RESEARCH REPORT
ANIMAL WELFARE

Title: Systematic literature review and needs assessment of housing systems for gestating sows in group pens with group feeding – **NPB #08-275** REVISED

Investigator: Mhairi Sutherland

Institution: Texas Tech University, Lubbock, TX, USA
(Present address: AgResearch Ltd, Ruakura Research Centre, Hamilton, New Zealand)

Date Submitted: October 25, 2013

Industry Summary:
Gestation sow housing is a current contemporary animal welfare issue. The current political atmosphere is driving producers to consider changing back to group housing systems for gestating sows. It is important for producers converting to group housing systems that they know the best way in which to manage their system. Group housing systems that incorporate group feeding pose specific management challenges for the producer and can potentially impact the welfare of the sow. This literature review summarizes the current available literature that discusses research conducted on group housed and group fed breeding and pregnant sows and the impact these systems have on production performance/efficiency, lifetime productivity and overall well-being of the sow. Several factors appear to affect the productivity and well-being of group housed and fed gestating sows, including space allowance, feeding frequency and provision of bedding. The main gaps in our knowledge include information on the impact of genetics, group size, air quality, time of grouping and group type. These findings are summarized in the producer factsheet and research needs assessment.

Keywords: Sow, Gestation, Group, Housing, Feeding, Review

Scientific Abstract:
Gestation sow housing is a current contemporary animal welfare issue. The current political atmosphere is driving producers to consider changing back to group housing systems for gestating sows. It is important for producers converting to group housing systems that they know the best way in which to manage their system. Therefore, the objective of this review is to address how specific characteristics of group housing systems that incorporate group feeding impact production performance/efficiency, lifetime productivity, and overall well-being of the sow. Research in this area has predominantly focused on the effects of space allowance, feeding regimes and grouping of gestating sows. From this literature review it is clear that there are many gaps in our knowledge regarding the management of group housed and fed sows which are summarized in this review.

Literature Review:

Introduction

Gestation sow housing is a current contemporary animal welfare issue particularly in the United States and Europe (McGlone et al., 2004). The two main housing systems used for gestating sows are individual stalls and group housing. However, the current political atmosphere is driving producers to consider changing to group housing systems for gestating sows. Gestation stalls and tethers have been banned or are being phased out by the European Union, and in the United States legislation to ban gestation stalls has occurred in Florida (2002), Arizona (2006), Oregon (2007), Colorado (2008), California (2008) and Maine (2009).

It is important for producers converting to group housing that they know the best way in which to manage their system. Currently, there is limited research evaluating sow housing systems and most of the research to date has focused on the comparison between stalls and group housing. To complicate the issue, there are many components involved in housing systems that can potentially impact the performance and well-being of the sow. One major challenge for producer's using group housing systems is managing feed intake of sows so that sows maintain a uniform and healthy body condition score throughout gestation. Group housing systems that incorporate group feeding systems pose specific management challenges for the producer and can potentially impact the welfare of the sow.

Group housing of sows that incorporate group feeding systems is probably the oldest and longest used approach to rearing pigs. Yet, despite this history there is currently little literature available for swine producers to rely upon when trying to make decisions on how to adopt a group housing production system. There are a variety of feeding methods that can be used when group feeding group housed sows, but these can be divided into two main methods; floor feeding and providing feed in troughs or feeders. In both systems, feed is either manually or automatically delivered onto the floor or into troughs/feeders.

All housing systems have advantages and disadvantages for the overall performance and well-being of the gestating sow. It is not only important to develop and evaluate new systems but also optimize existing housing systems. Therefore, the objective of this exhaustive review is to address how specific characteristics of group housing systems that incorporate group feeding impact production performance/efficiency, lifetime productivity, and overall well-being of the sow. It is not the purpose of this review to compare the use of gestation stalls with group housing, but to focus on group housing systems that utilize group feeding systems so as to develop a needs for future research and a how to information sheet for producers.

Methodology

For this review, a scientific literature search was conducted using the Texas Tech University and AgResearch libraries. The three main databases that were used included AGRICOLA (USDA, indexes 2500 journals since 1970), CAB International (indexes over 9000 journals, books and conference proceedings) and Scopus (indexes over 16,000 peer-reviewed journals, and numerous conference proceedings and books). Additional databases included: MEDLINE (1960 to present), PUBMED (1960 to present), BIOSYS (1960 to present), AGRIS: International Information System for the Agricultural Sciences and Technology (1974 to present), Animal Behavior Abstracts (1982 to present), Biological and Agricultural Index Plus (1983 to present) and Biotechnology Research Abstracts (1983 to present). For those publisher websites and databases with "Find similar content" and "Find same author" functions, we followed these additional leads. Literature was also obtained by using the reference section from the articles gathered. Keywords used during the search included group housing, gestation, sows, feeding, etc. and resource materials were sorted based on the variables measured in the research (e.g. group type, space allowance, bedding, etc.) as well as factors affected (e.g. reproductive performance, well-being and productivity etc.).

