RESEARCHREPORT
ANIMAL WELFARE

Title: Effect of Timing of grouping of sows during early gestation on welfare and performance of sows and group pens with electronic sow feeders – **NPB #08-154** REVISED

Investigator: John Deen

Institution: University of Minnesota

Date Submitted: July 16, 2010

Lay Interpretation

This study proposed to look into the effect of the timing of mixing of sows in large groups during early gestation on sow performance by looking at three treatments of five, 19 and 33 days post-breeding. Differences were seen shortly after mixing in the amount of injuries and cortisol levels. There was a tendency to see decreased fertility rates with lower times in the stalls before entry into pens. With early mixing there appears to be increased amounts of aggression. The study supports European guidelines of utilizing gestation stalls until after implantation before introduction of sows into pens. It has an added benefit in that sows that are found to be not pregnant are often identified before the creation of a cohort in gestation pens, thus increasing the utilization of facilities, and decreasing the likelihood of subsequent mixing events.

Key Words: sow housing, mixing, aggression, implantation, electronic-sow feeders

Introduction

The primary source for social stress in group-housed sows is the interaction with other sows. Different factors such as group size, space allowance, social hierarchy and resource-availability may influence the interaction between sows in a group that causes social stress. In many breeding herds, sows are grouped following breeding. Mixing/regrouping of unfamiliar pigs is often followed by aggression to establish social hierarchy (de Groot et al., 2001). Social stress has been reported to adversely affect immunocompetence, growth and reproductive performance (von Borell, 1994). The aggressive interactions consequent mixing of unfamiliar sows lead to severe injuries and may adversely affect sow longevity (Anil., et al., 2005).

Ekkel et al., (1995) showed that health, welfare, and production performance of pigs were improved when pigs were housed without regrouping. It has been suggested that the adverse effects of stress on reproduction are pronounced during estrus cycle and in early pregnancy, especially during implantation (Moberg, 1985). The stress during implantation stage (12 to 24 d after breeding) and early embryonic development is suggested to lower conception rate and litter size in group housed sows (Safranski, 2003). Cortisol is considered as the mediator of the effect of stress on reproduction (Turner et al., 2002). There are also indications that corticotrophin releasing factor and arginine vasopressin may suppress the secretion of lutenizing hormone by central mechanisms in the brain without the involvement of cortisol (Tilbrook et al., 2002). Arey and Edwards (1998) reported a lower litter size for sows mixed at weaning compared to sows grouped 4 wk post-weaning (11.8 vs. 12.4).

Anil et al., (2003) reported no difference in terms of farrowing rate among the sows bred and maintained in stalls for 28 d and then transferred to pens with electronic sow feeder (ESF) for the rest of gestation compared to sows bred and reared in pens with ESF. Olsson and Svendsen (1997) reported lower farrowingrates in sows regrouped every third week during pregnancy than sows not regrouped. Similarly, te Brake and Bressers (1990) reported that sows mixed at 17 days (approx. 10 days after first service) had a higher return rate and lower litter size than those moved after 10 days or 31days (4 vs. 11 vs. 3% and 10.8 vs. 10.5 vs. 11.4 for days 10, 17 and 31 respectively).

However, a recent review of experimental studies (Turner et al., 2005) proposed that reproduction in female pigs is resistant to the effects of acute or repeated acute stress or acute or repeated acute elevation of cortisol. Turner et al., (2002) suggest that stress needs to be severe and prolonged to affect reproduction. This has been supported by Kongsted (2006) who found no convincing relationship between reproductive performance and indicators of social stress and fear in sows. However, the author has cautioned that the finding does not exclude such a possibility altogether and that the lack of relationship could be due to the inefficiency of the applied indicators to express variation in levels of social stress.

