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The Impact of Gestation Housing Systems on Sow Longevity

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Introduction

Recent announcements by many of the major US commercial pork producers to begin phasing out gestation stalls from their production systems has resulted in even greater interest in group gestation housing systems. In the late 1960s or early 1970s pork producers began moving their gestation sows from group housing systems, ranging from outdoor lots, pens in barns and other existing facilities, pens in renovated finishing facilities, to individual gestation sow housing systems or what is commonly referred to as the gestation stall. These facilities are specifically designed with the aim to provide individual sow management. What was lacking in many of the older group housing systems was the ability to provide individual feeding and health management. New innovations in housing systems have included electronic sow feeders (ESF) and other technologies in order to provide individual management to sows in a group sow housing system. Group gestation housing systems will introduce many new management challenges for those involved with commercial pork production. This paper is designed to give an overview of impacts that gestation housing systems have on sow longevity. Additionally, this paper will examine the impact that genetics might have on the behavior of sows housed in a group gestation housing setting.

Longevity Definition

Before a discussion on longevity can begin, the trait needs to be defined. In fact, one could argue that longevity is not the appropriate term to use in the pork industry. As it relates to humans, longevity implies living to one's natural lifespan. In the pork industry very few animals remain in the herd until through their natural life span, estimated to be between 12 and 15 years (Pond and Mersmann, 2001). Sows are culled when their productivity declines below some point or the sow has some reproductive problem or failure. Hence, a more appropriate term might be sow productive lifetime or something similar.

Defining sow longevity can differ depending on the goal of the study or the goal of the evaluation. For example, an economic evaluation could be concerned with lifetime productivity while genetic, nutritional or other studies might be concerned with length of life, herd life, productive life, parity removed, or some similar measure. D'Allaire et al. (1992) suggested that there are several ways to evaluate longevity in swine operations including removal rate, culling rate, replacement rate, percent gilts in herd, mean parity of females in inventory, and mean parity at removal. When making longevity comparisons across herds or operations, culling and replacement rate values can differ based on methods used to calculate values (D'Allaire et al., 1987). The values can also vary depending on which record keeping system is used and whether they adhere to the

National Pork Producers Council's Production and Financial Standards. In many cases, management practices employed by commercial pork operations make it difficult to use or apply simple definitions for sow longevity. For example, when replacement gilts are purchased and their birth dates are not provided, there is no way to accurately arrive at a length of life measure. It is clear that appropriate measures of longevity are dependent upon the objectives of the study.

Defining Sow Housing Systems

There are many types of systems when you begin to think about sow housing (stalls, tethers, groups, electronic group systems, straw bedded pens, etc.). Of course, the most widely used system in the U.S. is the stall or gestation stall. There is more variation or more types of loose housing systems. This is likely the result of an industry that is in the infancy stage or we have not settled on a standardized system. Before the U.S. pork system settles on a relatively standardize group housing system the sow management considerations and other factors will need to be worked out. Different group housing systems include static or dynamic groups. Facility variations include stall type (half stall, self locking, etc. feeding system (floor feeding, trickle feeding, electronic sow feeders, etc.), and facility (hoop structures, confinement structures, etc.). The management and other factors impacting sow longevity or sow productive lifetime likely differs depending on the type of gestation housing used (stall vs. group housed). Additionally, within the group housing system, management factors that will improve sow productive lifetime will likely differ based on the type group housing system utilized.

Housing Influence on Sow Longevity

Studies directly relating housing, flooring, and other environmental issues related to sow longevity are not plentiful. Muirhead (1981, 1983) outlines the advantages and disadvantages of different systems of sow housing. Comparisons between group and individually housed sows for different traits that can have an influence on sow longevity including trauma or injuries (lameness, shoulder sores, vulva biting, etc), general management (working conditions, sow observation), health (cross infections, new infections, exercise, etc.), nutrition , well-being, and other traits. All of these factors can indirectly or directly impact sow longevity. As you might expect, there are advantages and disadvantages relative to sow longevity for all sow gestation housing systems.

