Management and Feeding of Group-Housed Gestating Sows

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Summary

Moving pregnant sows from individual stalls to group housing will require many changes in management and feeding practices to maintain optimal biological performance and sow welfare. Dietary energy requirements of sows may change compared with stall housing but requirements for other nutrients are not likely to change significantly. Producers may need to consider feeding requirements to support optimal sow welfare just like they have historically considered feeding requirements for optimal pig production and sow longevity. Even though sows are housed in groups, caretakers must employ an "animal-directed" approach to satisfy the needs of individual sows. The move from individual stalls to group housing will require a honing and fine-tuning of the caretakers' pig knowledge and observational skills to ensure all sows receive proper care which leads to optimal performance.

Introduction

Market and societal concerns are pushing pork producers in the U.S. to adopt group housing systems for gestating sows. This shift raises many questions concerning the management and feeding of sows in groups. To maintain optimal performance, sows are fed restrictively during gestation which causes sows to experience hunger throughout pregnancy. When sows are housed individually, hungry sows express increased stereotypic behaviors as a way of coping with hunger (Johnston and Holt, 2005). Individually-housed sows have almost no other methods of dealing with reduced supply of feed. However, in group housing systems where sows have greater freedom of movement and greater interaction with contemporaries, sows become aggressive with penmates as they attempt to access more feed to satisfy their hunger. This aggression creates challenges for the proper supply of nutrients to each individual sow, may compromise the welfare of individual sows especially sows at the bottom of the social rank, and may decrease the productive life of sows.

Group housing of sows forces pork producers and their advisors to consider a wide array of factors that interact to provide the proper nutrition of the sow. Some of these factors relate to changes in the biological needs of the sow elicited by the housing system. Other factors relate to the method of feed delivery and specifics of the group housing systems employed. The ultimate goal is to maintain productive sows that experience optimal welfare.

Biological Changes in Nutrient Requirements

Moving sows from an individual housing system to a group housing system is unlikely to change the sow's requirements for amino acids, minerals, or vitamins. However, energy requirements of sows could change as a result of moving to group housing. The changes in energy needs are difficult to predict accurately because not all group housing systems provide similar environmental conditions for the sow. Body weight of sows, expected litter size, thermal environment, and activity level all interact to determine an individual sow's energy requirement. Sow body weight and predicted litter size are not expected to change substantially when sows move from individual to group housing (Table 1; Johnston et al., 2013). In contrast, thermal environment experienced by sows and measured as effective environmental temperature could change dramatically. The effective environmental temperature is a combination of ambient air temperature, humidity, presence of drafts, flooring type (bedded or not), ability of sows to huddle with penmates, and whether sows can stay dry. All these factors converge to determine the temperature sows experience and ultimately influences the sow's daily energy requirement.

The National Research Council (NRC, 2012) recently published a mathematical model to predict energy requirements of gestating sows. This model relies on scientific estimates of the effects of environment and housing conditions on energy requirements of sows.

The NRC model can be used to demonstrate how the environmental conditions mentioned above can influence energy needs of pregnant sows (NRC, 2012; DeRouchey and Tokach, 2013). The scenarios displayed in Table 2 depict a given sow (Parity 2 sow weighing 165 kg at mating and 225 kg at farrowing) under a variety of environmental and housing conditions. The scenarios assume feed offered contains 3,300 kcal ME/kg, 9% fermentable fiber and that there will be 5% feed wastage.

Effects of Temperature and Housing

The lower critical temperature for sows housed individually is 20° C. Once environmental temperatures fall below 20° C, the sow must consume increased energy to maintain body weight gain. Decreasing ambient temperature from 20 to 10° C increases daily energy requirements by 2,163 kcal ME daily (Scenario 1 vs. 2) or 655 g of feed daily. In other words, for every degree below 20° C (defined as a degree of coldness) energy intake must increase 216 kcal (65 g of feed) daily. In contrast, the same temperature drop (from 20 to 10° C) in group housing only requires daily ME intake to increase 721 kcal (Scenario 4 vs. 5) which is equal to 218 g of feed. Because group-housed sows can and do huddle together, less feed is required to adjust to colder temperatures for two reasons. First, the lower critical temperature for group-housed sows is 16° C instead of 20° C for individually-housed sows. So, group-housed sows do not begin to feel the cold and require additional feed until the temperature gets to 16° C. Second, group-housed sows can conserve heat while huddled together so each degree of coldness only requires 120 kcal of ME (36 g of feed) instead of 216 kcal required by individually housed sows. If room temperature and activity level are equal, group-housed sows require about 15% less energy and feed than similar sows housed individually (Scenario 3 vs. 5).

