Animal Well-Being

Group Housing Systems: Production Flow and Management

The statements and opinions expressed in this article are those of the author(s).

Objectives

- Understand how variability in sow breeding group numbers can be managed in group housing
- Managing sows in pens, including heat checking and routine daily management
- Identifying and managing compromised sows
- Managing the environment

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Introduction

This factsheet will outline important issues to consider when developing operating procedures for sows housed in groups during gestation. Topics addressed within this factsheet are those pertinent to issues that may arise after sows are placed into pens. Certainly there are important criteria to consider in developing decision rules in forming sow groups. However those principles are covered within the *Group Housing Systems: Forming Gilt and Sow Groups* factsheet. Please review that factsheet to determine how best to place sows into groups.

When managing sows in groups, similar conception and farrowing rates should be expected, compared to sows housed in stalls [1]. However sows must be provided adequate feeding space, feeding opportunity, floor space and access to water, along with maintaining the preferred ambient temperature range and providing appropriate care. Increases in culling due to injury may occur, dependent on the group housing system used and management employed [2]. For the most part, decisions governing the flow or the "snake" of gestation sow housing will be similar to that of sows that are housed in stalls. However there are important differences in managing sows in pens versus sows in stalls that will be coved in this factsheet.

Managing Gestating Sow Flow

In developing the production flow two key elements are critical. The first is having a feeding place for each sow, and the second is having adequate floor space. Adequate floor space for sows in group housing is not a well-established standard. For example the European Union requires 24 sq. ft. per female while no such regulatory standard exists in the U.S. In general, the scientific literature suggests that floor space allocation for mixed parity groups of females (i.e. gilts, young and older sows in the same pen) should be a **minimum of 18 sq. ft.** per animal, and can be dependent on group size. For larger sows more space is often suggested. In addition, floor space allocation per sow should never drop below **15-16 sq. ft.** per female and if females are housed at this square footage, increases in injuries and culling should be expected, resulting in a decrease in performance capabilities [3-4]. Please see the *Group Housing Systems: Floor Space Allowance and Group Size* factsheet for more information on floor space for group housed sows.

Within this factsheet, reference will be made to the *minimum* floor space of 18 sq. ft. per female as well as the design specification for floor space. The *design specification* for floor space is the target floor space that is to be provided for each sow (e.g. 20 sq. ft.) within the design of the facility. In managing sows in gestation, both the concern of adequate feeding space and floor space will be discussed in managing production flow.

Females Group Penned After Mating. If sows are to be group penned immediately after mating the number of spaces needed to house them through gestation will be the number of sows per breeding group multiplied by the number of weeks in gestation. In other words approximately 16 weeks of sow inventory will be needed in gestation housing, if penned within a few days after mating. To better illustrate this issue an example of a weekly breeding schedule will be used. The weekly breeding targets will be 120 sows per week, which approximately represents a 2,500 sow herd. If the herd you manage is smaller or larger than this number, it can be changed dependent on the relationship to a 2,500

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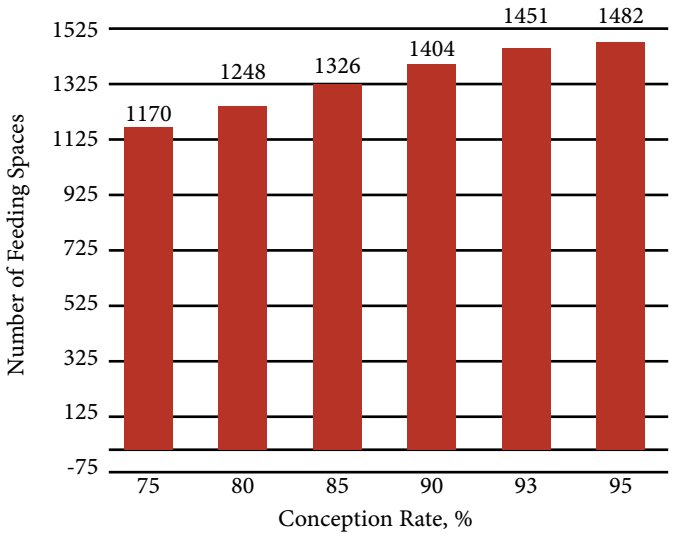
sow herd. For example if the herd in question is 1,250 sows, the example can be reduced by 50%. A 625 sow herd would reduce the example to 25%. For larger herds the example can be changed accordingly. For example a 3,650 sow herd would increase the example by 150% while a 5,000 sow herd would increase the example by 200%.

When sows are grouped immediately after mating, there should be a feeding space for each sow within a breeding group. Within the previously mentioned example each breeding group should have 120 feeding spaces. How the feeding spaces are configured will be dependent on the feeding system used. If sow groups remain static (see *Group Housing Systems: Forming Gilt and Sow Groups* for more information), in that there will not be new sows added to pens with resident gestating sows, then the number of sow feeding spaces needed for gestation will be equal to the target number of sows to be bred each week multiplied by the number of weeks in gestation. For the example of 120 sow breeding group this would equal 1,920 gestation feeding spaces (120 sows per week * 16 weeks of gestation). Care will need to be taken to account for the number of sows per pen so that there is a good understanding of how many pens will be needed for each breeding group. For instance if sows are placed into electronic sow feeding (ESF) pens, the entire breeding group could be placed into one large pen with two ESF feeders, or divided into two pens with 60 females each and one ESF feeder in each pen. However, if sows are to be placed into small pens, 20 sows per pen, then 6 pens will be needed to properly house each breeding group.

