Influence of stage of gestation at grouping and presence of boars on farrowing rate and litter size of group-housed sows

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Summary

Objective: To determine the impact of stage of pregnancy at grouping and presence of boars on fertility of group-housed sows.

Materials and methods: In Experiment One, 617 mixed-parity weaned sows were assigned at the time of insemination to be housed individually or in groups of 15. Each group of 15 unfamiliar sows comprised three sows at each of 2, 7, 14, 21, and 28 days from breeding. Sows were floor-fed a standard gestation ration once daily (approximately 2.5 kg per sow). After 5 weeks in groups, sows were re-housed in individual stalls until farrowing. In Experiment Two, 1584 sows on two farms were relocated after insemination to outdoor paddocks in groups of approximately 50, with or without inclusion within the group of three mature boars. Sows and boars were allowed ad libitum access to feed for an 8-hour period every third day, and the boars were removed after 2 weeks.

Results: In Experiment One, there was no effect of grouping per se, or day of gestation when grouped, on farrowing rate or subsequent litter sizes. In Experiment Two, farrowing rates and litter sizes were not affected by boar exposure.

Implications: These data indicate that sows can be successfully group-housed during gestation. Inclusion of boars in the social group does not improve fertility of group-housed sows.

Keywords: swine, sows, boars, group housing, fertility

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Resumen – Influencia de la etapa de gestación al momento del reagrupamiento y la presencia de machos sobre el porcentaje de fertilidad y tamaño de camada de hembras alojadas en grupos

Objetivo: Determinar el impacto de la etapa de gestación al agrupar y la presencia de machos sobre la fertilidad de hembras alojadas en grupos.

Materiales y métodos: En el Experimento Uno, 617 hembras destetadas de paridad mixta se asignaron al momento de la inseminación para alojarse individualmente o en grupos de 15. Cada grupo de 15 hembras desconocidas constó de tres hembras de 2, 7, 14, 21, y 28 días después de la inseminación. Las hembras fueron alimentadas en el piso con una ración de gestación estándar una vez al día (aproximadamente 2.5 kg por hembra). Después de 5 semanas en grupos, se volvieron a alojar a las hembras en jaulas individuales hasta el parto. En el Experimento Dos, 1584 hembras en dos granjas se trasladaron después de la inseminación a corrales al aire libre en grupos de aproximadamente 50, con o sin la inclusión de tres machos maduros dentro del grupo. A las hembras y los machos se les permitió acceso ad limitum al alimento por un periodo de 8 horas cada tercer día, y los machos se sacaron después de 2 semanas.

Resultados: En el Experimento Uno, no hubo efecto de la agrupación per se, o del día de gestación cuando se agruparon, sobre el porcentaje de fertilidad o el tamaño de camada subsiguiente. En el Experimento Dos, el porcentaje de fertilidad y el tamaño de camada no fueron afectados por la exposición a los machos.

Implicaciones: Esta información indica que las hembras pueden alojarse, con éxito, en grupos durante la gestación. La inclusión de machos en el grupo social no mejora la fertilidad de hembras alojadas en grupos.

Résumé – Influence du stade de gestation lors du regroupement et de la présence de verrats sur le taux de mise-bas et la taille de la portée de truies logées en groupe

Objectif: Déterminer l'impact du stade de gestation lors du regroupement et la présence de verrats sur la fertilité de truies logées en groupe.

Matériels et méthodes: Au cours de l'expérience 1, 617 truies de parité mixte ont été assignées au moment de l'insémination à être logé seule ou en groupe de 15. Chaque groupe de 15 truies non-acclimatées était constitué de trois truies chacune à 2, 7, 14, 21, et 28 jours post-saillie. Les truies étaient nourries sur le plancher avec une ration standard pour gestation une fois par jour (environ 2.5 kg par truie). Après une période de 5 semaines

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en groupe, les truies ont été placées dans des enclos individuels jusqu'au moment de la mise-bas. Lors de l'expérience 2, 1584 truies ont été relocalisées après leur insémination dans des enclos extérieurs en groupe d'environ 50, avec ou sans présence dans le groupe de trois verrats matures. Les truies et les verrats avaient accès ad libitum, à tous les 3 jours, à la nourriture pour une période de 8 heures, et les verrats ont été retirés du groupe après une période de 2 semaines.

Résultats: Dans l'expérience 1, le regroupement ou le jour de gestation lorsque mis en groupe ne semblait pas avoir d'effet comme tel sur le taux de mise-bas ou la taille des portées. Lors de l'expérience 2, les taux de mise-bas et la taille des portées n'étaient pas affectés par la présence des verrats.

Implications: Ces résultats indiquent que les truies peuvent logées en groupe sans problème durant la gestation. L'inclusion de verrats dans le groupe social n'améliore pas la fertilité de truies logées en groupe.