It is likely that the negative effects of regrouping on reproduction are dependent on the presence of concurrent stressors (Soede et al., 2006). Tsuma et al., (1996) reported no effect on embryo survival in sows mixed at 11 d of pregnancy compared to unmixed sows. Van Wettere et al., (2008) reported that mixing gilts in small group of 6 animals during pre-implantation period (first 10 d of gestation) does not affect embryo development or survival up to 26 d of gestation. However, this study did not measure compromise in welfare in terms of behavioral and physiological indicators or the effect of grouping during implantation period. Soede et al., (2007) demonstrated no detrimental effects on reproductive performance in stall-housed gilts when exposed to acute stressors such as mixing for half an hour, avoiding visual/physical contact in stalls, nose slinging for 5 min and unpredictable feeding events during days 3, 4, 9, 10 and 14 of gestation. Soede et al., (2006) reported that weekly regrouping of gilts in groups of 4 for 6 weeks, starting 15 d before insemination did not impair reproductive performance in terms of pregnancy rate, ovulation rate and embryo survival compared to stable groups. Cassar et al., (2008) reported no significant effect on farrowing rate or subsequent litter size when 15 sows in different stages of gestation (2, 7, 14, 21 and 28 d) were grouped together. However, this study also did not quantify the behavioral and physiological indicators of stress at the time of grouping.

Mixing/grouping is unavoidable to make efficient use of the available resources in commercial herds. Further, the shift in swine housing systems in the US from stalls to group pens also

warrants detailed exploration of this issue to provide valid recommendations to the producers on the timing of grouping to minimize the adverse effect of stress on performance of sows.

Although previous studies have addressed the effect of stress on performance of sows it is not clear whether it is the timing, duration, intensity or type of stress that is crucial in determining the embryo survivability. The cause of any possible effect on sow reproductive performance may be mediated through aggression and consequent stress. Nevertheless, many previous studies have failed to explore the link between a compromise in welfare in terms of physiological and behavioral indicators and reproductive performance. Further, most of the previous studies have focused on small groups of sows which unrepresentative of the current industry methods. Similarly, the effect of stages of gestation at mixing on reproductive performance, although explored in many studies, is yet to be clarified with certainty. Therefore, it is important to understand the extent of compromise in welfare due to mixing/grouping during early gestation (peri-implantation period) that affects the process of implantation and subsequent reproductive performance of the sows.

Objective

- To analyze the effect of mixing of sows during early gestation (peri-implantation stages) on reproductive performance due to welfare compromise consequent to mixing.

Materials and Methods

In this study group size, space allowance and pen designs were same for all grouping treatments. This study was conducted at a 1200 sow unit in southern Minnesota, involving 225 sows of mixed parity, allocated to 3 treatments representing 3 peri-implantation stages (a mean of 5, 19 and 33 d post breeding, housed in stalls till that point), and representing time points before, during and after the implantation period. A biweekly weaning system is followed in the unit. The study used 5 pens and thus 5 replicates, with a new replicate created every 2 weeks. Each pen had fully slatted floors with an ESF and 3 watering bowls per pen. Removals from pens were not replaced.

Each pen had 13 to 18 sows from each of the treatments simultaneously mixed together in a pen for the rest of their gestation after that time period until removal to the farrowing crate. Data on welfare indicators (behavior, injury rates and location, lameness and salivary cortisol, body condition and incidence of mortality) and performance variables (farrowing rate, conception rate 45 days after AI, litter size at birth, litter weight at birth, number of mummies and stillborn, piglet sex ratio, preweaning mortality, litter weaning weight, and farrowing interventions such as induction and assistance) were collected.

Details on the Measurements:

A. Extent of effects on welfare were measured in terms of

1. Behavior: A time-lapse video recording facility with time-code generator were employed to record the behavior of pigs. Five sows from each treatment were randomly selected in each replication (total 75 sows) and behavior of these sows were recorded using a time-lapse video recorder for 24h. Behavior was assessed on day of introduction and one week after mixing. The recordings were analyzed for agonistic behaviors and non-agonistic social behaviors, their frequency and duration using the software The Observer.

