

Animal Well-Being



Gestation Stall Design and Space: Care of Pregnant Sows in Individual Gestation Housing

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

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Introduction

The objective of this document and accompanying training material is to describe the best management practices for sows in gestation crates or stalls. If one keeps pregnant sows in individual accommodations, how should they be best managed?

The document will not argue the merits of individual versus group housing for sows during breeding, gestation or farrowing. Also, care of sows in group housing is not an objective of this material. This document is not the proper place for a discussion of the merits and pitfalls of different terminology. Many sows in the world are kept in individual housing systems that are termed crates, stalls or even pens.

Likewise, this document is not the place for a discussion of when gestation starts. Sows are often weaned from a farrowing house and placed in a breeding area that may be a stall or a group pen. After confirmation of pregnancy (about day 35) some sows may be moved from the breeding area to the gestation area. Breeding or gestation areas may be stalls or group pens. Because the management of sows housed in stalls differs little during the breeding and gestation phases, this material may be used for both phases, that is, after weaning and either before or after confirmation of pregnancy.

History of Sow Housing and the Gestation Stall

The domestic pig has been domesticated for over 9,000 years [1]. The European/Asian wild pig was an omnivore that lived in close proximity with humans. At first pigs were hunted, and later they were fed so that hunted herds remained close to human populations. Then, pigs were kept in special pens and fields designed for ease of pig management. Then, from outdoor pastures, indoor-outdoor combined systems were developed. Individual confinement systems were introduced hundreds of years ago, particularly for farrowing. In the 1950s, pigs were kept in organized pens with mixtures of indoor and outdoor systems. Although the farrowing stall was common even 100 years ago, we know in the 1950s producers began exploring keeping pregnant sows in individual accommodations. By the 1960s, individual accommodations during gestation

were common and by the late 1980s the majority of pregnant sows were kept in individual accommodations, most typically the gestation stall/pen. Considering the long history of domestication of the pig, the individual gestation stall is fairly new.

Overall Science of Pregnant Sow Behavior, Physiology, Performance and Health in Stalls and Pens

Much has been written about the science of sows in gestation accommodations. Three reviews of the scientific literature reached the conclusion that sow overall welfare was similar in stalls or group pens [2-4]. A recent update on the scientific literature largely confirmed this view [5]. While one earlier review from European authors suggested sow welfare was better in group housing than in stalls [6], the body of literature supports the notion that sow welfare is similar in well-managed group pens and well managed stalls. This document will address the features that make the gestation stall well managed.

Sow Sizes in Commercial Settings

The size of an individual stall depends, of course, on the size of pregnant gilts and sows and some performance standards that indicate when a stall is of adequate size. First, the sizes of sows will be reviewed, and then performance standards for adequate size will be addressed.

Pregnant gilts and sows vary in body size with age and stage of pregnancy. Older sows are longer, wider and taller than young gilts. And as pregnancy advances, sows clearly get larger in width. Thus, gilt and sow body size changes in an upward-sloping, saw-tooth shape with sows becoming wider as gestation progresses, then less wide after parturition, and all the while getting longer, taller and wider through successive pregnancies. Most sows are not kept past parity 8 and we know that sows grow larger in size through their eighth pregnancy (they may plateau after this point).

A detailed study of sow sizes was made by McGlone, et al. [7] at large-scale commercial swine enterprises. The commercial farm

had similar management and genetics over many sites. Sows body dimensions were measured in relation to parity and stage of pregnancy, genetic lines and individual farms. Mean values of sow sizes are presented in Table 1. Sow height, width, depth and length were measured. Height was the length from the floor to the dorsal (top) surface of the hip of a standing sow. Depth refers to the dorsal (back) to ventral (belly) length which measures the sow size (width) while lying down. Sow width refers to the width of the body at its widest part in this genetic line (the shoulder), or the width while standing. Length refers to the distance from the tip of the snout to the posterior (ham), so length does not include the tail length.

Two key take-home messages were clear from the measure of sow dimensions. First, genotypes differ significantly in body dimensions – some are longer and some are shorter. Second, even with same genotype and same diets, when kept with different caretakers, sows varied in dimensions. Farm C (Table 1) had sows that were longer and wider than sows on farms A and B (this study controlled for parity and stage of pregnancy).