The most common housing system for weaned and gestating sows in North America is individual stalls. While stalls are effective for ease of artificial insemination and individual feeding, they are criticized on animal welfare grounds because of the degree of physical restriction that they impose. This has resulted in an increased movement at both state and corporate levels toward group housing during gestation. Although there has been considerable earlier research on the impact of group housing of pregnant sows on their fertility, previous workers have tended to employ relatively few sows housed in small groups and usually with some sort of individual feeding system.[1-4] The use of individual feeding systems significantly adds to the space requirement as well as the cost of a retrofit of existing operations.

An advantage of housing and feeding sows in groups is that, although more space per sow is required, original construction costs are lower. Also, anecdotal evidence indicates that day-to-day management of groups of pregnant sows requires less labor input and is beneficial to worker morale (oral communication, Arkell swine facility staff, 2004). Disadvantages include greater difficulty in controlling individual sow feed intake, potentially leading to a greater variation in body condition that may adversely impact lactation performance and subsequent fertility. However, recent evidence indicates that feeding sows in groups does not always result in a greater variation in body condition.[5,6] Sows typically engage in vigorous fighting when unfamiliar groups are first mixed, which results in signs of acute stress, including elevated circulating cortisol concentrations.[7] It has been suggested that repeated acute stress and elevations of cortisol during the period preceding estrus and ovulation do not impact sow or gilt fertility,[8,9] but that fertility may be adversely affected if the stress is relatively severe and prolonged.[10,11] Due to the expectation of prolonged stress due to aggression when sows are first grouped and at subsequent group feedings, and the belief that this stress will reduce fertility, the field recommendation is that sows not be moved or mixed before the completion of placentation (ie, 28 days after insemination).[12] It is believed that mixing after this time will minimize any effect of stress on the maintenance of pregnancy. If such an effect were demonstrated, the effect of stage of pregnancy when mixed would need to be defined.

Some degree of aggression is inevitable when unfamiliar sows are mixed, so information is needed on how to reduce the amount of aggression. It is known that the submaxillary salivary glands of boars release pheromonal steroids and that if these glands are excised, gilts are more aggressive towards the boar.[13] Other data indicate that inclusion of a boar in a newly formed group of barrows, gilts, or both,[14,15] or provision of boar pheromonal steroids by aerosol spray,[16] reduced the number of aggressive interactions. In contrast, another study indicated that inclusion of a boar in the social group at the time of mixing had little impact on aggression of bred sows,[7] although, interestingly, sows having direct contact with a boar had higher salivary cortisol during the first 2 days after mixing than sows in the control group. Therefore, the effect of boar inclusion in newly formed sow groups requires further investigation. The objectives of these experiments were to test the hypotheses that mixing strange sows earlier than 28 days after breeding reduces sow fertility and that including boars in the social group for 2 weeks after group formation would mitigate this adverse effect of mixing.

Materials and methods

These studies were performed at the University of Guelph Arkell Research Station (Experiment One) and on a commercial facility in Michigan (Experiment Two). The institutional animal care committees of the University of Guelph and Michigan State University approved the protocols of the respective studies.

Experiment One

This study employed 617 mixed-parity Yorkshire sows housed individually (n = 122) or in groups (n = 495) at the University of Guelph swine facility to examine the effect of gestational age at mixing on sow fertility. Sows were weaned into groups of three to four and exposed to a mature boar to facilitate the onset and detection of estrus. Sows were artificially inseminated with 3×10^9 Yorkshire sperm (Ontario Swine Improvement, Innerkip, Ontario, Canada) at estrus detection and again at 24-hour intervals while still in good standing estrus. Following insemination, sows were housed in individual gestation stalls (2.13 m × 0.66 m) until they were either moved to a different stall in the gestation barn or mixed in groups of 15 sows. All sows in a pen were grouped at one time. Space allotment for each group of 15 sows was approximately 2.25 m^2 per sow. As previously described,[6] the pens measured approximately 3.0 m × 11.5 m and were divided widthwise into three sections, two feeding-lying sections and one dunging area, by two partial walls made of concrete block (0.2 m wide, 1.5 m long, and 1.1 m in height). The dunging area (3.0 m × 5.0 m) had a slatted floor where hanging drinkers were located. Each feeding-lying area (3.0 m × 3.3 m) had a solid concrete floor and two separate drop feeders, each comprising three drop pipes, suspended from the ceiling. Pens were separated lengthwise on one side by spindle penning and by two partial walls adjacent to the feeding-lying areas, and on the other side by solid concrete walls. The sows were fed once daily (approximately 2.5 kg per sow per day) between 8:00 AM and 8:30 AM. For the group-housed sows, feed was distributed onto two separate areas of the floor by a drop-feeding system.