Results

Several studies describing the effects of group housing on production, performance/efficiency, lifetime productivity and/or overall well-being of gestating sows did not give sufficient detail on the feeding system used, for example it was not possible to determine whether the sows were group or individually fed. If studies did not describe the feeding system in enough detail these studies were removed from the literature review. Of the studies that involved group housing of sows and group feeding systems, the two main feeding systems were floor feeding or feeding sows in a trough / feeder. Often in these studies it was not specified if feed was delivered automatically or manually, therefore all of these studies were included in the review and treated equally. In many studies, group housing systems were compared with individual stalls or group feeding systems were compared with individual feeding stalls, in these cases only the information relevant to group feeding of group housed sows was extracted and used for this review.

<u>Space allowance</u>

Behavior

Space allowance can affect the time budget of gestating sows. Behavior over a 24 hour observation period differed among sows that were floor fed and kept at either a space allowance of 1.4, 2.3 or 3.3 m^2/sow with sows kept at 1.4 m^2/sow spending more time lying and less time standing, walking, drinking and performing aggressive behaviors (Salak-Johnson et al., 2012).

The frequency of aggressive interactions is influenced by space allowance. Gilts kept at a space allowance of 0.98 m^2/pig and floor fed performed a greater number of aggressive interactions at the time of feeding, on day 2 after grouping / mixing compared with gilts kept at or 1.97 m^2/pig (Barnett et al., 1992). Furthermore, sows that were group housed and floor fed were found to perform fewer aggressions at feeding with increasing space allowance on day 2 after grouping / mixing when a range of space allowances were compared (1.4, 1.8, 2.0, 2.2, 2.4 or 3.0 m^2/sow) (Hemsworth et al., 2013). These effects were greatest early on after grouping (Hemsworth et al., 2013).

Space allowance may also influenced vulva biting behavior in sows. In a comparison among three farms which had group housed sows that were floor fed, the incidence of vulva lesions was low except on one farm which had 44.7% of sows affected. This farm also kept sows at the smallest space allowance (1.8 m^2/sow). Limited feeding space and lack of room for submissive sows to escape their dominant attackers was suggested as the cause for this increased incidence of vulva biting (Zurbrigg and Blackwell, 2006).

The performance of stereotypic behaviors was influenced by space allowance among sows that were kept at 1.4, 2.3 or 3.3 m^2/sow. Sows kept at 1.4 m^2/sow spent less time performing oral-nasal-facial behaviors directed towards the floor and bars, but spent more time sham chewing (Salak-Johnson et al., 2012). Increased sham chewing behavior may reflect increased feeding motivation. Sows in small pens may eat faster due to more competition as a result of restricted space and therefore experience increased feeding frustration, however there was no difference in feeding time between sows kept at 1.4, 2.3 or 3.3 m^2/sow (Salak-Johnson et al., 2012).

Physiology and the immune system

Limited aspects of physiology and the immune system have been studied in regards to the effect of space allowance on group housed and group fed sows, however gilts kept at a space allowance of 0.98 m^2/pig and floor fed had higher total and free cortisol concentrations than gilts kept at a space allowance of or 1.97 m^2/pig (Barnett et al., 1992). Total and free cortisol concentrations on day 2 after grouping / mixing were also found to decrease as space allowances increased when several space allowances (1.4, 1.8, 2.0, 2.2, 2.4 or 3.0 m^2/sow) were compared in sows group housed and floor fed (Hemsworth et al., 2013). Conversely, cortisol concentrations were lower in sows kept at a space allowance of 1.4 and 2.3 m^2/sow compared with 3.3 m^2/sow (Salak-Johnson et al., 2012).

Space allowance influenced the immune response in pigs; the cell-mediated immune response was lower in group housed pigs kept at a space allowance of 0.98 m^2/pig compared with 1.97 m^2/pig (Barnett et al., 1992). But, Salak-Johnson et al. (2012) and Hemsworth et al. (2013) found no effect of space allowance on the immune response in sows housed at a space allowance of 1.4, 2.3, or 3.3m^2/sow or 1.4, 1.8, 2.0, 2.2, 2.4 or 3.0 m^2/sow, respectively.

Injuries

Scoring the number or severity of lesion scores on sow in different housing systems is a common measure of aggression and welfare. The effect of space allowance on the incidence of lesion scores can vary in the literature. The incidence of lesion scores, assessed weekly, did not differ among sows floor fed and kept in groups at a space allowance of 2.3, 2.8 or 3.2 m^2/sow (Séguin et al., 2005). Furthermore, space allowance did not affect skin lesions / injuries in sows kept at space allowance of 1.4, 1.8, 2.0, 2.2, 2.4 or 3.0 m^2/sow (Hemsworth et al., 2013). However, sows kept at 1.4 compared with 2.3 or 3.3m^2/sow had higher lesion scores, in particular around the shoulders and the rear, which could be indicative of increased aggression amongst these animals as a result of more competition for food (Salak-Johnson et al., 2007).

