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Effect of day of mixing gestating sows on reproductive fertility and animal well-being

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Introduction

Public concern about the welfare of keeping sows in stalls has given rise to both legislative and consumer pressure to increase the use of group housing systems. At this time the US states of Florida, Arizona, Oregon, Colorado, California, Maine have begun the ten-year phase-outs of all intensive confinement systems including swine gestation stalls. Currently, an estimated 60-70% of breeding sows in the US are housed in gestation stalls[1] and with most of the 5.8 million sows in the US breeding herd located in the remaining pork production States, the impact of any move from stalls to group housing will have large ramifications for reproductive performance, management and animal welfare. The concern about housing sows in stalls involves compromised animal welfare from limited behavioral expression, restriction of movement, feet and leg problems, and limited social interaction.[2,3] However, group housing itself may also result in reduced animal welfare that arises from increased social confrontations, social stress, and competition for space and feed. In group housing, factors that can impact the welfare and interaction of sows include the size of the group, available pig space, pen design, social hierarchy, size of the animal, management of resources such as food and water, and the mixing of unfamiliar sows in either static or dynamic systems.[4]

From a producer standpoint, profitability of the breeding herd depends upon the ability of management to maximize pigs produced per sow/year.[5] However, there has been considerable concern regarding improper time for mixing sows with regard to critical events in the process of pregnancy establishment and litter size. The largest concern with loose housing comes from the stress associated with mixing in early gestation. It is a common belief that mixing animals during time of implantation should be avoided, but the data is inconsistent. Reproductive failure has been reported in sows that have been mixed and maintained in groups from the time of weaning in comparison to those sows kept in stalls.[6] Also, it has been reported that exposing sows to stressors at breeding,[7] and the stress from mixing sows before or after the time of embryo implantation[8] results in reproductive failure. Moreover, other studies have shown that productivity of sows in stalls is better when compared with those mixed and housed in groups.[9] Data comparing pens versus stalls supply evidence that reproductive problems in group housing most likely occur in early gestation while problems that occur as a result of stall housing occur later in gestation and most often appear in the form of lameness.[10] Yet other reliable sources of research report no such effects on reproduction in females that are mixed before estrus,[11] within the first 10 days of gestation, or even up to 28 days following breeding.[12-14] The discrepancy in whether reproductive failure is observed or not may be related to the nature of the aggressive behavior and the stress that results from group size, pen design, day or time of mixing, parity or animal size discrepancies, season, group dynamics, and feed intake and feeding system.[8,15]

The critical question that must be addressed is whether the gestation stall is necessary for a period of time during gestation to minimize reproductive losses as well as for improving the well-being and longevity of the sow. It is essential to obtain scientifically-sound data as to the appropriate time a producer should mix sows following breeding, without compromising reproductive performance, and animal well-being. This management information is extremely important for pork producers to determine the individual components that are essential in a group housing scheme that will not only improve the well being of the sow but contribute to the sustainability of pork production. This information has significant economic relevance since it will affect facility design, construction, management and animal flow for holding and mixing sows following breeding. If mixing bred females on specific days causes increased reproductive failure and reduced well-being and can be substantiated in commercial operations, then this information will be important to the industry for lobbying for the need for the stall, and for aiding producers in decision making for animal flow, group management, animal production, and animal well-being. If however, reproductive failure or differences in well-being are not evident, then producers will have increased flexibility to design structures without the need for holding each wean group for up to 30 days in gestation stalls before mixing into groups. Therefore we designed a study to test our hypothesis that mixing sows within specific days of gestation will reduce the reproductive performance and measures of animal welfare.

Interface

Methodology

This experiment was performed on a 6,000 sow, commercial farrow-to wean facility located in western Illinois during the summer months. The facility consisted of 84 pens (18 ft. × 58 ft) with fully slatted floors and an electronic sow feeder in each pen. The facility also maintained standard (23 × 84 in.) gestation stalls over slatted floors with drop feeders and a trough watering system. All sows were provided space in excess of recommendations. The facility was curtain sided and environmentally regulated by an evaporative cooling system. Supplemental lighting was provided for 10 h a day starting at 0600 h and ending at 1600 h.