Theoretically, energy requirements of sows will increase once environmental temperatures exceed the sow's upper critical temperature. However, since most pregnant sows are limit-fed, environmental temperatures above the sow's upper critical temperature are not considered important under practical conditions (NRC, 2012).

Effects of Sow Activity

Activity utilizes energy so increases in activity require additional dietary energy. Activity is often defined as standing, walking, and exploratory behaviors in swine. Activity level of sows can increase in any housing system for various reasons. But, one would expect activity of group-housed sows to increase compared with individually-housed sows because sows have greater freedom of movement (Salak-Johnson et al., 2012). Salak-Johnson et al. (2012) reported that activity of group-housed sows with varying floor space allowances ranged from 135 to 240 minutes daily. Increasing activity from 120 to 240 minutes daily increases energy requirements about 313 kcal ME which can be satisfied with an increase of 94 g of feed (Scenarios 1 vs. 4 and 2 vs. 3).

Effects of Bedding

Bedding, usually straw, is almost never used for individually-housed sows but can be used in group-housing systems. Bedding has value as an insulator in cold temperatures and can reduce the energy requirement of group-housed sows by 479 kcal ME daily (Scenario 5 vs. 6). The presence of bedding reduces the lower critical temperature of group-housed sows to 12° C. Bedding's value as an insulator against heat loss is greatly diminished if the bedding becomes wet. Fortunately, sows in group housing systems often have the ability to select the most desirable locations for lying and may be able to avoid uncomfortably wet bedding in cold environments.

Practical Implications

As mentioned previously, it is nearly impossible to provide a broadly applicable, accurate prediction of energy requirements for group-housed sows because conditions are not standard across group housing systems. Moving sows into groups will make them better able to resist cold temperatures due to their huddling behavior; however, they will likely increase activity which will require more energy than individually-housed sows. So, producers can use the guidelines listed here to provide a starting point for adjusting the feeding programs to account for group housing. Of course, careful monitoring of sow body weight gain, sow body condition and sow performance will provide the most accurate assessment of needed changes in nutrient intake levels for pregnant sows moved to group housing.

Diet and Feeding Management to Improve Welfare of Group-Housed Sows

The market-driven shift from individual stalls to group housing of pregnant sows is based on an expected improvement in sow welfare. Improvements in sow welfare resulting from the increased freedom of movement can be erased quickly by excessive and un-controlled aggression among sows in group-housing systems. Aggression at the time sows are mixed in the group and daily aggression, particularly at feeding time, can cause injury, lameness, low feed intake, and poor performance of sows (Kemp and Soede, 2012). Young sows are usually subordinate to older sows in groups and become the recipients of greater aggression than older, dominate sows. The negative effects of this aggression against subordinate sows can be dramatic. Li et al. (2012) reported that farrowing rate increased from 67% to 94% when first-parity sows were mixed and housed with gilts compared with sows. In pens with sows, the first-parity sows were the subordinate females and the recipients of increased aggression and injuries. However, in gilt pens, first-parity sows were not the focus of aggression from older sows. Interestingly, performance of gilts housed with first-parity sows was not reduced. Reduced feed intake during pregnancy, even drastic reductions for as little as 36 hours, can reduce pregnancy rate of sows and litter size. Kongsted (2006) studied 14 commercial herds to understand the relationship among feeding intake, stress, and reproductive performance. Backfat gain in the first three weeks after mating was used as a proxy for feed intake of sows mixed in groups at about 8 days postmating. She reported over a 9 percentage point greater pregnancy rate in sows that gained 1 mm of backfat depth weekly compared with sows that lost 1 mm of backfat depth weekly (Fig. 1). So, pork producers need to consider feeding and management approaches to mitigate the negative effects of aggression among sows in group-housing systems so that individual sow performance and welfare can be optimized.