Productivity and reproductive performance

Space allowance in group housing systems when sows are group fed can affect sow productivity. Space allowance had no effect on body condition score on sows kept at 2.3, 2.8 or 3.2 m^2/sow before entering and at the end of the housing treatment, (Séguin et al., 2005). However, body condition score were lower in sows kept at 1.4 compared with 2.3 or 3.3 m^2/sow (Salak-Johnson et al., 2007). Furthermore, sow's kept at 1.4 m^2/sow had lower body weight at day 110 of gestation than sows kept at 2.3 and 3.3 m^2/sow and sows kept at 2.3 m^2/sow had greater back fat than sows kept at 1.4 or 3.3 m^2/sow (Salak-Johnson et al., 2007). Conversely, back fat gain was highest in sows kept at a floor space of 1.4 compared with 1.8, 2.0, 2.2, 2.4 or 3.0 m^2/sow (Hemsworth et al., 2013).

Reproductive performance has been shown to be influenced by space allowance when sows are group housed and group feed. Sows were kept in groups at a space allowance of 2.3, 2.8 or 3.2 m^2/sow had a similar number of live born piglets per litter and average piglet birth weight (Séguin et al., 2005). However, Salak-Johnson et al. (2007) found that sows kept at 3.3 m^2/sow had larger litter sizes, but there no effect on number born alive, number weaned, litter birth weights and litter weaning weights compared with sows kept at 1.4 and 2.3 m^2/sow (Salak-Johnson et al., 2007). Furthermore, farrowing rate increased as space allowance increased when a range of space allowances were compared (1.4, 1.8, 2.0, 2.2, 2.4 or 3.0 m^2/sow), but space allowance did not affect other measures of reproductive performance such as sows culled for non-reproductive reasons, litter size, number of still born and number of mummies (Hemsworth et al., 2013).

Summary

The literature suggests that space allowance of sows group housed and group fed can influence the behavioral time budget of sows, with smaller space allowances resulting in more time lying. Smaller space allowances may also cause more competition, especially at feeding, resulting in more aggressions, higher lesion scores, and an increased incidence of vulva biting and sham chewing. Smaller space allowances were also shown to increase cortisol concentrations in pigs and reduce the cell-mediated immune response. There is also an indication that larger space allowances can positively affect sow productivity and reproductive performance. Therefore, space allowance appears to be an important component of group housing systems that employ group feeding of sows.

Research needs

- Comparison of different space allowances within group housing systems in relation to sow parity, genetics and group type (static vs. dynamic) as all these factors can potentially impact the optimal amount of space required by gestating sows.
- In the majority of studies reported, sows were floor fed, therefore a comparison of different group feeding systems is needed.

Group size

Very few studies have investigating the effect of group size on the performance, productivity and well-being of gestating sows in group housing systems that are also group fed. It is difficult to compare the effect of group size on the production, productivity and well-being of gestating sows between studies as group size is often confounded with space allowance. Hemsworth et al. (2013) investigated the effect of three group sizes (10, 30 and 80) on the productivity and well-being of group housed gestating sows that were floor fed. Hemsworth et al. (2013) found that a group size of 10 sows resulted in fewer skin injuries on day 9, 23 and 51 after grouping and the lowest total injuries over the entire study period. Live weight gain was also highest in sows in groups of 10, but there was no effect of group size on cortisol concentrations, aggressive behavior at feeding and reproductive performance traits (Hemsworth et al., 2013).

Summary
Smaller group sizes (10 sows per pen) appear to result in fewer skin injuries / lesions and increased live weight gain in gestating sows, but not to affect other measures of stress or reproductive performance.

Research needs

- More research is needed on the effect of different group size on the productivity, reproductive performance and well-being of gestating sows, to determine the optimum group size for group housed sows that are group fed.
- A comparison of different group feeding systems in relation to group size is needed.

Flooring and bedding

In the majority of studies evaluated in this review several flooring types were investigated including solid concrete floors, concrete slats and a combination of the two. However, flooring type was not directly evaluated in relation to group housing and feeding of gestating sows. However, Jensen et al. (2012) found that solid pen floors in group-housing systems increased the risk of sow mortality (Jensen et al., 2012), irrespective of feeding system (electronic sow feeder, individual stalls or competition based, unprotected feeding). In several studies, the addition of bedding material has been investigated in group housing systems for gestating sows where sows are also group fed.

Behavior
Providing group housed and group fed sows with bedding material can affect behavior, including behavioral time budgets and stereotypic behaviors. Whittaker et al. (1999) evaluated the effect of providing sows housed in pens with solid concrete flooring, straw bedding, which was added daily. During feeding, sows with straw bedding were more active (spent more time standing), performed more aggressive interactions (bites, knocks and threats), but performed less vacuum chewing and tongue sucking (Whittaker et al., 1999). In another study, gilts were provided with peat moss as a bedding material. Gilts provided with peat moss spent less time performing oral behaviors, such as sham chewing, biting the bars, licking or chewing objects and playing with the nipple drinkers (Boyle et al., 2002) and more time rooting

the floor and smelling fixtures. In addition, gilts provided with peat moss as a bedding material spent more time lying in lateral recumbency, which is a more relaxed sleeping posture (Boyle et al., 2002). Furthermore, group housed sows given a bale of straw once or twice a week performed fewer stereotypic behaviors, however the provision of straw did not completely abolish these behaviors (Arellano et al., 1992).