The institutional animal care and use committee of the University of Illinois at Urbana-Champaign approved the use of animals for this study. The assignment to treatment occurred during the summer months of June-August 2010. Sows assigned to treatment (n = 1435) were of mixed parity (2-6) and were PIC C-22 and C-29 genetics. Sows were farrowed in individual crates in a single room and were weaned following a 19-21 day lactation. Groups of sows (n = 58) were weaned on Monday-Saturday each week and placed into individual stalls for detection of estrus and breeding. Sows were checked for estrus twice daily in the AM and the PM using fenceline exposure to a mature boar. Sows were inseminated twice at 24 h intervals using extended swine semen containing ~3.0×10^9 sperm/dose. At onset of estrus, sows were randomly assigned to one of four treatment groups (Table1): 1) sows maintained in stalls from weaning through the remainder of gestation (Stall, n = 20/replicate); 2) sows housed in stalls after weaning and then mixed in groups of 58 immediately after breeding (D 3 Mix); 3) sows housed in stalls after weaning and mixed in groups of 58 at day 14 of gestation (D 14 Mix), and 4) sows housed in stalls from weaning until after d 35 of gestation and then mixed in groups of 58 (D 35-Mix). Due to initial concerns about reproductive failure with one of the treatments, the study started by using full replicates (all treatments) followed by use of partial replicates (all treatments except the D 14 mix) in sequence. This pattern occurred to allow 2 partial and 6 full replicates. For each treatment, sows were maintained in their final housing systems until ~D 110 of gestation at which time they were moved into farrowing crates.

During the study, sows were fed a conventional lactation and gestation diet with nutrients meeting or exceeding NRC requirements. The lactation diet contained 30% and the gestation diet contained 20% DDGS. Feed was given ad-libitum in lactation while sows received ~2.3 kg/d of feed from weaning until 100 d of gestation with adjustments given based on body condition on d 30, 60, and 90. At 100 d of gestation, all sows received an additional 0.9 kg of feed.

Measures of well-being

Measures of animal well-being were assessed in 4 full replicates and 2 partial replicates for each treatment. Sows were observed and scored for body condition, and lesions on the head, neck, body, leg, and vulva, and also for leg inflammation, and lameness. Evaluation occurred for all animals on days 3, 6, 9, and 12 after mixing or movement into their stall and then occurred bi-weekly thereafter until movement into the farrowing crate.

Aggressive behaviors were assessed for all sows assigned to be mixed but not for those in stalls. On the day of mixing (day 1 of mixing) sows were digitally video recorded for 12 h to assess the number of fighting events. Video recording occurred using a fixed-mount recorder located above the pen that allowed visualization of the entire pen. Recording began immediately before mixing and continued for 12 h. Aggressive interactions were recorded. Aggressive interactions included aggressive and submissive behaviors that were defined in sequence as: 1) sows facing each other, 2) side by side alignment, 3) heads up with biting and body movement. Biting targets included face, ear, neck, body, and rump. Aggressive encounters were considered terminated when one sow retreated. Interference from another pig was considered an additional fighting event. Pushes (given with head or shoulder) were also considered agonistic behaviors.

For assessment of hormone (cortisol and progesterone) response to treatment, sub-groups of sows were created on either day 3 after mixing or movement into their permanent stall. All sows were classified based on lesion score and assigned to low (L), moderate (M), or high (H). Lesion scores were defined individually for the head, body

Table 1: Allocation of weaned sows to treatment.

Treatment	Gestation day of mixing	Replicates	Sows assigned
Stall	No mix	8	160
D 3 Mix	3-7 days	8	464
D 14 Mix	13-17 days	6	347
D 35 Mix	> 35-50 days	8	464

and vulva. Sows were randomly selected from each lesion category (n = 5) for sub-sampling. Blood was taken from the sub-sample of sows on days 3 and 9 following mixing or movement into their permanent stall for cortisol. A single sample from the same animals was obtained on d 14 for measurement of progesterone to assess luteal function. Baseline cortisol was established by sampling sows prior to mixing or movement into permanent stall, with collection of a single blood sample from a random population of 20 sows within each treatment. For collection of all blood samples, sows were snared and samples collected within 2 minutes via jugular vein puncture using vacuum tubes. All collections occurred between 0900-1100 h. Samples were allowed to clot at RT for one hour and were then transferred to 4°C for 12 h. Samples were then centrifuged at 400 × g at 4°C for 15 min. Serum was transferred into polypropylene tubes for storage at -20°C until assay.