den Hartog et al. (1993) evaluated different sow housing systems with regard to productivity, labor input and management, well-being, health, and economics. Further, den Hartog et al. (1993) reiterated five criteria that have been previously identified that should be avoided when developing housing systems for sows "1. malnutrition, 2. thermal and physical discomfort, 3. injury or disease, 4. suppression of normal behavior, and 5. fear and stress." Similarly, den Hartog et al. (1993) pointed out research that has identified requirements of sow housing systems from a commercial pork producer perspective that include "1. high biological performance, 2. low labor input, 3. ease of management, 4. acceptable capital cost, and 5. acceptable financial returns". In the den Hartog et al. (1993) study, the major difference between the different housing systems was replacement rate which favored ($P < 0.05$) stall housed sows when compared to tethered or group housed sows (Table 1). They also reported that the stall housed sows had lowest hoof lesion score when compared to the other types of gestation housing systems evaluated. However, it is difficult to determine whether these effects are direct results of the housing system or from other factors or a combination of other factors within the study.

Bates and coworkers (2003) conducted a study which compared two gestation systems, stalls (SG) and group housed and fed with an electronic sow feeder (ESF). In their study, the percentage of sows returning to estrus was not different between the treatment groups. However the percentage of sows returning to estrus by 7 days post-weaning was 72.0% for the ESF group while the SG group was only 68.4, a difference of 3.6% that was significant ($P < 0.05$) (Table 2). Farrowing rate was also higher ($P <0.05$) for the ESF group (94.3%) when compared to the SG group (89.4%), a difference of 2.9%. Sows not returning to estrus and found in pig (contributes to lower farrowing rate), often are culled shortening their productive lifetime or reducing their longevity. However, this same study indicated that lactating sows had poorer weaning performance when housed in a group with an electronic sow feeder compared to lactating sows housed in farrowing stalls. Hence, in this case one could extrapolate that sows housed in a stall have poorer longevity that sows that were group housed and fed with an electronic sow feeder.

Morris and coworkers (1998) compared the performance of sows housed in conventional gestation stalls and the Hurnik-Morris group housing system. This system was described by Morris and Hurnik (1990). I will paraphrase their description of the system as follows: Briefly, this system consists of pen housing for a group of six sows and multiple pens which provide 2 m^2 per sow. On the ends of the pens are computer controlled entrance and exit gates. The entrance and exit ends have 1.2 m and 1.8 m wide walkways that are made of slats that are slightly elevated and extend into the pen 1.8 m on the exit side of the pen only. The flooring between the two elevated slatted areas is solid concrete where bedding can be used. Two drinkers are located near the exit of each pen. There is a walk way to a feeding area where there is the same number of electronic feeders as there are sows per pen. The exit gate of a pen is designed to open at the same time the feeder entrances are open. After the sow enters the feeder and an electronic identification is read the feeder door closes behind the sow. The computer is set to allow sows to feed approximately 10 minutes. After feeding is complete, the sow feeder raises to allow the sow to exits to the alley where sows are allowed 10 minutes to return to their pen where the entrance has been electronically opened. Sows are moved to their pen by a moving electric gate if they do not move from the alley to their pen within the allotted time, usually 10 minutes. If a sow does not exit the feeder a small electrical impulse (like an electric fence) is used to encourage her to move back to her pen. Additionally, there is separate pen housing (1.8 m x 3.6 m pens) for boars where exposure of sows can occur for estrus detection and breeding pens (3.0 m x 3.6 m). The boar pens are located near the exit of the feeders. If sows leaving the feeder remain near the boars an electronic recording of the time and duration of the sow’s visit is made which indicates the sow(s) may be in estrous. The report indicates the sows were fed 3 times per day using this system. No cost estimates of this system were provided. They reported that lifetime number of pigs born alive ($P < 0.02$) and weaned ($P < 0.045$) were higher for sows housed in the Hurnik-Morris group housing system (Table 3). Additionally, the number of sows removed or culled from the conventional stall system was higher ($P < 0.25$) when compared to the Hurnik-Morris system. They concluded that the higher parity found in the Hurnik-Morris system as well as the greater lifetime productivity indicates that the system supports greater longevity and the system has positive effects on animal well being (Morris et al., 1998).