2. Salivary cortisol: saliva samples (from sows selected for behavior observation) were collected on the day before mixing when they are in stalls, one day after mixing when they are in pens and one week after mixing. Saliva samples were collected using a salivette with cotton wool swab (SARSTEDT, Aktiengesellschaft and Co, Numbrecht, Germany). Sows were allowed to chew the cotton wool swab clipped to a flexible thin metal rod until the swab was thoroughly moistened. Care was taken to keep the sows minimally disturbed to avoid activity during the process of saliva collection and the saliva samples were collected between 10-11am on all collection days. The Salivette with moistened cotton swabs were centrifuged at 2000 rpm for five minutes to extract the saliva and kept frozen at -20^0C until radioimmunoassay. Approximately 0.5 ml saliva was obtained from each swab. The solid phase cortisol radioimmunoassy kit, (Coat-A-Count TKCO, Diagnostic Products Corporation, Los Angels, U.S.A) was modified[7] to measure cortisol concentrations in saliva.

3. Injury levels of all sows were recorded (De Koning, 1984; Hodgkiss et al., 1998) one week post mixing. The injury scores were based on frequency and severity of wound on different body locations (ranging from 0 to 3; no injury, mild, obvious and severe respectively) and the scores were added together to get the total injury scores (TIS). The same individual did injury scoring at all instances.

4. Sows were weighed and backfat measurements were taken on the day of weaning and on 109 d of gestation.

B. Reproductive performance

Data on performance variables including farrowing rate, conception rate 45 days after breeding, litter size at birth, litter weight at birth, number of mummies and stillborn, piglet sex ratio, preweaning mortality, litter weaning weight, wean to service interval and farrowing interventions (induction, assistance) were collected from the PigCHAMP database of the unit.

Data analysis: Treatments were compared using parametric (one way ANOVA) and non-parametric (Kruskal-wallis one way ANOVA) methods for welfare indicators and production performance. The association between welfare indicators and production performance were analyzed using correlation analyses (Pearson or Spearman rank correlation depending on the type of data) and mixed model procedures. All analyses were performed using SAS software.

Results and Discussion

In all analyses the sow was the unit of analysis. Behavior and injury levels for the sows at 5, 19 and 33 days post-breeding (DPB) were compared and the assessments are as follows.

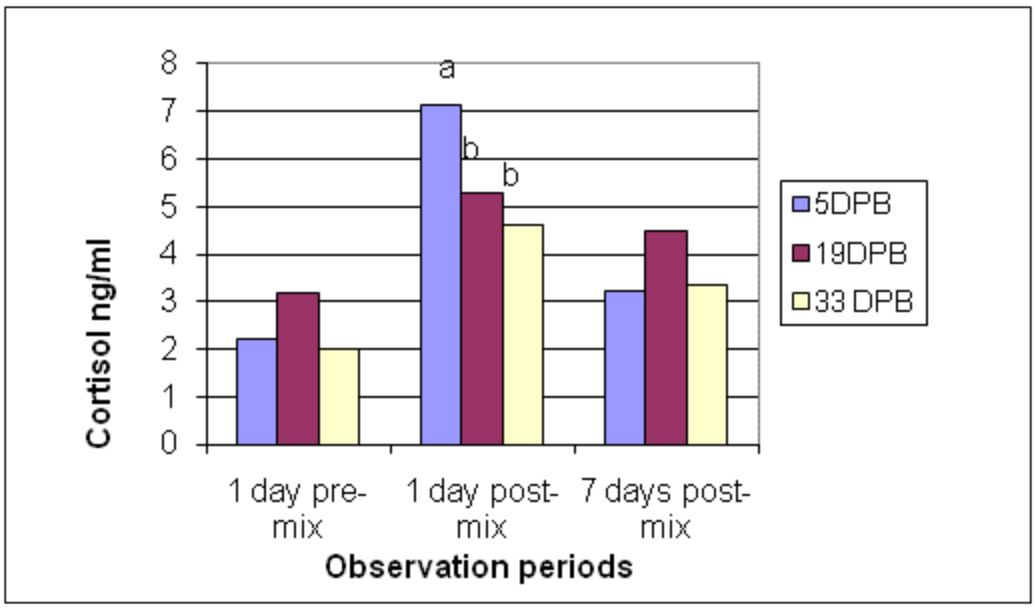

Figure 1: Mean cortisol levels among sows at different observation time points Values with different superscripts differ significantly in their means ($P<0.05$)