Nutrition and feeding management can play a role in controlling aggression among sows. Historically, producers and swine nutritionists have focused on the nutrient needs of sows to optimize reproductive performance and more recently, sow longevity. However, as the industry moves sows to group-housing systems, we might have to consider nutritional requirements for optimal sow welfare in addition to those needed to satisfy performance and longevity goals. There might be one level of nutrient/feed intake necessary to support optimal reproductive performance and a higher level required to support optimal sow welfare (Johnston and Holt, 2005).

Reducing Aggression at Mixing

One of the periods of most intense aggression among sows is at the time of mixing. Controlling aggression at this time would be very useful in helping mitigate the negative effects of aggression on sow welfare and performance. A common recommendation is to increase feeding levels right before and for a couple days after mixing to reduce aggression (DeRouchey and Tokach, 2013). The central idea is that sows are more satiated by elevated feeding levels and are more inclined to lie down and less apt to seek a fight with penmates. Full-feeding for 24 or 48 hours after mixing can markedly reduce the number of aggressive interactions among sows while feed is available. In many commercial settings, full-feeding is not practical but significant increases (100%) in feeding levels likely will help reduce aggression. One must be on the lookout for increased feed wastage with such high feeding levels.

The amino acid, tryptophan, has been investigated as a supplement that might reduce aggression among sows at mixing (Li et al., 2011). Tryptophan is a precursor of serotonin. Serotonin has sedative effects by suppressing aggression, excitement, anxiety, and pain. Supplementing crystalline tryptophan to the diet at 2.3 times the requirement for three days before and three days after mixing in pens had no significant effects on the incidence of aggression among sows. The authors theorized that the limited feed intake of sows (2.3 kg/d) during the period after mixing overwhelmed the ability of dietary tryptophan to exert any sedative effects on recently weaned and mixed sows.

Managing Individual Nutrient Intake to Control Competition in Group Housing

Throughout gestation, sows housed in groups are subjected to competition among penmates for resources (feed, water, lying space) which may lead to aggression from penmates. Much of this aggression stems from the fact that sows are limit-fed during pregnancy. Limiting feed intake increases frustration in sows and contributes to increased incidence of stereotypic behaviors. Stereotypic behaviors such as sham chewing, bar biting, and nosing or licking the floor when feed is not present are used as an indicator that sows are not satiated. Simply increasing the amount of feed offered will reduce the incidence of stereotypic behaviors because sows are more satiated (Bergeron et al., 2000). Sows that are fuller with feed are less likely to engage in aggressive acts with penmates. Unfortunately, increasing feed intake supports excessive maternal gain in body weight which suppresses feed intake during the subsequent lactation and compromises sow longevity. So, large increases in feed intake to control aggression are not practical in commercial production settings.

An obvious solution is to dilute the energy and nutrient density of the gestation diet so that increased feed intake is possible without the associated excessive increases in sow body weight. Typically, this approach employs high levels of dietary fiber. Stewart et al. (2010) fed sows a wheat-barley-soybean meal control diet (5% crude fiber) or a high fiber diet (15% crude fiber; 30% soy hulls + 14 % sugar beet pulp) to sows housed in dynamic groups with an electronic sow feeder and observed the activity of newly-introduced sows. The high fiber diet significantly increased lying time of sows and decreased standing, sitting, and exploratory behaviors (Table 3). These behavioral changes suggest that the sows were more satiated and content. The high fiber diet had no effect on the occurrences of aggressive behaviors after mixing but did reduce the incidences of head thrusts and biting during the 12 observation periods beginning at mixing and lasting for 3 weeks after mixing. The overall incidence of aggression in this study was very low and may not be characteristic of other dynamic group housing systems. This study suggests that high fiber diets can influence behavior of sows but the evidence supporting a reduction in sow aggression is weak. The apparent increase in sow contentment displayed by increased lying behavior may be elicited by the slow digestion of high-fiber diets and the prolonged postprandial peak in blood glucose concentration. Diets high is fermentable fiber (45% sugar beet pulp) fed to sows elicit a higher and more stable concentration of glucose between meals compared with a conventional grain-based diet. The elevated glucose between meals suggests that sows feel more satiated and are more content.