Physiology

The stress response to two different housing systems was assessed using an adrenocorticotropic hormone (ACTH) challenge. Gilts were group housed in pens with solid flooring and a slatted dunging; peat moss was used as a bedding material in half of the pens. Gilts housed with peat moss had a lower salivary cortisol response to an ACTH challenge compared with sows housed in pens without bedding, suggesting that these animal may have experienced more stress than their bedded counterparts (Boyle et al., 2002).

Injuries

Skin injuries / lesions and vulva biting have been associated with the presence or absence of bedding material in group housed and group fed sows. Total lesion scores, in particular forelimb and hind limb lesions were lower in gilts housed in pens with peat moss than gilts housed on solid flooring at day 31 and 75 after grouping (Boyle et al., 2002). Sows housed in pens with concrete flooring and provided with straw bedding daily had more vulva lesions than sows that were not given access to straw bedding (Whittaker et al., 1999). In addition, vulva biting was associated with straw bedding (irrespective of feeding system), supporting the idea that vulva biting is an aggressive act rather than a redirected behavior like tail biting (Rizvi et al., 1998).

Summary

Solid concrete flooring may increase the risk of injury and mortality in gestating sows, regardless of feeding system. Providing bedding can reduce the cortisol response and performance of stereotypic behaviors in gestating sows, however it may also increase aggressions and the incidence of vulva biting.

Research needs

- A comparison of different flooring types and bedding materials in relation to group feeding systems.
- More information on the effect of flooring type and bedding materials on productivity and reproductive performance of gestating sows.

<u>Pen shape/size</u>

It is difficult to compare the effect of pen shape / size on the production and well-being of gestating sows between studies as pen shape / size is often confounded with space allowance and group size. Séguin et al. (2005) investigated the effect of keeping sows in group pens measuring 34.0 to 49.5 m^2 (small pens) or 72.5 to 74.5 m^2 (large pens). Sows were drop fed once a day on the floor. Pen size had no effect on body condition score, on the number of live born piglets per litter, on the average piglet birth weight or weekly lesion scores (Séguin et al., 2005).

Pen shape and size was shown to affect the behavior of sows at the time of grouping / mixing when they were moved into group pens for the first time. Gilts were either mixed in a small square or rectangle pen (1.4 m^2/pig), a large pen (3.4 m^2/pig), a small square or rectangle pen that had partial stalls or a large pen that included partial stalls (Barnett et al., 1993). On the day of grouping, pigs were fed outside the treatment pens and were not fed again until the following morning, where they were fed on the floor. Sows grouped in the small rectangle pens performed fewer aggressive interactions between 15-90 min post-mixing. Furthermore, partial stalls in the small square pens reduced aggressions at feeding compared

with small pens with no stalls and small rectangle pens with stalls. There was no effect of pen shape or size on number and length of lesion (Barnett et al., 1993).

Summary
Due to the confounding effects of pen size / shape and space allowance it is difficult to make any conclusions regarding the effect of pen size/shape on the productivity and well-being of group housed sows. However, pen shape may effect aggressive interactions at grouping.

Research needs

- More information on the effect of pen size and shape (without the confounding factor of space allowance) on the production and well-being of group housed sows with different group feeding systems.

Feeding regime

Diet
Sows are commonly fed a restricted diet during gestation and several strategies have been evaluated to increase satiety and reduce negative behaviors associated with this feeding regime. One strategy is to increase the fiber content of the diet. Whittaker et al. (1999) floor fed sows once daily, one of two diets with the same iso-energetic value; a conventional diet compared with a high fiber diet (600 g of unmolassed sugar beet pulp per kg of diet). Sows fed the high fiber diet spent more time feeding, but there was no difference in aggressive interactions. Furthermore, sows fed a high fiber diet had fewer vulva lesions (Whittaker et al., 1999).

In another study, Danielsen and Vestergaard (2001) fed gilts a conventional diet or two different high fiber diets (consisting of sugar beet pulp or mixed fiber sources). All diets had similar levels of estimated daily net energy and were fed twice a day in troughs. Gilts fed the high fiber diets spent more time lying and less time standing, and they spent more time eating and less time foraging. Furthermore, gilts fed a diet that consisted of sugar beet pulp spent less time sham chewing and performing aggressions (Danielsen and Vestergaard, 2001).

Brouns and Edwards (1994) fed sows a conventional diet once a day or a high fiber diet (sugar beets) *ad-libitum*. Low-ranking sows were disadvantaged in the once a day, conventional diet, feeding system as shown by lower body weight gain. However, in the *ad-libitum* system, low ranking sows changed their feeding strategy and achieved comparable feed intake / body weight gain as higher ranking sows (Brouns and Edwards, 1994).