Figure 1 shows the results of the cortisol analysis. As can be seen, there was a significant increase in cortisol for sows that were mixed five days post-breeding, immediately after entry into the pen, though these differences were not seen one week later. No parallel difference was seen at seven days. For all sows there was an increase in cortisol levels after removal from the gestation stalls. This parallels work done by Anil et al (2008) that exhibited a distinct increase in cortisol after mixing. It does suggest a protective mechanism through the maintenance of sows in gestation stalls for some time after mating.

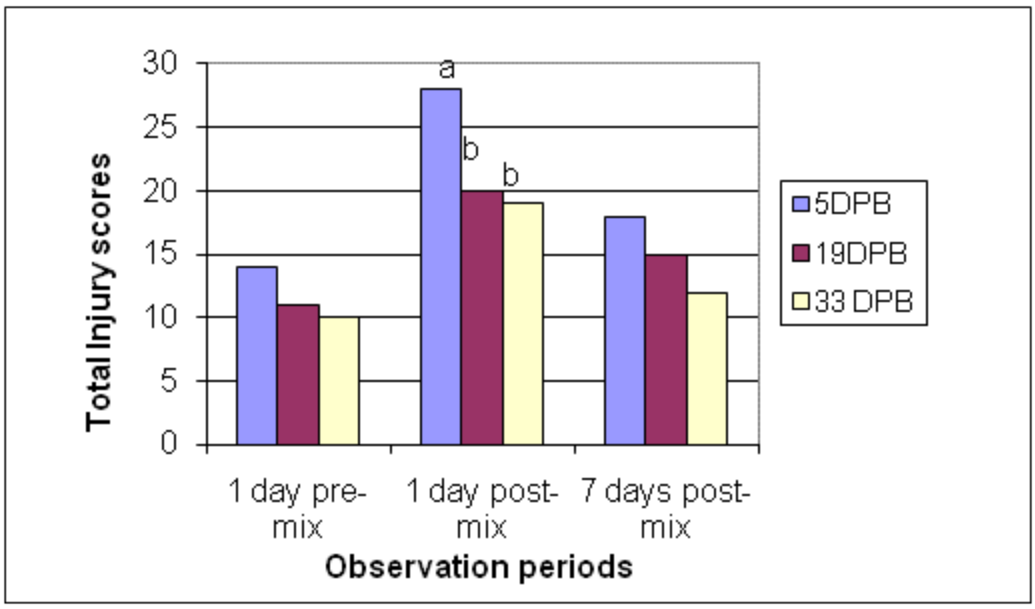

Figure 2: Mean total injury scores among sows at different observation time points. Values with different superscripts differ significantly in their means ($P<0.05$)

The injury scores, as shown in Figure 2 parallel the differences seen in the cortisol levels. Agonistic behavior is assumed to be the major cause of the injuries, and the locations of these injuries reflect this assumption. Most of the injuries are seen on the shoulders of the sows, as well as the hams.

Figure 3 reflects this assumption as well. Total lying behavior was lowest in the five days post-breeding group and highest in the 33 days post-breeding. There was a great deal of activity initially during mixing, and that level was decreased somewhat at seven days, though there still appear to be a nonsignificant trend in lower levels of lying behavior for shorter days post-breeding. This may lead to more aggression, but it also brings into question concerns about the energy expenditures required with such a level of activity.