A common gestation stall is 24 inches wide by 7 feet long. One can see from Table 1 that for these genotypes in that production system that the common stall size would have contained these sows in terms of the stall length and height. The sows were less than 6 feet long and thus a stall of 7 feet long is often more than adequate. Some genotypes are longer than others. O’Connell, et al. [8] found Irish sows were about 3 inches longer than the sows in the U.S. study [7]. The performance criteria set by the National Pork Board for sow length states that sows must be given a space long enough so they may lay down without a need to rest their head on the feeder and their rear quarters coming into contact with the back of the stall at the same time (they must be able to lay down comfortably). A very long sow may be so long that she cannot lie down on the floor. While most stalls are 7 feet long (or longer), in some designs the feeder rises above the floor without a space under the feeder. If the raised feeder extends more than 1 foot inside the stall, then a 6-foot-long sow may have a difficult time lying down comfortably. This is more commonly a problem in farrowing stalls (not discussed here) than in gestation stalls.

Sow width (width while standing) was about 16 inches – well contained within a 24-inch wide stall. However, when the sow depth was considered (the width while laying down), it was a different matter. The average sow was contained in a 24-inch-wide stall, however, half the sows are wider than average. Sow depth (width while lying down) actually ranged from 16.9 to 28.5 inches wide.

One must consider the consequences of putting a sow that is 28.5 inches wide (or deep) in a 24 inch wide space. Her teats, udder and legs will extend into the neighbor’s space. Her body will be compressed while she is lying down. Very large sows will not be able to lay down in full lateral recumbancy in a 24-inch-wide stall. And while such large sows may appear uncomfortable, there is scant evidence that the rates of wounds, lameness or other issues are associated with a smaller stall width (ex., 24

inches wide). However, the National Pork Board’s Pork Quality Assurance® Plus (PQA Plus®) program suggests sows must be able to lay down completely in the stall.

For sow spaces, the range of options could be to keep sows in an accommodation that provides:

- Body space plus a few inches (as in the USDA regulations for non-ag animals)[31]
- Body space exactly
- Less body space than body size, but wide enough so sows can lay down completely (as in the PQA Plus requirement)
- Less body space so that even laying in lateral recumbancy is not possible

Table 1. Body dimensions of sows. Adapted from McGlone, et al. [7]. All measures are in inches.

Item	Height ^a	Depth ^b	Width ^c	Length ^d
Farm (XY genotype)				
A	34.1	22.8	15.9	66.6
B	34.7	22.7	15.6	66.6
C	35.1	22.6	16.4	69.2
Genotype				
XZ	34.2	22.0	15.9	67.8
XY	34.7	23.0	16.0	67.6
X	34.4	24.2	17.1	65.6

^aFloor to dorsal surface of hip

^bAt last rib, dorsal to ventral surface distance

^cAt shoulder (widest part of this genetic line of pig)

^dSnout to posterior (not including the tail)

Ethical and financial reasons drive a particular producer to adopt a given space for pregnant sows. This document does not make a judgment about which option should be used, rather it gives objective information so such a decision can be made.

As a practical matter, one can estimate the size of gestation stalls needed if one wished to accommodate the body space of all gilts and sows. Larger sows need a 28.5-inch-wide stall, but if gilts are in a 28.5-inch space, they may be able to turn around. Thus, to accommodate all females, some smaller and some larger stalls are needed. Models were presented by McGlone, et al. [7] based on the parity distribution on a commercial farm and the design-limiting feature of stall width. The model data presented in Table 2 show the percentage of stalls of different widths that are needed to accommodate all gilts and sows. Only 38% of sows were contained in stalls with a 24-inch width; 48% of sow stalls would have to be 27.3 inches wide; and 14% of the stalls would need to be 28.5 inches wide to accommodate all sow widths.

Two disclaimers must be made clear. First, genotypes and farm management cause sow sizes to change. Second, the parity distribution will change the distribution of stall sizes needed. Thus, if one wished to have three gestation stall sizes, it would be prudent to measure both sow sizes (at least depth) and understand

a farm's parity distribution before the mix of sow stall sizes was determined. Indeed, commercial stalls are now offered in multiple sizes to accommodate this approach.

Table 2. Model distribution of three sow stall sizes (widths) based on the parity distribution in McGlone, et al. [7] Note that the stalls should be 7-feet long with a feeder that is either recessed in the floor or outside the stall.

Stall width, inches	% of stalls needed
23.8	38%
27.3	48%
28.5	14%

Styles, Options and Designs for Well-Managed Gestation Stalls

Feeding Systems

Quite a lot is known about how to feed gestating sows in stalls. A good overview was provided by Aherne [9]. Basically, the feeding of the pregnant sow can vary considerably without impacting reproductive performance of the sow. Sow behavior, however, changes with changes in feeding levels (discussed below).

Most sows are fed to attain a target degree of body fat as often measured by backfat thickness. When sows vary in backfat thickness from 0.49 to 0.73 [10], reproductive performance was about the same. If sows are overfed (and become fatter) during gestation, lactation feed intake will be reduced [11, 12]. If sows are severely restricted in feed intake during gestation, they may not produce enough milk protein in lactation to cause optimal piglet growth.