Andersen et al. (1999) investigated the effect of a wet compared with a dry diet on the behavior of group housed sows. Aggressions were lower when sows were group feed a wet diet in a trough when there were no partitions or only shoulder partition compared with sows that were fed a conventional dry feed. This may be because wet feed has increased volume, promoting satiety and thereby reducing the motivation for fighting. Another explanation is that eating time is less with wet feed, meaning that more individuals will compete for rations simultaneously, reducing aggressive competition (Andersen et al., 1999).

Feeding frequency
In the literature, the effects of feeding group housed and group fed sows at different time intervals has been evaluated. Floor feeding sows once daily or on alternative days had no effect on lameness, vulva lesions or body condition score, however sows fed on alternative days were also fed hay which may have provided them with a source of enrichment, allowing the sows to preform foraging and rooting behavior, reducing the incidence of feed competition and aggression rather than increasing the incidence of vulva biting or aggressions (Zurbrigg and Blackwell, 2006).

Feeding dry sows once a day rather than twice a day (regardless of feeding system) increased the risk of vulva biting 2-fold, however this was survey data so it is not possible to know the exact feeding systems involved (Rizvi et al., 1998).

Feeding gilts and sows twice or six times per day was evaluated (Schneider et al., 2007). Gilts and sows were housed in group pens and group fed on the solid portion of the floor using drop feeders. Fed was dropped either twice per day (morning and afternoon) or six times per day. Sows fed six times per day vocalized more in the morning and afternoon feeding periods, but there was no difference in other behaviors such as frequency of lying, been active, oral-nasal-facial behaviors etc. Sows fed twice per day had more skin and vulva lesions (however the difference between treatments was relatively small) and a small increase in feet, leg, and hoof problems. There was no difference in body weight, average gaily gain or back fat change between feeding regimes. There was a trend for sows fed twice per day to farrow more total pigs born, but there was no difference in other reproductive performance traits (number born alive, still births and mummies). Gilts fed 6 times per day initially had a tendency for greater average daily gain and a tendency for greater back fat after day 42, but there no other difference in reproductive performance, skin and vulva lesions and feet and leg scores (Schneider et al., 2007).

Summary

High fiber or wet diets may reduce aggressive and stereotypic type behaviors including vulva biting in group housed group fed gestating sows. Fewer feedings per day may increase the incidence of aggressive interactions and vulva biting. Increased feeding frequency may also increase average daily gain in gilts, but not sows. However, little is known about the effect of diet type and feeding frequency on the reproductive performance of group housed, group fed sows.

Research needs

- More information is needed on the effect of feeding regime (diet type and feeding frequency) on different group housing feeding systems, especially in regards to reproductive performance.

<u>Group formation criteria / mixing</u>

One of the biggest challenges facing producers with group housing systems is to reduce aggressive interactions at the time of grouping / mixing when sows are first moved into group pens. Several strategies have been evaluated in the literature. Barnett et al. (1996) evaluated four methods to reduce aggressions among sows at the time of mixing, which included controls, individual stalls for feeding within the pen, administration of Amperozide (an anti-aggressive drug) and grouping pigs 30 minutes after sunset. Four unfamiliar gilts were mixed at a space allowance of 1.4 m^2/pig. Grouping pigs after sunset and administering Amperozide reduced the number of aggressive interactions at mixing compared with controls. The individual stalls reduced aggressions around feeding compared to group housed pigs that were floor fed as a group. No difference in the number of lesions among mixing treatments were found (Barnett et al., 1996).

To reduce aggressive interactions at grouping / mixing, Barnett et al. (1994) evaluated six strategies: food present at the time of mixing in the morning or afternoon, food provided *ad-libitum* for 24 or 48 hours and grouping pigs after sunset or control (grouped in the morning after feeding). Grouping pigs after sunset reduced the number of aggressive interactions compared with feeding pigs in the morning or afternoon after mixing. Providing food *ad-libitum* for either 24 or 48 hours reduced aggressions at the time of feeding, but only while food was present. There was no difference in aggressions at feeding on day 2 and 10 after mixing. No treatment influenced the number or length of the lesion scores (Barnett et al., 1994).

Sow parity can influence the productivity of group housed gestating sows. Kongsted et al. (2007) found that back fat and back fat gain increased with increasing parity number in sows and this observation was greater for group housed sows, group fed (in either troughs or on the floor) compared with individually fed sows. Older sows (> 3rd parity) also spent more time eating than younger sows in group feeding systems (Kongsted et al., 2007). Greater back fat in older sows is likely related to increased time spent feeding, which could be related to the dominance ranking of these older animals. Furthermore, older sows initiated most of the aggressive interactions in group housing / group fed systems (Jensen et al., 2007). Sows eating less than 20% of the time during all observations had a significantly higher risk of returning to oestrus compared with sows eating more frequently (regardless of feeding system) (Kongsted, 2006), and chance of pregnancy and litter size was positively correlated with back fat gain from weaning to 3 weeks after mating (Kongsted, 2006). Therefore, sows which spend less time eating and have lower back fat gain may be more at risk for reduced reproductive performance and this may occur more often in young animals in group housing – group feeding systems.