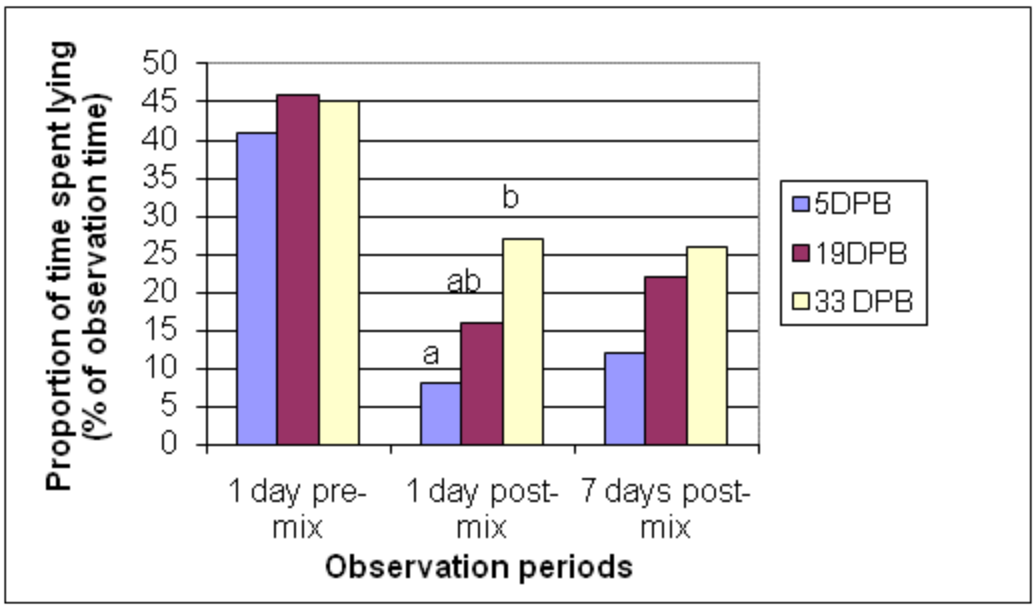

Figure 3: Proportion of lying behavior among sows at different observation time points. Values with different superscripts differ significantly in their means ($P<0.05$)

We did not see significant differences in other behavioral measures, except for the inverse of lying' though there was a trend towards higher numbers of agonistic events in the 5DPB sows, 15 vs a mean of 7 for the others. However there was very high variation in these behaviors between styles. As in previous studies, much of these aggressive behaviors were actually seen at the entry to the ESF and competition for resources appears to be one of the major drivers.

No differences were seen in mortality rates, as there was no mortality during the study. Additionally no difference was seen in lameness rates between the treatments. Likewise differences were not found in body weights, nor condition scores.

When we looked at productivity measures, we did not find significant differences, though we did see a tendency towards increases in conception rates and farrowing rates. For conception rates (5dpb=88%, 19dpb= 89%, 33dpb= 91%, p=.09), nor the farrowing rates (5dpb=83%, 19dpb= 86%, 33dpb= 92%, p=.06), the results demand further study. It should be pointed out as well that removals from the gestation pens were much lower for the 33 DPB sows as the sows were removed

in many cases pre mixing, allowing for better space utilization. It should be emphasized that in this study opens sows were not replaced thus decreasing that utilization of the pen space. If, in fact, the space needs to be used, this will increase the amount of aggression seen in the pens.
No significant differences or trends were seen in other variables, of particular note was the fact that we did not see a difference in litter size, though it has been previously reported.

It appears that the major factors associated with the causation of stress and injuries in the groups studied was the aggression consequent to mixing. It has been suggested that unfamiliar animals and amount and distribution of resources can influence dominance aggression, competitive aggression and defensive or protective aggression in pigs. The comparison of cortisol and injury levels at different time points regardless of the treatment suggests that mixing was a major stress factor.

We have seen the high levels of aggression during the first 24 h after grouping in dynamic group of pregnant sows similar to that observed in the present study. Aggression during mixing has been reported to increase cortisol in pigs. In the present study the cortisol level, regardless of the grouping treatment, was higher following mixing, and may be reflective of some of the negative effects of pen systems.