Most producers feed sows to a target body composition (ex., body condition score of 2.5, on a 1-5 scale). Feed intake is easily managed when sows are housed individually. The amount of feed delivered can be adjusted for individual sows, depending on their needs. Because there is no performance advantage to feeding sows more feed, most sows are limit-fed to attain the desired body fat. The consequences (positive and negative) of limiting feed intake to individual sows include:

- The caretaker must pay careful attention to body condition in relation to feed allowance at an individual sow level.
- Feed intake must be increased if the thermal environment becomes cold (see thermal environment section below).
- Some sows express oral-nasal-facial behaviors at a high level when they are limit fed.
- Feed costs are minimized.
- A minimal amount of manure is produced (if sows are overfed, they will convert the extra feed to body tissue less efficiently, and will produce more manure and greenhouse gases).

The 2012 NRC Nutrient Requirements of Swine gives detailed information on the composition of feed for pregnant sows (and

pigs of all stages of life)[13]. In addition, it discusses the need for adjustments in the quantity and quality of feed in different common situations (such as temperature extremes).

From a management perspective, the swine caretaker must determine the feed form, the calorie density of the feed, the frequency of feeding and the system of feed delivery for pregnant sows. Feed form can be cubes (large pellets), standard pellets or meal.

Calorie density of a standard corn-soy-vitamin-mineral diet requires feeding sows about 2 kg/day, or a larger amount of a lower calorie-dense diet may be fed (ex., a high-fiber diet). Feeding a high-fiber diet may improve sow productivity [14]. Some authors reported that feeding a high-fiber diet (meaning more lbs. of feed/day to obtain more gut fill) may improve sow productivity or welfare [15]. but other authors did not find this [16, 17]. Certainly feeding a high-fiber diet will create a greater volume of manure that must be handled [18].

Sows can be fed every third day (ad libitum each 3 days; this is an older procedure no longer in practice), once per day, or twice per day or multiple times per day (ex., 6 times/day). Increasing the feeding frequency did not impact productivity or welfare [19]. However, feeding every other day or every third day was considered a welfare problem by some authors [20].

Feeding sows different calorie diets will change their behavior. Stereotyped oral-nasal-facial (ONF) behaviors will decrease both when fewer calories are fed and when more calories (than typical) are fed. Terlouw, et al. [21] showed stereotyped oral-nasal-facial behaviors decreased when sows were fed more calories. Likewise, Schneider, et al. [19] showed few ONF behaviors in the days when sows were not fed. Thus, only when sows are limited (as is common in production systems around the world) do oral-nasal-facial stereotyped behaviors become expressed at a high level in some sows. ONF behavior is more a function of feeding level than housing system [21].

Watering Systems

Sows should be given high-quality water ad libitum. Ad libitum means free access. Water may be provided continuously or in prescribed periods (ex., 2 or more periods per day in which sows may consume as much water as they choose).

High-quality water means water that has a low bacterial count and does not have excessive minerals. Watering devices should be checked at least daily to ensure that water flow is adequate for sow needs.

The amount of water pregnant sows need will vary with air temperature, humidity and feed consumption [22]. Industry guidance suggests pregnant sows need 3 to 6 gallons of water per sow per day. Higher water volumes are needed in warmer weather.

The Thermal Environment

Both the *Swine Care Handbook* [22] and the *Ag Guide* [23] give thermal requirements for sows (and pigs of other ages and sizes). Gestating sows do quite well and have few health or performance problems in a wide range of air temperatures from 5 to 90 F. The

preferred temperature range during gestation (60-75 F) are commonly provided on commercial farms (Table 3).

When the air temperature is above 90 F, cooling in some form should be provided. This may be evaporative cooling, fans, drip cooling or a combination. Above 90 F, reproductive problems will arise. Warm weather is associated with seasonal infertility, and so interventions to cool sows help both sow comfort and reproductive productivity.

Below 5 F, interventions might include use of bedding or provision of supplemental heat. Because most indoor units have water pipes, it would be rare for air temperature to be below freezing (32 F), so it is unlikely that indoor sows would be very cold. From 60 F down to freezing, the lower air temperatures would necessitate interventions, such as provision of more feed, or bedding or group housing so sow body condition and health can be maintained. Most gestation units have heaters to keep the inside air temperature well above freezing.

Table 3. Air temperature ranges for adult swine. Adapted from the *Swine Care Handbook* [22].

Adult stage	Lower limit*	Upper limit*	Preferred Range
Breeding/Gestation	5 F	90 F	60-75 F
Lactation	50 F	90 F	60-80 F

* Below and above lower and upper limits, producers should intervene to provide warmth or cooling.