The beneficial effects of dietary fiber on sow satiety and behavior are not always consistent. Jensen et al. (2012) fed sows a restricted quantity (2.6 to 3.0 kg/d) of high-fiber diets that contained 20% pectin residue, 45% potato pulp, or 33% sugar beet pulp and measured the sows' motivation to consume feed. Compared with a barley-wheat control diet, sows fed the high fiber diets did not express a reduced motivation to consume feed as expected. Only when a high fiber diet containing a mixture of pectin residue, potato pulp, and sugar beet pulp was offered in a semi-ad libitum setting did sows show a reduced motivation to feed. This study suggests that potential benefits of high fiber diets on sow satiation and potentially behavior may be mitigated by offering restricted amounts of feed. Holt et al. (2006) included 40% soybean hulls in a corn-soybean meal based diet hoping to reduce stereotypic behaviors of limit-fed sows housed in individual stalls. Increasing crude fiber from 2.7 to 14.8% had no influence on expression of stereotypic behaviors by sows. The lack of effect may have been do to the highly insoluble character of the fiber used and(or) the limited amount of feed (2.19 kg) offered daily to sows. Presumably, if the high-fiber diet did not influence expression of stereotypic behaviors, it is unlikely the high-fiber diet would influence aggression in group-housed sows, but this was not tested directly. More recently, Li et al. (2013) reported that gestating sows fed a diet containing 40% dried distillers grains with solubles (7.16% ADF) in dynamic groups with access to an electronic sow feeder displayed increased aggression toward penmates compared with sows fed a corn-soybean meal diet (3.10% ADF). In apparent contrast, if sows were housed individually in gestation stalls, the DDGS-containing diet increased lying time and decreased stereotypic behaviors suggesting that sows were more content than contemporary sows fed the corn-soybean meal control diet. The differential effect of dietary DDGS on sow behavior across housing systems is puzzling.

Considered in total, there seems to be little chance for using increased dietary fiber to mitigate aggression among group-housed sows when sows are fed restrictively. If any fiber source could reduce aggression, it seems that a highly fermentable fiber has the best chance of success. Nonetheless, it seems that any potential benefits of feeding high-fiber diets on sow behavior and aggression are overwhelmed by the negative effects of restricting feed intake needed to prevent sows from becoming too fat during gestation. The best approach to controlling aggression from competition for feed may be to employ a non-competitive feeding system (e.g. electronic sow feeder, or free access stalls) but capital and installation costs, and available space in existing or new buildings may not be available for such feeding systems.

Stockmanship

The move from individual stalls to group housing for gestating sows requires important changes in how animal caretakers approach their duties. In a stalled system, a given sow is always in the same place each day. If a given sow is sick and not eating, this is easily detected because her allotment of feed remains well after all other sows have consumed their allotment. If a sow requires special attention for ill-health or other conditions, the caretaker simply records the location of the sick sow and can return to that location multiple times to find the sow. However, in a group system, sows are mobile so a sick sow cannot necessarily be identified by remaining feed or her location. So, caretakers must be more cognizant of sow behavior to identify sick sows, injured sows, and submissive sows that are not consuming sufficient feed. Producers that successfully implement a group housing system must adopt an "animal-directed" approach that focuses on individual sows (Kemp and Soede, 2012).

An animal-directed approach means that caretakers consider and evaluate each individual sow even though they are housed in groups. The first goal is to determine if all sows are consuming their allotted quantity of feed.