Injuries in group systems are produced by aggression. An aggression sufficient to cause injuries is likely to have elicited cortisol release. Aggressions occurring at the time of mixing are generally severe as it is part of the effort to establish a hierarchy. The intensity and number of such aggressive interactions were more in the sows with lower days post-breeding. The positive correlations between cortisol concentrations and TIS in these sows support this.

References

Arey D, Edwards SA. Factors influencing aggression between sows after mixing and the consequences for welfare and production. *Livest Prod Sci* 1998;56: 61-70.

Cassar G, Kirkwood RN, Seguin MJ, et al. Influence of stage of gestation at grouping and presence of boars on farrowing rate and litter size of group-housed sows. *J Swine Health Prod* 2008;16:81-85.

de Groot J, Ruis MAW, Scholten JW, et al. Long-term effects of social stress on antiviral immunity in pigs. *Physiology & Behavior* 2001;73:145-158.

De Koning R. Injuries in confined sows: Incidence and relation with behaviour. *Ann RechVet*1984; 15:205-214.

Ekkel ED, van Doorn CEA, Hessing MJC, et al. The Specific-Stress-Free housing system has positive effects on productivity, health, and welfare of pigs. *J Anim Sci* 1995;73:544-1551.

Hodgkiss NJ, Eddison, JC, Brooks PH, et al. Assessment of the injuries sustained by pregnant sows housed in groups using electronic feeders. *Vet Rec*1998;143:604-607.

Kongsted AG. Relation between reproduction performance and indicators of feed intake, fear and social stress in commercial herds with group-housed non-lactating sows. *Livest Sci* 2006;101:46-56.

Moberg GP. Influence of stress on reproduction: measure of well-being. In: Moberg, G.P. (Ed.), *Animal Stress*. American Physiological Society, Bethesda, Maryland, 1985;pp.245-267.

Olsson AC, Svendsen J. The importance of familiarity when grouping gilts, and the effect of frequent grouping during gestation. *Swed J Agric Res*1997;27:33-43.

Safranski T. Comfortable sows make more pigs. http://www.thepigsite.com/FeaturedArticle/Default.asp?AREA=Reproduction&Display=157. Accessed on May 24, 2003.

Soede NM, Roelofs JB, Verheijen RJE, et al. Effect of Repeated Stress Treatments During the Follicular Phase and Early Pregnancy on Reproductive Performance of Gilts. *Reprod Dom Anim* 2007;42: 35-142.

Soede NM, van Sleuwen MJW, Molenaar R, et al. Influence of repeated regrouping on reproduction in gilts. *Animl Reprod Sci* 2006;96:133-145.

te Brake JHA, Bressers HPM. Applications in service management and oestrus detection. In: *Electronic identification in pig production:Proceedings of an international symposium*,RASE, Stoneleigh,1990;pp.63-67.

Tilbrook AJ, Turner AI, Clarke IJ. Stress and reproduction: central mechanisms and sex differences in non-rodent species. *Stress* 2002;5:83-100.

Tsuma VT, Einarsson S, Madej A, et al. Endocrine changes during group housing of primiparous sows in early pregnancy. *Acta Vet Scandi* 1996;37: 481-490.

Turner AI, Hemsworth PH, Tilbrook AJ. Susceptibility of reproduction in female pigs to impairment by stress and the role of the hypothalamo-pituitary axis. *Reprod Fertil Deve* 2002;14:377-391.

Turner AI, Hemsworth PH, Tilbrook AJ. Susceptibility of reproduction in female pigs to impairment by stress or elevation of cortisol. *Domest Anim Endocrinol* 2005;29:398-410.

von Borell E. Neuroendocrine integration of stress and significance of stress for the performance of farm animals. In: *Proceedings of the 28th International Congress of the International Society for Applied Ethology*, Research Centre Foulum, Denmark,1994;pp. 23-28.

van Wettere WHEJ, Pain SJ, Stott PG, et al. Mixing gilts in early pregnancy does not affect embryo survival. *Anim Reprod Sci* 2008;104:382-388.