0.22
Gestation d 42 until farrowing				
Initial weight, lb	415	427	5.91	0.12
Final weight, lb	473	473	10.09	0.95
Gain, lb	58	49	8.79	0.35
ADG, lb	1.01	0.85	0.16	0.39
ADFI, lb	4.50	4.50	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	18.93	20.07	0.67	0.17
Final backfat, mm	18.02	19.07	0.54	0.13
Backfat change, mm	-0.93	-1.05	0.59	0.85

[a]Gestation d 0 to 42, each value is the mean of 12 replications with 12 gilts per pen.
[b]Gestation d 42 until farrowing, each value is the mean of 6 replications with 17 to 23 gilts per pen.
[c]Data was analyzed as a balanced incomplete block design with days on trial as a covariate.
[d]Pens that were fed twice daily received feed at 07:00 and 15:00 hours; Pens that were fed six times a day received feed at 07:00, 07:30, 08:00, 15:30, 16:00, and 16:30 hours, respectively.
[e]Feed drops were adjusted if gilt was removed from trial.

Table 4. Effect of Feeding Frequency on Reproductive Performance of Gestating Gilts and Sows

	Frequency of Feeding per Day			
Item	2	6	SE	P-value (P <)
Sow Farrowing Record				
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				
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

Table 5. Effect of Feeding Frequency on Aggressiveness and Soundness Scores of Gestation Gilts and Sows

	Frequency of Feeding per Day			
Item	2	6	SE	P-value (P <)
Sows				
Aggressiveness				
Skin	1.51	1.34	0.04	0.01
Vulva	1.08	1.03	0.02	0.04
Structure				
Feet/Leg	1.21	1.12	0.03	0.01
Hoof	1.05	1.01	0.01	0.02
Gilts d 0 to 42				
Aggressiveness				
Skin	1.36	1.37	0.03	0.82
Vulva	1.06	1.06	0.01	0.94
Structure				
Feet/Leg	1.03	1.03	0.01	0.75
Hoof	1.01	1.00	0.01	0.24
Gilts d 42 to farrowing				
Aggressiveness				
Skin	1.22	1.27	0.04	0.22
Vulva	1.12	1.12	0.01	0.92
Structure				
Feet/Leg	1.09	1.11	0.01	0.12
Hoof	1.04	1.04	0.01	0.86

Table 6. Effect of Feeding Frequency on Area under the curve[a]

	Frequency of Feeding per Day			
Item	2	6	SE	P-value (P <)
Feeding Time				
AM	8,458	8,540	41.4	0.07
PM	8,348	8,906	41.4	0.01

[a]Area under the curve is the sum of the decibel level measured over a two hour sampling period.

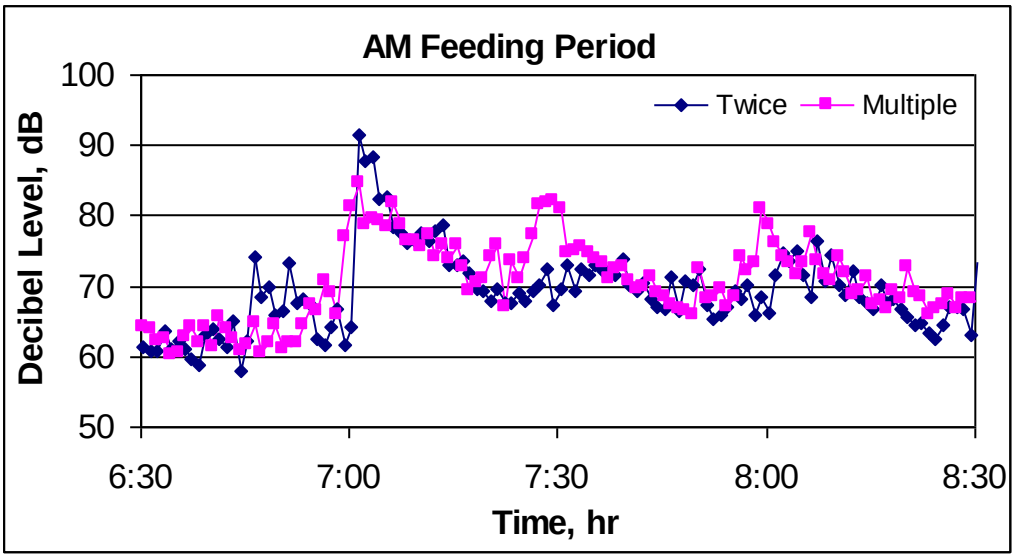

Figure 1. Area under the curve measured in a two hour period over the morning feeding period. Area under the curve is calculated as the sum of the peak decibel level.

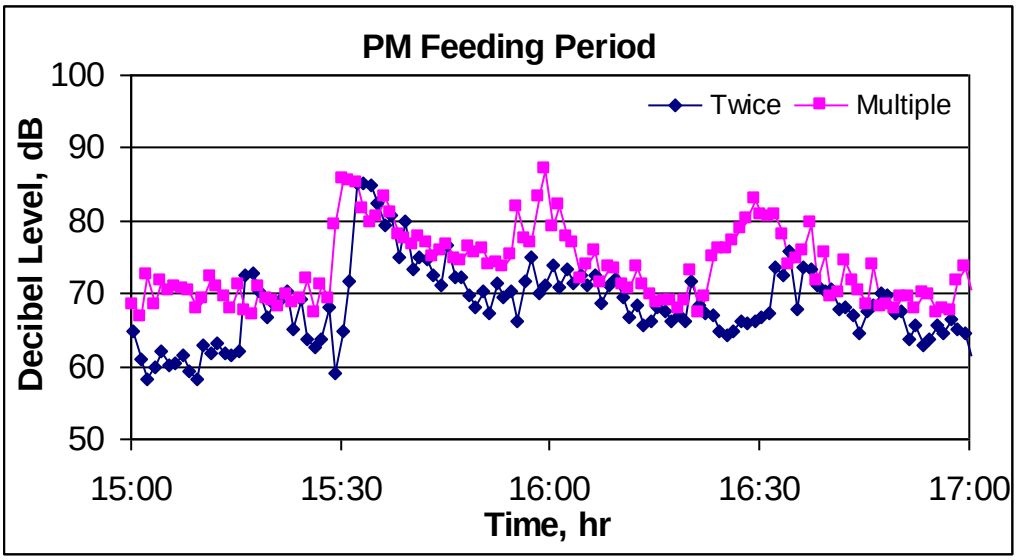

Figure 2. Area under the curve measured in a two hour period over the afternoon feeding period. Area under the curve is calculated as the sum of the peak decibel level.