Summary

Grouping sows after dark or giving pigs an anti-aggression drug can reduce aggressive interactions immediately after mixing and partial stalls and *ad-libitum* access to feed can reduce aggressions at feeding. Grouping sows of similar parities may also be advisable to reduce the effect of social ranking on sow performance.

Research needs

- More information on the effect of different group feeding systems in relation to group formation criteria on the performance and well-being of group housed sows.
- Understanding the impact of parity and/or social rank on the productivity and well-being of group housed, group feed sows.
- More information on different grouping criteria on the productivity and well-being of group housed, group feed sows, such as group dynamics or body condition score.

<u>Outdoor systems</u>

Group housed sows in outdoor production systems are predominantly fed using group feeding systems. Barnett et al. (1985) found that sows in paddocks spent more time active than group housed sows indoors and this was predominantly due to time spent rooting/grazing, wallowing or walking in the paddock. There was no difference in glucose, urea and protein levels between pigs housed indoors or outdoors (Barnett et al.,1985).

A challenge for producers rearing sows outdoors is to reduce pasture damage due to natural foraging behaviors of pigs. Rachuonyo et al. (2005) compared four forages for grazing and ground cover for pasture reared pigs: alfalfa (*Medicago sativa*), tall fescue (*Festuca arundinacea*), white clover (*Trifolium repens*) and buffalograss (*Buchloe dactyloides*). Pigs were floor-fed a standard pelleted gestation diet once per day. Sows / gilts spent more time grazing white clover and alfalfa than tall fescue or buffalograss and rooted more white clover than the other forage types, therefore buffalograss and tall fescue provided better forage to maintain ground cover rather than providing a nutrient supply.

Martin and Edwards (1994) floor-fed outdoor group housed sows a conventional dry sow diet, a high fiber diet or a conventional diet which provided 1.13 times the digestible energy as compared with the other diets. Feed was presented in roll form (16 mm diameter and 12 m long food line) once a day down the center of the paddock. Sows fed a high fiber diet spent more time feeding and less time rooting, suggesting a higher degree of satiety. Providing the feed in a long line rather than a pile meant that low ranking sows were able to obtain access to feed undefended by dominant animals (Martin and Edwards, 1994).

Braund et al. (1998) fed sows housed outdoors a conventional diet once daily, a high fiber diet once daily or a high fiber diet *ad-libitum*. All diets provided the same daily energy allowance and were served to the sows as a 16 mm diameter roll. Sows fed a high fiber diet spent more time lying and less time performing foraging behaviors than sows fed a conventional diet, however this reduced foraging behavior was not sufficient to reduce pasture damage to a commercially acceptable level (Braund et al., 1998).

Summary

Outdoor housed sows spend more time active, including spending more time foraging. This increased foraging behavior can led to increased pasture damage even when different forages are provided. However, little is known about the effect of feeding system on the productivity and reproductive performance of outdoor group housed gestating sows.

Research needs

- More information on the effect of different diets and forages to prevent pasture damage and increase the productivity and well-being of outdoor reared sows.

Others

There were several specific characteristics of group housing systems which could not be explored due to the lack of information on these characteristics in regards to the production and well-being of group housed and group fed gestating sows.

Research needs

- Information is needed on the effect of genetics, feed/water resource location, group type, air quality and timing of grouping on the production and well-being of group housed sows group fed.

Conclusion:

Managing group feeding in group housed systems is a major challenge for producers particularly in respect to managing individual sow feed intake so that all animals maintain a uniform and healthy body condition score throughout gestation. Furthermore, good management of gestating sows that are group fed will depend on other aspects of the housing system, such as space allowance, group size and bedding. The objective of this review was to address how specific characteristics of group housing systems that incorporate group feeding impact production performance/efficiency, lifetime productivity, and overall well-being of the sow. However, there were limited studies evaluating the impact of group feeding on group housed sows in differently managed systems, especially in regards to production performance/efficiency, lifetime productivity, and overall well-being of the sow. Therefore, there are numerous gaps in our knowledge in regards to how best manage group housing systems that group feed gestating sows. Several factors appear to affect the productivity and well-being of group housed and fed gestating sows, including space allowance, feeding frequency and provision of bedding. The main gaps in our knowledge include information on the impact of genetics, group size, air quality, time of grouping and group type. These findings are summarized in the producer factsheet and research needs assessment.

Literature cited

Andersen, I.L., K.E. Bøe, and A.L. Kristiansen. 1999. The influence of different feeding arrangements and food type on competition at feeding in pregnant sows. Appl. Anim. Behav. Sci. 65: 91-104.