With sows penned in groups after mating, there will be sows removed from their breeding group and pen as gestation progresses, particularly those that recycle or need individualized care. Therefore as the number of sows per pen is reduced, the question arises if sows from other sow groups can be moved into the pens to take the place of the removed females to more efficiently use sow gestation space. Moving new sows into pens with resident sows is often referred to as dynamic grouping (see *Group Housing Systems: Forming Gilt and Sow Groups* for more information). Dynamic groups are best used for larger versus smaller pen groups. There is risk of injury when moving sows into pens with resident sows. Research suggests that if 20% or more of the total sows in a pen are new sows, fighting and injuries are reduced compared to when new sows make up 10% or less of the total sows in the pen [5]. Furthermore floor space allocation should be at or above the design specifications when forming dynamic sow groups to minimize fighting and injuries [6].

For sows that are penned after mating in dynamic groups (e.g. ESF and Free Access Stalls (FAS), fewer gestation spaces will be needed than for static groups penned after mating. After estrous detection is completed at 21 days following mating, females that recycle will be removed and returned to the breeding area. Three weeks of gestation space will be needed for all of the females mated. After estrous detection and removal of open females, space will be needed to house 13 week inventory of gestating sows. Using the 120 sow weekly breeding target example, 360 spaces would have to be available to house sows that have been mated and not passed estrous detection at 21days after mating. After recycled sows have been removed from pens, space would be available for new sows. Continuing with the 120 sow weekly breeding group example, if conception rate was 85%, 1,326 spaces would be needed for gestating sows (120 sows *0.85 conception rate*13 weeks). Therefore to house females that have been mated and not completed 21 day pregnancy detection and sows that have been confirmed pregnant, 1,686 spaces would be needed (360+1,326), in this example. In Figure 1 is description of the number of spaces needed for 13 weeks of gestation with differing conception rates.

Figure 1. Number of Feeding (Sow) Spaces per 13 Weeks of Sow Gestation Inventory with Varying Conception Rate



Based on a 120 weekly breed target, forming groups at approximately 30 days of gestation.

Dynamic Grouping Guidelines. For farms using dynamic sow grouping, the following guidelines can be used to guide the formation of dynamic groups; 1) Each sow should have an available feeding space; 2) Floor space allocation for the completed sow group should be at or above the design specification; 3) Do not mix new females into groups that are at 1-3 weeks of gestation; 4) The number of new sows entered into the group should be greater than 20% of the total, 5) Feed new entrants their daily allotment before placement into pens, 6) Mix in the evening in low light if possible and 7) Ideally, new introductions should not occur more frequently than every five weeks.

Females Group Penned After Pregnancy Detection. For sows that are to be group housed after pregnancy detection, it is assumed that after weaning, sows will be housed individually in stalls for a minimum of 3 weeks. While in stalls, estrus will be detected and individuals mated. Females will remain in stalls through pregnancy detection, which will typically occur between days 21 and 42 days of gestation before females are moved into pens. Following confirmation of pregnancy, pen space for 12-13 weeks of gestation for the sow inventory will be needed, depending on if sows are

placed into pens at 3 or 4 weeks of gestation. Less pen space will be needed if sows are grouped into pens later in gestation.

Conception rates can be expected to vary by 10-15 percentage points from breeding group to breeding group. For example if conception rates average 85-90% for the year, there will be individual breeding groups that will have conception rates as low as 70-75% while others will be near 100%. When housing sows in stalls, sows in breeding groups that have exceptionally high conception rates will be placed into available stalls without regard to restraints on space availability unless there is a shortage of gestation stalls, overall. However, this can be more challenging when housing sows in groups.

When moving a breeding group to gestation pens, a feeding space should be available for every sow along with appropriate floor space and water availability. As the number of total feeding and housing spaces in gestation are determined for the farm, variation in conception rates must be considered so that appropriate housing for every pregnant sow is accounted for. This will be challenging when breeding groups have higher than average conception rates. If the total number of sow spaces is determined based on average conception rates the number of spaces available for sows may be inadequate if conception rates run higher for a season, for example summer versus winter. Within the example of a breeding target of 120 females and an 85% conception rate, 13 weeks of inventory would require 1,326 spaces. However if for a season conception rates run higher than the average more spaces would be required. For example if for 13 weeks conception rate was 90%, the number of gestation sow spaces needed would be 1,404. The number of spaces necessary for 13 weeks for different conception rates when the breeding target is 120 females per week are shown in Figure 1.