However, other studies have reported results that conflict with the Morris et al. (1998) results. Backus et al. (1997) reported that sows gestated in stalls took fewer days to return to oestrus after weaning than sows that were group housed with electronic feeders. Barbari (2000) reported lower farrowing rates for farms that have group gestational housing. Stone (1981) and Friendship et al. (1986) both reported that improved sow longevity did not appear to be associated with sows housed in either individual stalls or grouped in pens during gestation. Svendsen (1975), in a study involving a limited number of farms, suggested that sows individually stalled during gestation had less culling when compared to sows housed in a group housing system. Number of piglets born alive tends to be similar in group stall gestational housing (Cronin et al., 1996; Backus et al., 1997). Conversely, Christensen et al. (1995) reported that straw bedding appeared to provide protection against gastrointestinal disorders. Abiven et al. (1998) indicated farms housing sows in stalls were at a higher risk of high mortality when compared to farms that tether sows during gestation. D'Allaire et al. (1992) reported that sows housed in individual stalls during gestation were less likely to die when compared to tethered sows.

The body of research literature (McGlone et al., 2004) seems to point to the fact that there is no clear cut advantage to any sow gestation housing system. Specifically, these reports do not seem to indicate a clear advantage for group or stall gestational systems for sows as it relates major contributors to sow culling or improved longevity, reproductive failure, and sow performance.

Housing Effects on Sow Injuries

Numerous studies have examined environmental effects on factors, like injury, which impact sow longevity through increased culling and mortality. Feet and leg soundness, locomotion problems, and claw disorders can be major contributors to sow culling. Olsson and Svendsen (2002) reported no claw injury differences in group housed sows when the dunging area was either solid concrete, partially slatted with concrete slats, or partially slotted with plastic slats. Further, Van Steenbergen (1989) indicated that an important contributor to constitution failure is leg and claw disorders. Douglas and MacKinnon (1993) stated that leg weakness accounts for a high percentage loss in first litter sows. Smith and Robertson (1971) reported excessive culling among sows housed in stalls or on group housing on partially slatted floors during gestation. This study found that feed and leg injuries led to partial or complete posterior paralysis (downer sows) that most commercial pork producers have experienced at one time or another. Some of the reported injuries in the Smith and Robertson study (1971) were attributed to poor casting, improper handling, and wear and tear on the slats. Similarly, D'Allaire et al. (1989), who reported that annual culling rates were higher in herds that had totally or partially slatted floors during gestation. MAFF (1981) found that where problems occurred in dry sows, there was no difference between sows housed on solid or perforated flooring. They further describe the most common problem in sows housed on perforated floors was injured teats. Ehlorsson et al. (2002) described that sows on partially slatted floors had more foot cracks and heel injuries when compared to sows housed on solid concrete floors or on straw bedding. In this study, severe foot injuries were two to three times higher on the partially slatted flooring when compared to either solid concrete or straw bedded pens.

Anil et al. (2001) reported that as size of sow increased in relation to individual gestation stall size, injury score also increased. In this same study, back injuries were related to gestation stall width, and the amount of time required for the sow to get up and lie down increases as sow size increases in relation to sow stall length. Additionally, Anil et al. (2003) reported that injury scores were higher in group pens with electronic sow feeders. However, as body weight increased, injury scores decreased for sows housed in the group pens. There was a significant negative association between second parity and total injury scores. Karg and Bilke (2002) reported higher mortality rates (12.2%) in outdoor production systems when compared to the mortality rate (5.1%) in indoor systems in Hungary. In the same study, average parity at death was 3.6 in indoor and 2.5 in outdoor production.

These studies appear to suggest that leg soundness scores, poor structure, or animals having a substantial number of feet and leg problems will not fare well regardless of the type of housing system utilized. Further, all commercial pork operations should require that all incoming replacement gilts have a thorough feet and leg evaluation in order to enhance the probability of that female having a long and productive life in the breeding herd.

Stockmanship

The type of sow gestation housing system can impact the stockmanship or the level of stockmanship that can be implemented on commercial pork production operations. Common management practices and the stockmanship of persons employed on pork operations does influence factors known to contribute to culling and / or mortality of sows from the breeding herd. Loula (2000, 2002) indicated that an inexperienced labor force having very little training and little background with livestock can contribute to high mortality for his veterinary clients. Additionally, he reported that sow observation is an important key to reducing sow mortality. Different sow housing systems may offer different capacities to accurately and clearly observe each sow in the operation on a daily basis. Castro and Piva (1999) suggest that management and human resources play an important role on all productivity aspects of modern swine operations. Further, English (2002) has pointed out the importance of good stockmanship on swine well being and productivity. Certainly, many stockmanship factors are important in the improvement of sow longevity. This seems to indicate that appropriate employee training programs are essential, particularly for those workers without previous livestock experience.