Each group of 15 unfamiliar sows comprised two or three sows at each of 2, 7, 14, 21, and 28 days from breeding. Attempts were made to balance treatments for parity. The sows were kept in the group-housing facility for 5 weeks, after which they were moved to individual gestation stalls until relocated to farrowing accommodations.

Five sows (one representing each day of gestation) were moved to a different stall in the breeding barn at times that corresponded to the mixing of groups. All animals were either grouped or relocated to new stalls at 10:00 AM to ensure that they had eaten prior to movement. In order to maintain the group social structure, any sow that came into heat during the trial was not removed from the group. Reproductive data recorded were total and liveborn litter size and farrowing rate.

Experiment Two

This study involved 1000 and 584 Yorkshire and Landrace sows, respectively, in two 3000-sow commercial farrow-to-wean herds located in southern Michigan during June to November, 2005. There were 20 weekly groups for Farm 1 and 12 weekly groups for Farm 2. In these herds, sows farrowed and lactated indoors in farrowing crates and were weaned into individual gestation stalls (2.13 m × 0.66 m) for estrus detection and breeding by artificial insemination. Semen was collected and processed in-house to provide insemination doses containing 3×10^9 sperm. All insemination doses within each breeding week were identical pooled semen. Sows were weaned on Tuesdays, and on the second Friday after weaning, bred sows were formed into groups of approximately 50 and moved into 0.5-acre outdoor paddocks. This resulted in breeding-to-mixing intervals of 1 to 5 days. Pregnancy status was determined by real-time ultrasound (50S Tringa; Veterinary Sales and Service, Stuart, Florida) at 25 to 30 days after insemination, and pregnant sows were relocated to a 7-acre paddock for the remainder of their gestation. Group integrity was maintained throughout gestation. Open sows were moved back to the breeding barn. Alternate sow groups included a team of three mature boars that remained with the sows for 14 days before being moved to a new sow group.

During gestation, sows were allowed ad libitum access to feed in three eight-hole feeders for an 8-hour period every third day. All paddocks were equipped with an automatic water supply and with deep bedded Quonset huts for shelter. Pregnant sows remained with their groups until rehoused into farrowing crates at 110 days of gestation. The effect of boar presence on sow fertility was assessed on the basis of farrowing rate to first service and subsequent total-born litter size.

Statistical analysis

All data were imported into Stata (Stata 9.1 Intercooled for Windows XP; StataCorp, College Station, Texas) for analysis. In Experiment One, a logistic regression model was used to study the effect of day of gestation at grouping on farrowing rate, compared to farrowing rate of the nongrouped control sows. In addition, Poisson analysis was applied to examine the effect of day of gestation at grouping on litter size. In Experiment Two, multivariable Poisson analysis was used to investigate the impact of boar exposure, farm, parity, wean-to-estrus interval, month of breeding, and the breeding-to-mixing interval on litter size. Logistic regression was applied to study the effect of boar exposure and other parameters (farm, parity, wean-to-estrus interval, month of breeding, and breeding-to-mixing interval) on farrowing rate. In both models, regular indicator variables were created for group-housed sows, and the nongrouped sows were assigned as the control group. In order to control for parity, it was included in the model for Experiment Two. In both models, farm was included as a fixed effect, and parity, wean-to-estrus interval, and breeding-to-mixing interval were continuous variables. In Experiment Two, univariable associations between independent variables and outcomes (litter size and farrowing rate) were investigated, and variables with $P < .2$ were included for multivariable analysis. For both experiments, the level of significance was set at $P < .05$.

Results

Experiment One

Farrowing rate, mean parity, and mean total litter size for each mixing day are shown in Table 1. Day of gestation at grouping did not affect farrowing rate (range 72.3% to 83.2%) ($P > .05$). In addition, day of gestation at grouping did not affect either total born litter size (range ± SE, 11.0 ± 0.4 to 11.6 ± 0.4) or liveborn litter size (range ± SE, 10.2 ± 0.4 to 10.7 ± 0.3) ($P > .05$).

Experiment Two

The mean breeding-to-mixing interval was 3.8 days for both pregnant and subsequently nonpregnant sows. In univariable analysis, boar exposure, parity, and farm had an impact on litter size ($P < .05$) and were included in the final Poisson model. However, wean-to-estrus interval, month of breeding, and the mating-to-mixing interval had no effect on the litter size ($P > .20$). When boar exposure, farm, and parity were included in the final Poisson model, there was no significant effect of boar exposure on subsequent litter size (Table 2). Parity, the breeding-to-mixing interval, and farm were associated with farrowing rate ($P < .20$) and were included in the final logistic regression model. However, boar exposure and wean-to-estrus interval had no effect ($P > .20$).