Managing these deviations in production flow is more challenging for group sow housing than for individual stall housing but is also dependent on the type of feeding and housing system used. For non-competitive feeding systems (e.g. FAS and ESF) varying numbers of sows per breeding group is less of an issue, as long as adequate floor space is provided and the feeding system can handle the varying number of sows per group. In a FAS system, as long as there is a stall for every female in the group, there is less of a concern even when sows are housed in dynamic groups. This is because females will often stay in the stalls for extended periods of time and the number of sows that are outside of the stalls will be less than the total number of sows in the group. This will reduce the number of aggressive actions taken against new members and submissive sows. When utilizing ESF systems, new group members will be protected during feeding, and will be able to consume their daily feed allocation without interruption. This is dependent on the feed station setting, which should allow all sows assigned to an ESF station to consume their feed allocation during the feed cycle.

For competitive feeding systems (e.g. floor feeding, trickle feeding, feeding stalls, etc.) that have a designated number of feeding places per pen (e.g. 20 feeding places), the number of sows per pen cannot exceed the number of feeding spaces. This can create difficulties when penning sows. Using our previous example of 120 sows per breeding group assume that a breeding group (Group 1) has a conception rate of 85% (Table 1). In this case Group 1 would have 102 sows to place into pens and each pen has 20 feeding spaces. These females would be placed into 5 pens with 2 sows in a 6th pen. If the next breeding group (Group 2; Table 1) has a 90% conception rate, 114 sows would have to be penned into 5 pens with 14 sows placed into a 6th pen. To house 13 weeks of gestating sows, and efficiently use space, sows from two different breeding groups will be mixed in one pen. If all sows within a breeding group are moved to pens at one time, sows will be mixed twice, so to fill all pens, which will cause an increased risk of injury and culling. For example, if Groups 1 and 2 (Table 1) were consecutive breeding groups, it would be logical to either place 18 sows from Group 2 into the pen of 2 sows from Group 1 to complete the pen or to place the fourteen sows from the second group in with the two sows from the first group. However, since the two sows from the first breeding group would be mixed twice within a week, they would be expected to have an increased risk of culling due to injury. Furthermore, if the 14 sows from Group 2 were placed into the pen of two sows from Group 1 the pen would have 16 sows and not 20. Depending on the conception rates of subsequent breeding groups it may be necessary to place four more sows into that pen, thus mixing sows two to three times. This further increases the risk of injury and culling.

Table 1. Penning Breeding Groups with Varying Numbers of Sows per Group

	Breeding Group Number	
Item	1	2
Number of Sows Mated	120	120
Conception Rate, %	85	90
Number of Sows to be Penned	102	114
Number of Sows per Pen	20	20
Number of Complete Pens and (20 sows per pen) extra sows	5 pens + 2 sows	5 pens + 14 sows

For competitive feeding systems, it is recommended that static groupings be used; forming pen groups once and not adding further sows into the pen once the pen has been formed. Therefore if the number of sows from a breeding group does not evenly divide into the number of pens provided, and a partial pen will be needed, it is suggested to hold the remaining sows in breeding stalls and move them to pens when forming the next breeding group, so that pens are filled at one time, and sows are mixed just once, this eliminates the need for a partial pen. For example consider the two weekly breeding groups of 102 and 114 mentioned in Table 1. The first 100 sows in Group 1 would fill 5 pens (20 sows/pen). The remaining two sows should be held until the next week and then moved into pens with the subsequent breeding group. This same practice should be used for the remaining 16 sows in the second group (2+114=116 sows).

For the second group, 100 sows would be placed into pens and the remaining 16 sows will continue to be housed in breeding stalls until the following week. This allows for sows to be mixed once and should reduce aggression and instance of injury. Care would need to be taken to make sure that sows from different breeding groups that are penned together be identified and taken to farrowing at the appropriate time.

For housing systems that will use dynamic groups (e.g. ESF, FAS, etc) when penning sows after pregnancy detection, please see the previously mentioned Dynamic Grouping Guidelines. **However caution must be used to identify sows from different breeding groups within the gestation facility or "snake" so that they can be moved to farrowing at the appropriate time.**

Increasing floor space to accommodate varying group size. For some group housing systems, it may be easier for the feeding system to accommodate differing sow group numbers than for others. For example ESF and floor feeding do not have a set number of feeding spaces where as feeding stalls (including trickle feeding) and FAS do. For pens that are equipped with feeding stalls and FAS the number of sows per pen cannot exceed the feeding spaces. However, with ESF and floor feeding, adjustments can be made to accommodate larger than expected sow groups. To accomplish this, in most cases the design specification for floor space must be at or above 22 sq. ft. per sow, if not higher. The higher the design specification for floor space the easier it will be to place more sows into a specified number of pens and maintain floor space allocation above the minimum of 18 sq. ft. Using the 120 sow breeding target as an example, assume that the design specification for floor space is 22 sq. ft. per female. Therefore when placing an average breeding group of 102 sows into pens the space allocated will be 22 sq. ft. per sow. However, if a breeding group experienced 95% conception rate, 114 sows would need to be placed into pens. The 114 sows could utilize same number of pens as the 102 sows and the space allocation per sow would be 19.8 sq. ft. Although this is below the design specification for the system, it would still meet the minimum specification of 18 sq. ft per female. **As long as the feeding and watering system can accommodate the increased number of females per pen** this can be a satisfactory solution to accommodate the increased number of sows that can occur due to variation in conception rates. This method should work best if gilts and younger parity sows are allocated to pens within increased stocking density, providing them at least 18 sq ft of floor space, while older sows are stocked near design specifications to provide them more space. If this option is considered when building new facilities or renovating old ones, care should be taken to develop the design specification for floor space to be high enough to accommodate the variation in breeding group size typically seen within the farm. More information on space allocation can be found in the *Group Housing Systems: Floor Space Allowance and Group Size* factsheet.