Flooring and Lameness

Most floors in the United States under gestation stalls are concrete – either slatted or partially slatted and partially solid. Materials other than concrete (ex., cast iron or plastic) can be used, but they are less common.

Sow lameness is an industry concern that is not unique to sows in gestation stalls. Lameness also is an issue among group-housed sows [24]. One cannot say if flooring is a cause of lameness with certainty because most sows are kept on fairly uniform flooring (concrete slats). We do know that genetics, nutrition and production system can contribute to lameness. However, sow studies on feet and limb integrity indicate that husbandry must pay careful attention to sow feet and leg health. Lame sows have a higher risk of removal from the farm [25].

Being in a gestation stall with limited exercise does not contribute in a meaningful way to the rate of lameness in sows. Although a lack of exercise did impact bone density, a lack of exercise did not cause an increase in lameness [26].

Flooring should be free from sharp edges and rough patches that may cause abrasions on sow feet and legs. Flooring that promotes manure removal may benefit sow feet and legs.

Fencing Materials and Space

One of the key complaints about the gestation stall is that it prevents sows from turning around (and some other postural adjust-

ments and social behaviors). Decades ago, Rick Balsbaugh invented [27] and Stan Curtis studied [28] the turn-around stall (as it was called). This accommodation had a swinging side gate that allowed sows to share space by swinging the gate towards their neighbor. This configuration allowed sows to turn around in the same total space as was provided by the standard gestation stall.

Gilts in turn-around stalls turned an average of 11 times per day in one study [28] and 75 times per day in another study [29]. Thus, the turn-around stall clearly allows, perhaps even promotes, turning around. Yet this accommodation style did not catch on in the industry. Some early adopters of the turn-around stalls found it had maintenance issues due to more moving parts and some sows were injured by the system. Finally, in states and countries where the gestation stall was banned, the turn-around stall also is not allowed as it is viewed as a stall.

One critical question for group housing is: What is the minimum space sows needed to turn around? The reciprocal question for sows kept in individual accommodations is: What is the maximum space that must be provided to assure that most gilts and sows do not turn around? If a gilt or sow turns around in a standard gestation stall, it is often with difficulty. Then, when it is time to feed, she may be facing the wrong way and will need to make another uncomfortable turn.

The USDA uses a pen dimension of body length plus 6 inches as the minimum space for laboratory animals (such as dogs) so they can turn around [31]. This standard is arbitrary. Boe, et al. [30] described the minimum space needed for pregnant sows to turn around. They found that sows could turn around with space as little as 50% of their body length (thus if a sow was 6-foot long, she would require a pen width of 3 feet [36 inches] to turn around). They found that for the sow to comfortably turn around (without touching the sides of the pen), it required a pen width at least equal to the sow's body length. While Boe, et al. [30] suggested sows needed 36 inches to turn around, McFarlane, et al. [28] suggested as little as a 22-inch width allowed pregnant gilts to turn around. Thus, the space needed to turn around (or not turn around) is highly dependent on the size, especially the length of the pregnant gilt or sow and the length of the stall (see above section on sow sizes).

Most fencing materials are made of welded metal. The front walls can be straight or sloped backwards towards the sow. A sloped front facilitates animal observation.

The side walls may be rectangular, or the back portion may be cut away near the top. This back is called an AI stall because the lower side walls facilitate artificial insemination of sows.

These front and side wall features are chosen for their functionality and because of producer preference. The welfare and health of the sow changes little with these design changes in side and front fencing, other than a suggestion that horizontal bars reduce neighbor-to-neighbor aggression (which is normally low) among some sows compared with vertical bars when in tethers [2, 32].

For some example stall fencing materials, see: <http://www.hogs-lat.ro/Global/Catalogs/NorthCarolina/HTML/index.html#/4/>

Daily Health Care

The *Swine Care Handbook* [22] and professional judgment suggests sows should be observed twice per day. The observations should be spaced by at least 4 hours. The caretaker should ensure that sows and their environment are observed for:

- Adequate air temperature/thermal environment
- Adequate feed delivery and consumption
- Adequate water flow and intake
- Integrity of penning/crating materials
- Space and inter-sow behaviors
- Health of individual sows

Assessing the health of sows requires training and competence. The observer will examine sows for, at least:

- Poor body condition, requiring more feed intake
- Lameness
- Wounds and abscesses
- Respiratory disease
- Urinary or reproductive disease
- Enteric (gut) diseases

Each of these health issues requires attention by the caretaker. Having Standard Operating Procedures in place to deal with each common health issue should be in place. Workers should be trained and assessed in these SOPs and sow health should be independently assessed by internal management and perhaps by third parties.

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