Reproductive measures

Measures of reproduction were assessed in all 8 replicates for treatments. Conception rates were assessed by trans-abdominal real-time ultrasound at days 28-32 of gestation. Subsequent measures of returns, farrowing, total born, born alive, stillbirths, and mummified fetuses, and wean to service intervals were recorded.

Data collection and statistical analysis

Sow management data was collected and recorded in a commercial software program and treatment data were collected and entered into Excel and analyzed in SAS. Binomial data for reproduction (pregnancy and farrowing) were analyzed using the GENMOD procedure of SAS for the main effects of treatment, replicate, and parity. The continuous response variables for reproduction (total born and born alive) were analyzed using the MIXED models procedures of SAS for the main effects of treatment and replicate. The number of sows/pens selected for this experiment and the sub-populations were based on a power analysis to detect a 10% difference in the treatment means with an 80% probability. This is based on the calculated CV (%) for actual reproductive traits and published measures for reproductive traits using a 20-35% CV.[16] Differences are reported with least square means at $P < 0.05$.

Preliminary results

Animal well-being

At this time, no measures for animal well-being are available for this publication.

Reproduction

Our preliminary reproductive results are shown below in Table 2. There was an effect of treatment on both conception rate and farrowing rate. Conception rates for sows in both the D3 and D 14 Mix were lower than sows kept in Stalls and those in the D 35 Mix groups. Sows in the D 35 Mix did not have a significantly lower conception rate than those in Stalls. Farrowing rates were also lower in the D 3 and D 14 Mix treatments compared to those kept in Stalls. However, only the D 3 Mix group was lower than the D 35 Mix and sows assigned to D 14 Mix were not significantly lower. Again, sows in the D 35 Mix did not differ in farrowing rate compared to Stalls. There was no effect of treatment on the averages for total born pigs, pigs born alive, stillborn, or mummified fetuses.

Conclusions

This study was conducted during the summer months of the year where reproductive failure would be expected to be higher than the rest of the year. The overall reproductive performance of this herd was very good for farrowing rate

Table 2: Effect of housing on reproductive measures in response to maintaining weaned sows in gestation stalls throughout pregnancy or following mixing sows in groups of 56 on either day 7, day 14 or after D 35 following breeding.

	Stalls	D 3 mix	D 14 mix	D 35 mix	Pooled SE	*P*-value
Included in analysis	152	455	345	457		
Conception rate	95.6%[a]	87.1%[b]	88.3%[b]	92.7%[a]	1.7	< 0.005
Farrowing rate	94.1%[a]	83.7%[b]	87.2%[bc]	90.8%[ac]	1.8	< 0.0005
Total born pigs	12.5	12.1	12.4	12.2	0.2	0.63
Pigs born alive	11.9	11.5	11.7	11.8	0.2	0.67
Stillborn pigs	0.5	0.5	0.6	0.6	0.1	0.56
Mummies	0.07	0.09	0.08	0.05	0.08	0.47

Means with different superscripts differ at $P < 0.05$.

and pigs born alive for all treatments. However, the results from this study lead us to conclude that mixing sows early at D 3-7 after breeding and during the implantation period (D13-17) can be associated with a 5-7% reduction in conception rate when compared to sows housed in Stalls or those mixed after day 35 of gestation. Farrowing rates were also reduced as a result of mixing sows immediately after breeding on Day 3 and at the time of implantation on Day 14 when compared to sows housed in Stalls. Further, mixing at Day 3 was also detrimental to farrowing when compared to mixing sows after day 35 of gestation. Surprisingly, mixing sows at the time of implantation on D 14 did not reduce fertility when compared to sows that were mixed after d 35 of gestation. There was no effect of treatment on any measure of total pigs born or pigs born alive. For reproductive measures alone, these results suggest that mixing sows in the 1st or 2nd week of gestation can result in reduced conception and farrowing rates when compared to housing sows in stalls. However, as expected, mixing sows after day 35 in gestation did not reduce conception or farrowing rates compared to sows housed in stalls. Collectively, these results suggest that the stall may be an important tool to help minimize stress and pregnancy losses in summer. Further, the use of the stall allows for controlled mixing and mixing at later stages in gestation that allow conception and farrowing rates to approach those for sows in stalls. Lastly, it must be mentioned that our lack of well-being results at this time do not allow us to fully interpret the reproductive measures in the context of the welfare assessments. This information will be critical for helping to identify the important housing systems and day of mixing on all measures with relevance to productivity and animal welfare.

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