Incorporating Gilts into the Breeding Herd. Successfully managing and placing newly mated gilts into the breeding herd is a critical component to maintaining a high performing sow herd. Gilts do not need as much floor space as older sows and can be housed at 15-18 sq. ft. without experiencing detrimental effects on performance. When forming groups with gilts, they should not be mixed with older parity sows if possible. Research indicates that older sows are more aggressive to younger females which results in an increased risk of injury and culling [6-7]. At the time gilts are placed into pens they should be housed with other gilts or younger parity sows, if possible. Please review the *Group Housing Systems: Forming Gilt and Sow Groups* factsheet for further information.

For ESF systems, gilts should be trained to use the ESF station before mating and penning during pregnancy. Typically gilts are trained to use the station for 2-3 weeks before they are mated and integrated into the sow herd. For example if gilts are typically mated at 8 months of age they can be moved into the breeding herd facilities at or soon after 7 months of age and trained to use the ESF station. Once this has been accomplished, heat can be detected and females mated. Once mated, gilts can then be managed according the procedures developed for forming sow groups.

Managing Females Group Penned After Mating. Females that are group penned after mating must be monitored for return to estrus with 21 days of mating. This is no different than managing mated females in stalls however the management techniques involved will vary depending on the housing system. When housed in groups stock persons should carefully observe daily sow behavior. Sows returning to estrus will exhibit their full complement of estrous behaviors. Sows will often become more vocal when in heat and also may be less interested in feeding. In addition, their vulva will redden and become swollen in appearance. Furthermore they will become rigid in their stance when pressure is applied to their back or when approached by a boar. Often females in estrus will pull their ears back when exhibiting standing estrus.

Exposure to mature boars is the most effective means in detecting heat in sows and gilts. When housed in pens, boars should be used to check for heat if at all possible. This can be done in multiple ways. Depending on the design of the gestation barn, boar stalls can be strategically placed near pens to be used for estrous detection. Females in pens can be moved from their pens into a pen adjacent to the boar in the stall. The act of moving females from their home pen to a pen adjacent to a boar along with boar contact will increase the likelihood to detect females returning to heat [8].

Another method that can be used is moving a boar into and out of pens to detect females in heat. Since inseminated females will not be in stalls, boars will have physical contact with females. Physical boar contact will stimulate a greater percentage of females to express behavioral estrus. If in heat, females more often will stand solid for the boar and exhibit many of the typical signs of estrus. However, boars can be more difficult to manage during physical exposure with estrous females. Stockpersons should carry sorting boards with them to direct the movement of the

boars and use them to push down boars that attempt to mount. In addition, boars may need to be rotated more often when allowing them physical contact with estrous females. Boars can become very aggressive when exposed to multiple females in heat and begin jumping and riding every female, regardless of estrous status, which could cause injury to sows and stock persons. Stock persons must be safety conscious when using boars to detect heat.

Depending on the configuration of pens and pen size, boars can be held in the alley in front of pens to using fence line contact to detect estrus. Using sorting boards, stock persons can move sows in pens closer to the alley where the boar is being held. Sows can be evaluated for estrus while across the fence from the boar. This method is not as effective when pens are large because of the time needed to move females in large pens to the fence line.

When housed in groups, the first females in heat will stimulate an estrous response for females that will come into heat soon after [9]. Stock persons should monitor pens and watch for females exhibiting visual estrous characteristics as the time for return to estrus approaches after mating. It should be noted that though females in heat will stimulate other open females to exhibit signs of estrus, they will not cause pregnant females to lose their litters.

Pregnancy Detection and Monitoring Returns. For females placed into pens after mating, pregnancy detection and monitoring for returns after pregnancy detection will continue to be a part of the management routine. However, pregnancy detection of sows housed in groups is more challenging compared to sows housed in stalls. Ultrasound devices can be used to detect pregnancy, however, since the sow can move, she may or may not stand still long enough to expedite detection of pregnancy. Stock persons will need to be patient and take the time necessary to complete pregnancy detection. Pregnancy detection may take longer when sows are housed in groups compared to stalls, as well as be more variable in time needed to complete pregnancy detection. Some farms have constructed an alley and chute system for sows in which all sows in the pen are moved into the chute for pregnancy detection and then moved back to their pen afterwards.

After pregnancy detection has been completed sows should be monitored for subsequent returns to estrus. Stockpersons should intently observe sows daily for behavioral signs of estrus to find those that return to estrus. Boar exposure, either direct boar exposure or fence line contact can be used as needed. Also, signs monitored to determine if a sow has aborted her litter, when housed in stalls, may not be useful with sows housed in groups. Things like watching for aborted fetal tissue behind the sow in a stall are not frequently seen when using group sow housing. Stock persons need to be aware that detecting sows that may have aborted their litter after pregnancy detection is more difficult when sows are housed in pens, because aborted fetal tissue can easily drop below the slats, in systems with slotted floors, or be consumed by sows in the pen.