Arellano, P.E., C. Pijoan, L. B. Jacobson, and B. Algers. 1992. Stereotyped behavior, social interaction and suckling pattern of pigs housed in groups or in single crates. Appl. Anim. Behav. Sci. 35: 157-166.

Barnett, J.L., C.G. Winfield, G.M. Cronin, P.H. Hemsworth, and A. M. Dewar. 1985. The effect of individual and group housing on behavioural and physiological responses related to the welfare of pregnant pigs. Appl. Anim. Behav. Sci. 14: 149-161.

Barnett, J. L., P.H. Hemsworth, G.M. Cronin, E.A. Newman, T.H. McCallum, and D. Chilton. 1992. Effects of pen size, partial stalls and method of feeding on welfare-related behavioural and physiological responses of group-housed pigs. Appl. Anim. Behav. Sci. 34: 207-220.

Barnett, J. L., G.M. Cronin, T.H. McCallum, and E.A. Newman. 1993. Effects of pen size/shape and design on aggression when grouping unfamiliar adult pigs. Appl. Anim. Behav. Sci. 36: 111-122.

Barnett, J. L., G.M. Cronin, T.H. McCallum, and E.A. Newman. 1994. Effects of food and time of day on aggression when grouping unfamiliar adult pigs. Appl. Anim. Behav. Sci. 39: 339-347.

Barnett, J. L., G.M. Cronin, T.H. McCallum, E.A. Newman, and D.P. Hennessy. 1996. Effects of grouping unfamiliar adult pigs after dark, after treatment with amperozide and by using pens with stalls, on aggression, skin lesions and plasma cortisol concentrations. Appl. Anim. Behav. Sci. 50: 121-133.

Boyle, L.A., F.C. Leonard, P.B. Lynch, and P. Brophy. 2002. The influence of housing system on skin lesion scores, behavior and responses to an ACTH challenge in pregnant gilts. Irish J. Ag. Food Res. 41: 181-200.

Braund, J.P., S.A. Ewards, I. Riddoch, L.J. Buckner. 1998. Modification of foraging behavior and pasture damage by dietry manipulation in outdoor sows. Appl. Anim. Behav. Sci. 56: 173-186.

Brouns, F., and S.A. Edwards. 1994. Social rank and feeding behavior of group-housed sows fed competitively or ad libitum. Appl. Anim. Behav. Sci. 39: 225-235.

Danielsen, V., and E-M. Vestergaard. 2001. Dietry fibre for pregnant sows: effect on performance and behavior. Anim. Feed Sci. Tech. 90: 71-80.

Hemsworth, P.H., M. Rice, J. Nash, K. Giri, K.L. Butler, A.J. Tilbrook, and R.S. Morrison. 2013. Effects of group size and floor space allowance on grouped sows: Aggression, stress, skin injuries, and reproductive performance. J. Anim. Sci. 91: 4953-4964.

Jensen, T.B.,R.N. Kirkwood, A.J. Zanella, and R.J. Tempelman. 2007. Influence of gestation housing on sow behavior and fertility. J. Swine Health Prod. 15: 132-136.

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

Kongsted, A.G., J.E. Hermansen, and T. Kristensen. 2007. Relation between parity and feed intake, fear of humans and social behavior in non-lactating sows group-housed under various on-farm conditions. Anim. Welfare. 16; 263-266.

Martin, J.E., and S.A. Edwards. 1994. Feeding behavior of outdoor sows: the effects of diet quantity and type. Appl. Anim. Behav. Sci. 41; 63-74.

McGlone, J.J., E.H. von Borell, J. Deen, A.K. Johnson, D.G. Levis, M. Meunier-Salaün, J. Morrow, D. Reeves, J.L. Salak-Johnson, and P.L. Sunderg. 2004. Review: Compilation of the scientific literature comparing housing systems for gestating sows and gilts using measures of physiology, behavior, performance, and health. Prf. Anim. Scientist. 20: 105-117.

Rizvi, S., C.J. Nicol, and L.E. Green. 1998. Risk factors for vulva biting in breeding sows in south-west England. Vet. Rec. 143: 654-658.

Rachuonyo, H.A., V.G. Allen, J.J. McGlone. 2005. Behavior, preference for, and use of alfalfa, tall fescue, white clover, and buffalograss by pregnant gilts in an outdoor production system. J. Anim. Sci. 83: 2225-2234.

Salak-Johnson, J.L., S.R. Niekamp, S.L. Rodriguez-Zas, M. Ellis, and S.E. Curtis. 2007. Space allowance for dry, pregnant sows in pens: Body condition, skin lesions, and performance. J. Anim. Sci. 85: 1758-1769.

Salak-Johnson, J.L., A.E. DeDecker, M.J. Horsman, and S.L. Rodriguez-Zas. 2012. Space allowance gestating sows in pens: Behavior and immunity. J. Anim. Sci. 90: 3232-3242.

Schneider, J.D., M.D. Tokach, S.S. Dritz, J.L. Nelssen, J.M. DeRouchey, and R.D. Goodband. 2007. Effects of feeding schedule on body condition, aggressiveness, and reproductive failure in group-housed sows. J. Anim. Sci. 85: 3462-3469.