D'Allaire et al. (1989) reported that herd size greater than 150 sows had higher annual culling rates. However, determining whether these differences were due to herd size, general management, or culling criteria in the herds with fewer than 150 sows was not possible. Numerous studies have reported that sow mortality rate was significantly associated with average female inventory (Christensen et al., 1995; Abiven et al., 1998; Koketsu, 2000; Sukumarannair et al., 2003). Babot et al. (2003) reported that intermediate herd size (401-600 sows) had the best lifetime productivity when compared to herds with fewer than 200 sows or greater than 800 sows. To the degree that sow housing systems impacts stockmanship or the ability to apply consistent outstanding stockmanship, longevity may be influenced by the type of housing system employed. It could be as simple that our mechanized sow housing system has allowed fewer people to manage more sows which in turn reduce the amount of time that a stockperson can spend observing any one sow within a large commercial herd of breeding females. However, Again, applying the results of this study are difficult as the U.S. pork industry has evolved such that very few sow herds of this size exist other than in the niche systems. This demonstrates the difficulty of predicting results of sow studies based on previous work because the industry has changed so much. How does the concept of group gestation play in a system that designed to wean 2000 pigs a week? This requires more 150 sows to farrow each week let a alone a total sow herds of 150 sows.

Genetic Selection for Sow Behavior
Livestock breeding programs have focused on improving traits of economic importance for many decades (Kanis et al., 2005). However, consumers are beginning to attach value to traits that have little or no direct economic effect at the farm level. These types of traits have been dubbed "societal important trait" (Kannis et al., 2005). It first glance, selection of gilts that interact well in a group sow housing situation may appear to be one of these "societal important traits"; however, selecting for animals that perform well in a group situation may have direct economic impact to a pork producer as well as being socially important.

Many producers have provided anecdotal evidence that some sows are less aggressive or more docile and have the temperament to perform better in a group sow housing situation. In fact, there are some classic studies that have examined how animals perform in a group setting or the so called competitive effects (Muir, 2005). Muir (2005) has stated that competition among domesticated animals can adversely impact productivity, in the case of sows, number born alive, number weaned, return to estrus, etc. The typical quantitative genetic selection ignores the competitive effects or interactions could result in selecting the wrong animals for a situation where the animals must perform in a group setting, in this case group sow housing situation. Technology now exists where effective selection can occur which account for the competitive effects that exist in any situation where a group of animals interact in a group, for example sows housed in a group setting, finishing pigs housed in a pen of 25 (small pen finishing) or 150 (large pen finishing), or a group of 2 or 3 hens housed in the same laying cage.

One commercial swine breeding stock company has attempted to select for group sow housing effects. Newsham Hybrids (USA) began working with the competition effects and incorporating the effects in the genetic evaluation models (Gunsett, 2005). From 1996 through 2002, Newsham developed and marketed the GENTEL® program that largely focused on the production of sow lines. After selection had occurred for several generations, Newsham (Gunsett, 2005) concluded anecdotally "that behavior within a pen appeared to be more docile, space allocation within a finishing pen could be reduced, reduced mortality of small pigs and finishing pigs was reduced, increased percentage of pigs were marketed at full market value". Additionally, Gunsett (2005) stated that the change in behavior could have a positive impact on the image of confinement production.

Molecular Selection for Traits related to Sow Longevity

Given that genetics will play a role with sow longevity and the ability of sow lines to perform well in a group setting as suggested above, it will likely be possible to find molecular markers that could be useful in identifying individuals or lines that may be more adaptable in a group sow housing setting. Molecular markers for improved length of productive life may have promise for improving the trait whether through direct effects or traits that impact longevity indirectly, for example behavior and its impact on sow production traits.