Females Group Penned After Pregnancy Detection. Sows that are group penned after pregnancy detection should have return to estrus monitored as discussed in the previous section. This should be evaluated as a part of daily animal care and will be discussed later in the factsheet.

Outcomes for Open Sows. Females that return to estrus after placement into pens can follow the same protocol as has been established for sows housed in stalls. If a sow is found open and is to be retained in the breeding herd, she should be moved into the breeding area and mated per farm operating procedures. Once mated the sow then would be managed according to farm protocol. Please review the *Group Housing Systems: Forming Gilt and Sow Groups* factsheet for further information. If sows are not to be retained in the herd, they should be managed per farm protocol for cull sows.

In some cases, farms that presently house gestating sows in stalls, will allow recycled sows to remain in the stall in which they were housed when found in heat. These sows are mated and remain in place until time to be moved to farrowing. It is suggested that when this situation occurs with sows housed in pens that sows be moved out of the pen and placed into a new breeding group. However if the farm plans to keep females that recycle in their resident pen, these sows can be mated in the pen and conceive with similar conception rate expectations as to any sow that recycles. Since the recycle sow remains with her pen mates, little if any fighting would be expected. However, this sow will have a different farrowing date than her pen mates. When pen mates are moved to farrowing, the sow with a later due date will have to be moved to some other area to finish her gestation, unless housed in a dynamic grouping system with multiple breeding groups housed in a large group.

Setting Feeding Amounts. Once sows are placed into pens, the amount of feed to be fed to the group of sows must be determined. For females placed into pens after mating, maintenance levels of feed should be provided to them until they achieve pregnancy. Too much feed after mating and before conception can reduce pregnancy rates.

For sows that have had pregnancy detection completed, females should be fed according to their need. Please see the *Group Housing Systems: Nutritional Considerations* factsheet for further information on determining feed allocation for gestating sows. For ESF, individual feed allocations per sow can be programmed into the software and each sow and will be fed a designated amount. For other systems where sows will be allocated the same amount as other sows within the pen, the amount fed will be determined by the condition of the sows grouped within an individual pen. This is one reason why it is recommended that sows of similar body condition be housed together to avoid over conditioned sows to be placed into the same pen as thin sows. This improves the opportunity to feed sows near to their individual need as is possible when group feeding. For systems that use small pens, sows can be penned based

on parity and body condition score. Young and thin sows can be placed in pens, while moderate conditioned sows can be housed by themselves and older and heavier conditioned sows can be penned together. If this type of penning management can be accomplished thin and young sows can be fed more while over conditioned sows can be fed less. This will improve the potential to maintain appropriate body condition across the herd.

It should be stated that though body condition scoring is often used to determine how much feed to provide to gestating sows, body condition scoring itself is an imperfect science. Indeed, it has been shown that the relationship between people assigning body condition scores can be low to moderate [10]. Therefore appropriate training and caution must be used by persons assigning and using body condition scores to set feeding amounts. More information on how to assign body condition scores is available through the National Pork Board.

Daily Animal Care

Within any type of pork production facility, independent of design, the development of daily routines are key to maintaining proper animal care. The primary daily care needs for sows will be the same, regardless if they are housed in stalls or in pens. However the methods used to provide daily care will need to be adjusted so that effective care is given in an efficient manner. As stock persons transition from stall to group housing systems, management should provide opportunities for training and further skill development so to improve the skill and competency of farm staff and maintain the overall productivity of the farm. Providing training will help the farm staff meet and work through the challenges of group housing systems, allowing for minimal effect on farm productivity through the transition period.

Prior to the farm staff entering the barn to start the work day, it is essential that they are prepared. The more time spent in the barns observing the animals, the more they will be able to avoid complications that can arise. Stock persons should be prepared with the needed equipment and supplies to complete their tasks once they enter the barn. A checklist of responsibilities and needed materials will help stock persons organize for the day and negate any reasoning for them going back forth from the animal area to storage and supply areas.

Building observation skills into every task that takes place on the farm will help stock persons accomplish their daily routines while at the same time assessing the soundness and health of the animals. Traditionally, swine farms hire and train stock persons to become task oriented people, who focus on completing singular tasks throughout the day and the succession of these singular tasks to complete the work day. When working with sows housed in groups it is important for stock persons to focus on multiple tasks at one time and be aware of what is happening in the barn as a whole as well as in each pen. Improving stock persons observation skills is a challenging task, however, once accomplished will improve the overall efficiencies on the farm.

Group housing systems can increase the possibility of injury or lameness for the sow. Every time a stock person comes in contact with an animal, they should be evaluating it for soundness and health status. This should happen at every interaction with the sow, including feeding, heat checking, etc. Furthermore as stock persons are walking through the barn from one location to another they should be observing sows in pens as they pass by. It is important that the farm staff be able to identify issues that may arise and take care of those issues, as they complete their duties. For example, in ESF systems, during the initial training period when the training gates are in use, stock persons should regularly check to see if sows are moving through the feed station. It is imperative that each female be trained to feed in the station. Therefore as stock persons are walking through the barns, they need to recognize that sows may need assistance and training to enter into the feed station and to take the time to complete this task so that every sow has an opportunity to consume her feed allotment within a feed cycle. Stock persons must be able to observe and respond to issues as they arise to make group housing successful.