Table 1: Farrowing rate, mean parity (± SE), and mean litter size (± SE) of group-housed sows* (Experiment One)

Days after breeding	No. of sows	Parity	Farrowing (%)	Litter size (total)	Litter size (live)
Control	122	2.7 ± 2.2	82.0	11.6 ± 0.3	10.6 ± 0.3
2	98	2.8 ± 1.9	77.5	11.0 ± 0.4	10.2 ± 0.4
7	97	3.0 ± 1.9	75.3	11.2 ± 0.4	10.3 ± 0.4
14	101	2.8 ± 2.1	72.3	11.6 ± 0.4	10.7 ± 0.3
21	101	2.9 ± 1.9	83.2	11.4 ± 0.4	10.4 ± 0.3
28	98	2.4 ± 1.7	82.6	11.5 ± 0.3	10.6 ± 0.3

* Sows housed in groups of three or four for estrus detection, then either grouped (15 sows per pen, 2.25 m^2 per sow) or maintained in individual gestation stalls (controls) for 5 weeks.

Table 2: Farrowing rates and mean (± SE) litter size of sows by days after breeding (Experiment Two)*

Days after breeding	No. of sows	Farrowing rate (%)	Total born litter size
1	66	74.2	12.4 ± 0.4
2	115	73.5	11.2 ± 0.3
3	132	72.0	11.0 ± 0.3
4	340	78.5	11.6 ± 0.2
5	527	78.1	11.7 ± 0.1
Control (all sows)	667	76.1	11.4 ± 0.1
Boar exposed (all sows)	513	77.8	11.7 ± 0.1

* Sows were housed in gestation crates for insemination, and 1 to 5 days later were moved into 0.5-acre paddocks in groups of 50. Alternate groups included a team of three mature boars that remained with the sows for 14 days before being moved to a new sow group. Sows diagnosed pregnant at 25 to 30 days after insemination were moved into a 7-acre paddock until placed in farrowing crates at 110 days of gestation.

In the final model, farm, parity, and month of breeding were associated with farrowing rate. Older sows, sows on Farm 2, and sows bred in October and November had a greater chance to conceive and farrow ($P < .05$)

Discussion

The first few days after unfamiliar sows are mixed can be the most critical in terms of sow welfare, with sows typically engaging in aggressive interactions in order to establish a social hierarchy.[12,17] Further, if there is severe competition at feeding, the stress can be prolonged. Previous reports have indicated varied responses of litter size to housing management. A reduction in litter size associated with group housing or mixing of unfamiliar sows has been documented.[18,19] However, others report no effect on embryo survival or litter size.[1,8,20,21] These literature data suggest that factors such as group size, space allowance, or pen design may interact with the effect of grouping to impact (or not) subsequent litter size, resulting in no clear statement regarding the effect of housing management per se on subsequent litter size.

The data from the present studies indicated no consistent effect of group housing of bred sows on farrowing rates. This might be explained in part by the small number of sows per group resulting in insufficient power to detect a difference in farrowing rate between the control and treatment groups. However, in concert with literature data concerning litter size, reported effects of group housing of sows on pregnancy or farrowing rates have been inconsistent. No effect was observed in some studies,[8] while others reported lower[20,22] or even higher farrowing rates.[1] The literature data suggest that other factors likely interact with the effect of grouping to impact (or not) the ability to conceive and maintain a pregnancy to term. A possible interactive factor is the stage of pregnancy when mixed. Day 14 is close to the time of the first signal for maternal recognition of pregnancy and the start of placental attachment.[23] A physiological perturbation at this time has the potential to interfere with the successful establishment of pregnancy. Interestingly, te Brake and Bressers[19] noted a smaller litter size when sows were mixed at 10 days compared to those mixed at 17 or 31 days. From a clinical standpoint, it would be invaluable to know the pattern of returns to estrus in sows failing to maintain pregnancy, but this information has not been provided. If future studies provide this additional data, it would be possible to determine more accurately when the pregnancy was lost. This, in turn, would provide insight as to the potential mechanisms involved.

Previous studies have found that the physical presence of a boar reduced the frequency of aggressive behavior within groups of weaned sows, gilts, and slaughter-weight pigs.[15,24,25] However, our previous study showed little effect of boar presence on aggression in bred sows, but showed that sows mixed with a boar had higher salivary cortisol than sows with fenceline or no contact with a boar.[7] It is assumed that an effect on fertility after mixing of strange sows would be due to the stress associated with aggression and that if the presence of a boar affects the stress response, fertility may also be affected. Under the conditions employed in Experiment Two, our study fails to support an effect of boar presence on sow fertility. However, sows in Experiment Two were housed in large outside paddocks, allowing plenty of room for them to escape aggression, possibly negating any effect of boar contact. Because behavioral observations were not made on these outdoor farms, a relationship between presence of boars, levels of sow aggression, and sow performance could not be made.

Implications

- Under the conditions of this study, strange sows can be mixed into groups without adversely affecting fertility.
- The presence of boars during the period of mixing in large outdoor paddocks does not improve sow performance.

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