Recent work have identified molecular markers that ultimately may prove to be beneficial for improving length of productive life or sow longevity in commercial swine operations. Mote and others collected tissue samples from approximately 2,000 crossbred sows and obtained corresponding production information from two commercial pork operations in the Midwest. They evaluated seven markers IGFBP1, IGFBP2, IGFBP3, IGFBP5, COX2, CPT1A, and SLC22A5 on the entire data set. Four (IGFBP1, IGFBP3, CPT1A, and SLC22A5) of the seven genetic markers were significantly associated ($P < 0.05$) with a sow's ability to reach parity 5. Additionally, all but one, IGFBP3, of the seven genetic markers was associated with various other economically important reproductive traits. Most importantly, the favorable genotype for reproductive traits was also the favorable genotype for improved length of the sows' productive life for the genetic marker within the gene IGFBP1. Additionally, the genotype for CPT1A that was favored for sow productive life was also significant ($P < 0.05$) and favored for number of pigs born alive and total lifetime number of pigs born. By evaluating the genotypic frequency of the favorable alleles in the present population, it is evident that several of these genetic markers could be used to improve sow longevity or length of productive life as well as other reproductive traits through their use in a marker assisted selection program. This is just one example of the use of molecular genetics in improving a trait. As more molecular information become available, it is likely that other genes will be found that impact both economically important traits, like longevity, number born alive, etc. and the so called societal important traits., like behavior,

Conclusion

Gonyou (2002) indicated that there are numerous management options in group housing systems and that few standardized statements or recommendations can be made that apply to all group housing systems. The body of research papers reported on in this paper point to the fact that sow housing systems and their effects on sow productivity and longevity become difficult to determine when so many differences exist within let alone across sow housing systems. This is particularly true of the relatively new group sow housing systems. These studies points out the difficulty in documenting the specific challenges, either longevity or any other production parameter, because of the numerous criteria and the fact that there is no representative or standard group or individual sow housing system. Moreover, few studies make direct comparisons between different housing systems because they are costly to conduct and few entities are in a position to make these evaluations because of the lack of different facilities under the same management, using the same or similar genetic lines of females and other factors that would standardize the study so that the only differences are housing. These factors demonstrate the need for well designed studies to determine the differences between sow housing systems. That said these studies are difficult to conduct because of the necessary population size and associated costs to accurately estimate differences due to sow housing type. It appears to boil down to the fact that acceptable performance can be attained in a variety of sow gestation housing systems.

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Table 1. Comparison of three farm systems for pregnant sows (least square means ± SD) (Adapted from den Hartog et al., 1993).

	Housing		
Item	Stall	Tethering	Group
No. of litters	933	956	951
No. of pigs born alive	10.32 ± 3.0[a]	10.07 ± 3.0[b]	10.11 ± 3.1[a,b]
Average birth wt., g	1538 ± 235[a]	1,532 ± 241[a]	1507 ± 249[b]
Mortality, %	10.7	10.6	11.9
No. of litter per sow per year	2.24	2.24	2.22
Weaned pigs per sow per year	20.1	19.5	19.1
Replacement of sows during the study, %	43.7[a]	53.2[b]	55.6[b]
Timer per 24 h spent			
Sham chewing, %	9.58	7.63	7.29
Bar biting, %	0.20	0.92	0.00
In apathathy, %	0.19	0.27	0.29
Hoof lesion score			
4 wk Gestation	2.8	2.7	3.5
15 wk Gestation	4.0	4.0	6.8

Table 2. Treatment percentages for subsequent return to estrus variables and farrowing rate from sows housed in either gestation stalls or group housed with an electronic sow feeder (Adapted from Bates et al. 2003).

	Treatment	
Item	Gestation Stalls	Group housed – Electronic Sow Feeder
Return to estrus, %	91.7	94.5
Return to estrus, 7 days postweaning, %	68.4^{c}	72.0^{d}
Farrowing rate, %	89.4^{c}	94.3^{d}

Table 3. Trait LS means examining the effect of housing in gestation stalls (GC) and in the Hurnik-Morris (HM) system on sow and litter performance (Adapted from Morris et al. 1998).

Trait	GC	HM	SEM[a]	P
Initial and maintained herd size	29	23		
Total number of sows used in the study	90	59		
Average parity of sows	2.6	3.1	0.10	0.05
Total born / litter	10.2	10.8	0.53	0.21
Number born alive / litter	9.4	10.1	0.33	0.11
Number weaned / litter	8.0	8.6	0.26	0.14
Litter birth weight, kg	15.7	16.3	0.54	0.45
Litter weaning weight, kg	63.6	66.4	3.85	0.42
Lifetime total born / sow	27.2	35.1	2.52	0.02
Lifetime born alive / sow	25.1	32.8	2.31	0.02
Lifetime number weaned / sow	21.5	27.2	1.97	0.05
Lifetime weight of pigs born / sow, kg	43.1	53.1	4.01	0.08
Lifetime weight of pigs weaned / sow, kg	173.4	215.5	17.65	0.10

[a]Standard error of the mean