The daily work routine will be different based on the group housing system used. Production staff and farm management should develop a workable outline that highlights the important areas to be evaluated each day. Over time this can be updated and changed to accommodate the particular nuances experienced on the farm. For example, stock persons working in ESF systems will have to be aware of monitoring the radio frequency identification tags used for sows in operation of the feed station. This will include daily monitoring of feed consumed and re-tagging sows as necessary, as well as managing the feed system and training animals to use the feed system. Other group housing systems will have their unique features that must be evaluated daily.

In order to provide a complete evaluation of the animals and the facility, it is essential that the farm staff enter the pens to complete their observations. This will allow them to correctly assess the soundness of each animal and examine the area for equipment problems or failures.

For some large pen systems it has been found useful to provide large mats or bedding for the sows to stand/rest on. Assessing the mats to make sure they are properly attached and in good repair and observing any changes in bedding should be among the daily routine for systems that utilize this type of equipment. Gating or flooring that has become damaged can easily cause injury for the animals and should be repaired in a timely fashion. Walking the pens will also give the stock persons the opportunity to confirm that the water and feed equipment is working correctly. When assessing the animals for general health and soundness, walking the pens will help the farm staff identify animals with a health concern and pinpoint animals struggling with locomotion complications.

Difficulty in locomotion is a common culling reason for sows. Locomotion difficulties are often associated with lameness. This can take the form of short stridedness, inability to put equal weight

on all limbs or limping, stiffness and can ultimately lead to a sow's unwillingness or inability to stand or walk. The cause can range from injury, poor nutritional status, poor environmental conditions, infectious and non-infectious disease and poor conformation. Lameness is especially a concern among group housed sows. Research suggests that lameness is consistently associated with an increased risk of removal among group housed sows [2].

Farm staff should be trained in what situations can lead to lameness and to determine what is considered "normal" when animals are standing and moving. In addition staff should be challenged to identify sows that are in the early stages of changes in stance and gait. For example, sows that may have a wound which could lead to a joint infection should be identified early and treated. Animals that may be just beginning to change the distribution in their weight on their limbs (i.e. beginning to carry a foot, limp or "paw" the floor with one foot) should be identified, examined and treated. In addition sows that may begin to lay away from the group when they had previously been lying with the group may be starting to suffer a malady that should be examined. More information on assessing soundness and conformation can be found within the *Group Housing Systems: Genetic Considerations* factsheet.

Often in group housing, sows undergo routine treatment of feet and claws so as to reduce incidence of cracked hooves, dew claws, cracked and torn hoof pads. Dependent on the system this can be done multiple ways. It is not unusual for sows to be walked through a foot bath that includes copper sulfate mixed with water [7]. Sows would be walked through this mixture when moved including; movement to farrowing, movement to breeding, and if mixed after pregnancy detection, sows could be walked through a footbath when moved to gestation pens. This can help heal and prevent foot and heel lesions. Within ESF systems, a box with lime can be placed within the entry race so that sows walk through the box with lime each time they enter in an effort to keep their feet dry and treat new abrasions and lesions [12].

Identification and Management of Compromised Females

A critical factor when successfully managing sows in groups is the ability to identify sows that are compromised before they become too ill or injured to remain in the group. Care should be taken to identify compromised sows as soon as possible so that they can be treated and remain within the group. In order to complete this correctly, improved and refined observational skills among stockpersons are needed so that they will be able to identify sows whose health may be deteriorating. Cases may arise in which sows will need to be removed from pens for treatment and observation. Within the U.S. there are not established guidelines on how much space should be maintained within a gestation barn for sows that are compromised and removed from pens. However, several European countries have guidelines that suggest that up to 5% [13] of the gestation space should be maintained as "hospital" or "relief" areas for treating compromised sows removed from pens. The space for compromised sows can be pens, stalls or both. Both pens and stalls may be necessary, since some sows will need the extra space in pens to rise and lay down during recovery. It is important to note that in FAS systems, relief areas may not be necessary as long as water is provided in the stalls and sows needing additional care may not need to be removed from the pen. Compromised sows could be locked into a stall, monitored and treated there, as long as the sow can rise and stand within the stall and eat and drink as needed. Once the sow has recovered the stall can be unlocked and the sow can resume exiting into the group area.

Farms must determine what symptoms will trigger sows to be removed from pens. As mentioned previously early detection and treatment of health conditions should be emphasized so that sows can remain in pens. When assessing a sow for lameness, injury or health concerns, management must first consider if the condition is treatable while the sow remains in the pen before determining if the sow should be removed. Farm experience and consultation with the farm veterinarian will help in developing the criteria used to determine what cases will mandate removal. When considering a sow for removal, stock persons should look for sows that are; unwilling or unable to rise or walk, have increased vocalizations when encouraged to stand, reluctant to put equal weight on all feet, have open wounds that compromise their ability to function in the pen and in severe cases have a fever and are trembling. Any of these cases should be considered potential reasons for removal from pens. It should be cautioned though, that relief areas should not be used as crutch to cover up for inadequate sow observation and treatment in pens. Emphasis should be placed on finding compromised sows early in the onset of their health condition and treated as soon as possible, while remaining in their pen.