Séguin, M.J., D. Barney, and T.M. Widowski. 2005. Assessment of a group-housing system for gestating sows: Effects of space allowance and pen size on the incidence of superficial skin lesions, changes in body condition, and farrowing performance. J. Swine Health Prod. 14: 89-96.

Whittaker, X., S.A. Edwards, H.A.M. Spoodler, A.B. Lawrence, and S. Corning. 1999. Effects of straw bedding and high fibre diets on the behavior of floor-fed group-housed sows. Appl. Anim. Behav. Sc. 63: 25-39.

Zurbrigg, K., and T. Blackwell. 2006. Injuries, lameness and cleanliness of sows in four group-housing gestation facilities in Ontario. J. Swine Health Prod. 14: 202-206.

Producer factsheet

Space allowance

- Smaller space allowances (≤ 2.3 m^2/sow) may result in:
    - Increased competition, especially at feeding, resulting in more aggressions,
    - Higher lesion scores
    - Increased incidence of vulva biting
    - Increased incidence of sham chewing
    - Increased stress levels
    - Lowered immune response
    - Decreased body weight and body condition scores
- Larger space allowances can positively affect some aspects of sow reproductive performance.

Group size

- Smaller group sizes (10 sows per pen) results in fewer skin injuries / lesions.
- Smaller group sizes (10 sows per pen) results in increased live weight gain in gestating sows.
- Group size did not affect other measures of stress or reproductive performance.

Flooring and bedding

- Solid concrete flooring may increase the risk of injury and mortality in gestating sows.
- Providing bedding (straw or peat moss) can reduce:
    - The performance of stereotypic behaviors
    - Lesion scores
    - The stress response
- Providing bedding (straw or peat moss) can increase:
    - The performance of lying in a lateral recumbent posture (more relaxed posture)
    - Aggressive interactions
    - The incidence of vulva biting

Pen shape/size

- Pen shape (small and rectangle) may reduce aggressive interactions at grouping.
- Pen shape / size did not affect lesion scores.
- Pen size did not affect body condition scores.
- Pen size did not affect reproductive performance.

Feeding regime

- A high fiber diet can reduce vulva biting.
- A high fiber diet can reduce the performance of stereotypic behaviors.
- A high fiber diet can reduce the performance of aggressive behaviors.
- Low-ranking sows perform better (body weight gain) when feed is provided *ad-libitum.*
- Wet feed reduces aggressive behaviors.
- Fewer feedings per day may decrease vocalizing.
- Fewer feedings per day may increase the incidence of aggressive interactions.
- Fewer feedings per day may increase the incidence of vulva biting.
- Increased feeding frequency may increase average daily gain in gilts, but no sows.

Group formation criteria / mixing

- Grouping sows after dark can reduce aggressive interactions immediately after mixing.

- Partial feeding stalls or *ad-libitum* access to feed can reduce aggressions at the time of feeding.
- Different group formation criteria had no effect on skin injuries / lesion scores.
- Grouping sows of similar parities may be advisable to reduce the effect of social ranking on sow productivity and reproductive performance.

Outdoor systems

- Outdoor housed sows spend more time active, including spending more time foraging. This increased foraging behavior can led to increased pasture damage even when different forages are provided.

Research needs assessment factsheet

Space allowance

- Comparison of different space allowances within group housing systems in relation to sow parity, genetics and group type (static vs. dynamic) as all these factors can potentially impact the optimal amount of space required by gestating sows.
- In the majority of studies reported, sows were floor fed, therefore a comparison of different group feeding systems is needed.

Group size

- More research is needed on the effect of different group size on the productivity, reproductive performance and well-being of gestating sows, to determine the optimum group size for group housed sows that are group fed.
- A comparison of different group feeding systems in relation to group size is needed.

Flooring and bedding

- A comparison of different flooring types and bedding materials in relation to group feeding systems on the productivity, performance and well-being of gestating sows.
- More information on the effect of flooring type and bedding materials on productivity and reproductive performance of gestating sows.

Pen shape/size

- More information on the effect of pen size and shape (without the confounding factor of space allowance) on the production and well-being of group housed sows with different group feeding systems.

Feeding regime

- More information is needed on the effect of feeding regime (diet type and feeding frequency) on different group housing feeding systems, especially in regards to reproductive performance.

Group formation criteria / mixing

- More information on the effect of different group feeding systems in relation to group formation criteria on the performance and well-being of group housed sows.
- Understanding the impact of parity and/or social rank on the productivity and well-being of group housed, group feed sows.
- More information on different grouping criteria on the productivity and well-being of group housed, group feed sows, such as group dynamics or body condition score.

Outdoor systems

- More information on the effect of different diets and forages to prevent pasture damage and increase the productivity and well-being of outdoor reared sows.

Others

- Information is needed on the effect of genetics, feed/water resource location, group type, air quality and timing of grouping on the production and well-being of group housed sows group fed.