As discussed earlier, suboptimal feed intake compromises sow welfare and performance. The submissive sows in a pen are most at risk for low feed intake. Submissive sows may have the following characteristics: 1. they sleep alone rather than with the other sows in the pen; 2. they routinely are lying in the most undesirable locations in the pen; 3. when approached by a human, they are quicker than more dominant sows to flee and not return to the human; 4. they suffer a high number of scratches and injuries on the rear portions of their bodies that were received when retreating from fights; and 5. they seem to lose most of the fights with penmates at mixing time. In systems with electronic sow feeders, the submissive sows tend to be the last sows to access the feeder during a feeding cycle. If submissive sows are not accommodated in some way, they often will display poorer body condition than more dominant penmates. Feed wastage can be a problem in some group housing systems so feed allotments may need to be increased 5 to 10% to account for this wastage if it cannot be controlled (Johnston, 2010). The second goal of an animal-directed approach is to ensure all sows are healthy. Caretakers must be keenly aware of sow behavior to discern which sows are experiencing ill-health. Sows that seem depressed, are slow to rise and move, display obvious injuries or lameness, have bloody discharges or blood-stained hams and rear legs, and are isolated from and not interacting with penmates. Some feeding systems, such as an electronic sow feeder, may help identify sick sows. The feeding order of sows in a pen is rather consistent with an electronic sow feeder (Kruse et al., 2011). Sows that do not eat their daily allotment of feed at their usual spot in the order may be sick and should be given a special inspection.

The National Pork Board has recently commissioned a group of scientists and extension specialists to develop a "How To" management guide for gestation housing systems. The guide was developed for barn managers and barn workers in one of six gestation housing systems. The gestation housing systems include: individual stalls, group pens with electronic sow feeders, group pens with feeding stalls, group pens with free access (self-locking) stalls, group pens with trickle feeding, and group pens with floor feeding. Each guide includes management recommendations for feeding, mixing, health care, building and equipment maintenance, heat detection, worker safety, and many other nuances specific to each housing system. Each guide also includes a suggested routine for daily monitoring of the sows and the barn. These management guides are in final review and should be available sometime late in 2013.

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Table 1. Effects of individual stalls or pens during gestation on sow weight change and subsequent litter size[1].

Item	Stalls	Large Pens[2]	Small Pens[2]	Pooled SE	P value
No. of sows	326	335	154	--	--
No. of stalls or pens	326	13	26	--	--
Sow wt. gain in gestation[3], kg	41.5[a]	33.4[b]	39.5[a]	1.64	0.01
Pigs born live/litter	12.3	12.5	12.2	0.21	0.66
Pigs weaned/litter	10.3	10.2	10.1	0.20	0.89

1 Johnston et al. (2013)
2 Large pens = 26 sows/pen; Small pens = 6 sows/pen
3 Body weight change from day 35 to 109 of gestation
ab Means in the same row with different superscripts differ ($P < 0.05$).

Table 2. Energy and feed requirements of gestating sows[1,2]

	Scenario					
	1	2	3	4	5	6
Housing system	Individual			Group		
Sow standing time[3], min/day	120	120	240	240	240	240
Temperature,° C	20	10	10	20	10	10
Floor type	Slat	Slat	Slat	Slat	Slat	Straw
Feed intake (d 0-90)[4], kg/d	2.11	2.80	2.90	2.21	2.44	2.29
Feed intake (d 0—114)[4], kg/day	2.20	2.89	2.99	2.30	2.53	2.38
Energy required, kcal ME/d	6,890	9,053	9,367	7,203	7,924	7,445

1 Adapted from NRC (2012).
2 Assumed parity 2 sow with breeding weight of 165 kg and target final body weight of 225 kg. Diet was assumed to contain 3.300 kcal ME/kg and 9% fermentable fiber.
3 Estimated from Salak-Johnson et al. (2012).
4 Estimated feed intake includes required feed and 5% wastage. Feed intake was increased 400 g/d from day 90—114 of pregnancy.

Table 3. Effects of a high-fiber diet on behavior of gestating sows[1]

	Diet		
Behaviors	**Control**	**High Fiber**	**P value**
Lying[2]	0.689	0.765	< 0.05
Standing[2]	0.293	0.226	0.05
Sitting[2]	0.018	0.009	< 0.05
Exploration[2]	0.296	0.217	< 0.05
Aggressive encounters[3]	0.05	0.05	NS
Head thrusts[3]	0.02	0.00	< 0.01
Biting[3]	0.02	0.01	< 0.05

1 Stewart et al. (2010).
2 Percent of observation time recorded during 12 periods over 3 weeks after mixing.
3 Occurrences/min of observation time.

Figure 1. Relation between back fat gain in the 3 weeks after mating and pregnancy rate of sows housed in groups (Kongsted, 2006).