If sows are to be removed, care should be taken to consider the welfare of the sow during removal. In most cases, compromised sows can be *patiently* moved to relief areas for further treatment. In some cases the animal may be compromised such that she cannot travel to the relief area without assistance. In these cases, the farm must have a plan on how the animal will be moved, or if necessary, euthanized.

Sows that can rise and lay down without much difficulty and assistance can be placed into stalls for treatment. Sows that have difficulty rising or laying down may need to be placed into pens if possible. Part of the pen floor should be solid or have mats placed over a portion of the slats to provide the sow more comfort. This practice can aid in foot and leg health [12]. Mats can become slick if allowed to be covered in manure or exposed to moisture. If mats are used they should be kept as dry as possible. Mat types vary and it is recommended to utilize mats that are perforated to improve hygiene and cleaning, In systems that have solid flooring in relief pens, providing some bedding (e.g. straw) may provide the sow more comfort and assist in her recovery. However, if bedding is to be used, it should not be allowed to become soiled, nor be a detriment to the manure system.

The treatment protocol for compromised females should be developed in consultation with the herd veterinarian. Treatment of wounds, fever, lameness and other health issues routinely observed should be well outlined and discussed with stock people. Records should be maintained on each sow placed into the relief area. These records should include the sow's medical history as discussed in PQAPlus®, and also include the following supplemental information; 1) Date of placement into the relief area and return to gestation pen, if returned, 2) Breeding group and pen, and 3) Expected farrow date. The supplemental information can be used in multiple ways. The date of placement and return and expected farrow date can be used to determine at what stage of gestation sows are moved to the hospital area, their length of stay and if they recover. The pen of origin can be used to return sows to the pens housing their breeding group and the expected farrow date can be used to track when the sow should be moved to farrowing if she remains in the hospital area until her due date. Compiling this information will help the farm management review any routine complications that may occur and aid them in addressing these areas of management.

Reintroduction Strategies for Compromised Sows. Females moved into the relief area, may be re-introduced back with her pen mates, dependent on the group housing system used and the time spent housed away from her pen mates. When sows are re-mixed with females they are familiar with, fighting is reduced compared to when sows are mixed with unfamiliar females [14-15]. Reduced fighting is typically experienced among sows that have been penned together within the previous four weeks and the shorter the time apart the less fighting should occur when reintroduced. Within non-competitive feeding systems (i.e. ESF and FAS), reintroduction may be possible, because pen size may be larger and sows are protected during feeding. The larger pens provide more space for sows to escape from aggressive encounters with other sows. For competitive feeding systems (e.g. floor feeding, feeding stalls, trickle feeding) reintroducing sows back with her pen mates is highly discouraged.

Sows that are in the relief area longer than 3-4 weeks, reintroduction is not recommended. If reintroduction is absolutely necessary, management should closely observe sows that are reintroduced. For ESF systems, the sow may need to be briefly re-trained to use the feeding station and stockpersons should monitor that the reintroduced sow(s) have consumed their daily feed allocation. For FAS systems, sows can be directed into a stall and locked in, as long as there is water available, for a few days for re-acclimation and then allowed out into the group area.

With experience and as only necessary, reintroduction protocols should be developed so as to reduce conflict among the sows and allow the reintroduced sow to maintain her health status and body condition. For sows that are to be reintroduced with their pen mates, the sow in question should be in good health and fully recovered from the condition that caused her removal.

One strategy may be to feed the sow that will be reintroduced her full daily allotment, before placed back into the pen. Systems using FAS could then place the reintroduced sow into stall and lock her in for a few days before allowing her to move out into the free space. Within ESF systems, sows could be fed their full allotment as previously mentioned and then placed into the pens after the bulk of the sows have been through the feeder within a feed cycle. This should occur 12 hours or later in the feed cycle and if possible in the late afternoon or evening when the lighting may be reduced [16]. This should reduce aggression. However, some fighting will occur and stock people should closely monitor reintroduced sows for at least 48 hours to make sure the health and welfare of the reintroduced sow is not compromised.

For those cases where sows have to remain in the relief area for more than 4 weeks, or if their health does not recover to be suitable to be reintroduced back with her pen mates, the sows should remain in the relief area until the time comes to move them into the farrowing area. This guideline can be modified for non-competitive feeding systems based on the system design and the experience of the farm with reintroducing sows back in with their pen mates. After completing lactation, for sows that had extended time in the relief area, it should be determined if they are fit enough to be housed in groups and retained or be culled.

Facility Monitoring and Environmental Management

Gating and Flooring. Maintaining the environment is an important component for group sow housing. Sows will be moving within pens and may be engaged in aggressive confrontations with other sows, especially at the time of mixing. Gating should be maintained so that there are no rough or sharp edges exposed to sows as they move about the pen. Flooring should be also be evaluated to ensure good footing. Slats that begin to deteriorate or are broken should be fixed as soon as possible. Stock persons should evaluate pens daily for sharp or rough edges on gating or inadequate flooring. In addition, stockpersons should also evaluate sows daily for cuts, wounds and other injuries that could have occurred due to changes in penning or flooring. If a sow is found with an injury that could have been the result of gating or flooring maintenance, stock people should evaluate the pen for areas that may have caused such injury and complete repairs.

If facilities use mats or bedding within pens, these comfort materials should also be evaluated daily. Sows will often push mats around and may dung or urinate on them. Mats will have to be managed and stabilized so that they will not fall into manure holding areas and also so that sows can't tear them apart. Bedding should be managed dependent on time of the year. Too little bedding in colder months may be detrimental to the sow's ability to maintain her body temperature. Too much bedding in the summer will cause the sow either to be too hot, or sows will not utilize the bedded area. If sows do not lie in the bedding, they will overcrowd the non-bedded areas. It should be mentioned that bedding is best used by farms in which the bedding will not

negatively impact manure handling. Facilities that have slatted floors only should not consider using bedding.

Watering. Watering devises should be checked regularly and kept in working order. Drinking devises should have adequate pressure to maintain water flow, but not so much that it becomes uncomfortable for the sow to drink water. Gestating sows will drink up to 6 gallons of water per day while in gestation and typically average 2-4 gallons per day [17]. The flow rate for nipple drinkers should be 34 ounces per minute and no more than 15 sows per drinker. For cup drinkers the flow rate should be 4 cups (32 ounces) per minute, with no more than 15 sows per drinker. Farms with ESF feeders that provide water during feeding, can use fewer drinkers outside of the feeding station than farms which use other systems. However farms using ESF should also provide some drinkers outside the feeding station. For farms that feed every sow at once (e.g. floor feeding, FAS, feeding stalls, etc), pens should have adequate drinking capacity available. Since all sows will eat at the same time, they will all be thirsty at the same time. Having no more than 15 sows per drinker, and at least two drinkers per pen is advisable.

Warm Weather. Temperature management for sows in groups will be of similar concern as when housed in stalls. During warm weather, ambient temperature within gestation buildings should be at or within three degrees above outside ambient temperature if at all possible. While completing daily evaluations, sows should not exhibit open mouth breathing nor lying on their side so as to expose the entire side of their body to the floor surface. These are signs that sows may be in heat distress. To alleviate heat distress, the use of sprinkling or cool cells can be used with group housed sows as with sows housed in stalls. Dry and wet concrete will conduct heat away from the animal and can be effective during warmer ambient temperatures. However caution should be taken when using direct water applications to sows housed in pens. Sprinkling or dripping water onto sows in pens can make floors slick and difficult for sows to walk across without injury. Care should be taken so that sprinklers or drippers are on timers that will sprinkle and shut off and are positioned such that sows can be sprinkled and move away. In addition, sprinklers or drippers should be positioned so that feed storage is not affected. The feed in systems such as ESF, and large dump boxes for floor feeding can become wet and difficult for the system to drop feed. If feed becomes wet it and could also become moldy, affecting the daily intake of the sow.

Cool Weather. Sows prefer cooler temperatures to warmer temperatures and are comfortable at 60-65o F. Sows can become chilled if kept too cold, which can adversely affect their productivity and welfare. Stockpersons must be aware that during cold weather, certain materials will conduct or wick away the sow's body temperature. If sows can only lie on concrete, these materials will effectively reduce the temperature by five degrees Fahrenheit (Table 2) even though the ambient temperature may be at or above the sow's comfort zone. The advantage to group housing is that sows can lie together and conserve body temperature but this should be carefully monitored so that sows do not become chilled. During daily observation, sows should not be shivering or huddled so close they begin to pile on top of each other. In addition their skin should be normal in color. Bedding or rubber mats can be used to improve the lying area for sows, especially during colder temperatures, even indoors. As mentioned before, if bedding or mats are used, care should be taken to manage them properly. For more information on bedding, the UK organization BPEX provides a good publication regarding different types of bedding for use with pigs *http://www.bpex.org.uk/articles/301431/Knowledge_transfer_bulletin_15_Bedding_options_for_the_English_pig_industry.aspx,* and Iowa State University has released a publication on the amount of bedding necessary for different stages of swine production *http://www.ipic.iastate.edu/publications/230.BeddingManagement.pdf.*

Table 2. Heat Conductivity of Selective Materials[a]

Item	Change in Heat Conductivity[b], °F
Straw	+5
Plastic Flooring	-3
Dry Concrete	-5
Wet Concrete	-15

[a]Adapted from [18]. [b]Change in effective temperature experienced by the animal, primarily in colder environments.

Summary

Pork producers can expect similar levels of productivity from the sow herd whether housed in pens or in stalls if managed properly in either case. The overall objective for managing sow flow when using gestation stalls and pens is the same; providing the appropriate space, feed and water to every gestating sow. Planning to accommodate differences in breeding group numbers may be more important when housing sows in pens versus stalls and requires adequate planning by the management team. Dependent on when sows are group penned, new estrus and pregnancy detection protocols may need to be developed. In addition, stockpersons must develop keen observation skills and act promptly as sows need treatment or specialized care. Farms will need designated areas to treat compromised sows and provide dedicated care for these animals.

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