Animal Well-Being

Group Housing Systems: Genetic Considerations

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

Objectives

1. Identify genetic considerations (behavior, feet and leg soundness, etc.) that might contribute to producer success when using group sow housing gestations systems.
2. Identify feet and leg soundness factors that sows remain in the breeding herd regardless of the type of gestation housing system utilized.
3. Demonstrate the ideal underline and external genetalia that contribute to the sows' ability to have a long and productive herd life irrespective of the gestation housing type used.
4. Provide example of the important traits taken on replacement gilt candidates and demonstrate a systematic approach to evaluating these traits that contribute to the gilts ability to remain in the breeding herd for a long and productive herd life.

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Introduction

Many factors contribute to the success of a pork production operation regardless of the type of gestational housing system. Many of the traits considered important to a successful pork production operation are heritable [1,2] meaning that genetics plays some role in the trait expression that is observed. This is the case with group sow housing situations. The traits under at least some genetic control that will likely play a relatively large role in the success of group sow housing are those related to behavior, feet and leg soundness, and body conformation. Unfortunately, specific trials examining the heritability, or the degree that genetics influences a trait, when sows are maintained in a group sow housing situation, has not been conducted. Hence, for many traits we are left to use information from other sow housing situations to evaluate traits that will contribute to the success of a pork operation using group sow housing gestation systems.

Behavior

Selection under a group housing setting has been reported to be successful in a research setting [3], however, commercial application of this system has not been successful. That does not mean that some traits under genetic control cannot be selected to improve the success of group sow housing systems. Selection for traits like temperament, feed intake and other traits would contribute to developing a system that utilizes group sow housing. While direct selection on behavioral traits in swine has generally not been practiced by commercial breeding stock suppliers, genetic suppliers have focused on many traits associated with improved productivity (pigs per sow per year, body weight gain, mortality rates), changes in physiological traits (blood parameters, immune response) and selection for improved anatomical traits (gait, feet and leg soundness, etc.)[4]. Most if not all of the traits commonly selected for by commercial genetic suppliers are intertwined with behavioral traits in swine. Typically, animals expressing behavioral traits that are considered negative, would also adversely impact important productivity traits [5,6]. At some point, additional characteristics not related to traditional productivity traits may need to be included in the breeding program in order enhance an animal's ability to meet society's demands placed on livestock producers to produce food protein for human consumption [7,8].

Growth Rate

Target growth and backfat performance levels have been developed because of their association with gilt reproductive development and puberty attainment. Ideally, replacement gilts should be mated on the 2nd or 3rd estrous cycle. As gilts reach puberty, the date is recorded and the subsequent number of heat – no service records for each gilt is known. Traits like backfat and growth rate can be used to help select gilts for reproductive performance when records for gilts estrus, not-served events are not recorded. Gilts should

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be in the top 75% of their contemporary group for growth rate. Growth rate can be evaluated as average daily gain, days to some constant weight or age, or expected progeny difference for growth. Growth rate among replacement gilts is important as it has been demonstrated that slow-growing females often do not cycle properly [9], can have delayed first estrus and become problem breeders later in life if kept as a breeding herd female.

It has been demonstrated that within a contemporary group, gilts that reach puberty earlier (150-175 days of age) tend to remain in the breeding herd longer. In other words, they have better longevity or sow productive lifetime indicies.

Backfat

Backfat is important if replacement females are produced within the producer's herd (i.e. internal multiplication program to produce their own replacement gilts).

Recommended backfat levels are farm specific and may change due to genetics preference, environmental factors, and carcass characteristics. In general, a target backfat (tenth rib) of 0.70 - 0.85 inches (18 – 22 mm) at around 300 lbs. (136 kg) is recommended [9]. However, this can vary with genetic line. Producers should consult their genetic supplier when developing target growth and backfat levels that are desirable for their specific markets.

Producers should consult the National Swine Improvement Federation Guidelines for Uniform Swine Improvement to obtain proper measurement and adjustment criteria for growth, backfat and loin muscle area [10].
http://www.nsif.com/guidel/guidelines.htm

Important gilt evaluation traits

There are many criteria which can be used to evaluate replacement gilt candidates [11]. Figure 1 illustrates the traits that are desirable as producers evaluate their candidate replacement gilts. The traits can be used with the gilt evaluation flow diagram shown in Figure 2 to develop a systematic procedure for evaluating traits on all replacement gilt candidates.

Figure 2. Flow chart for gilt evaluation (Adapted from Gadd, J. 2011 [12])

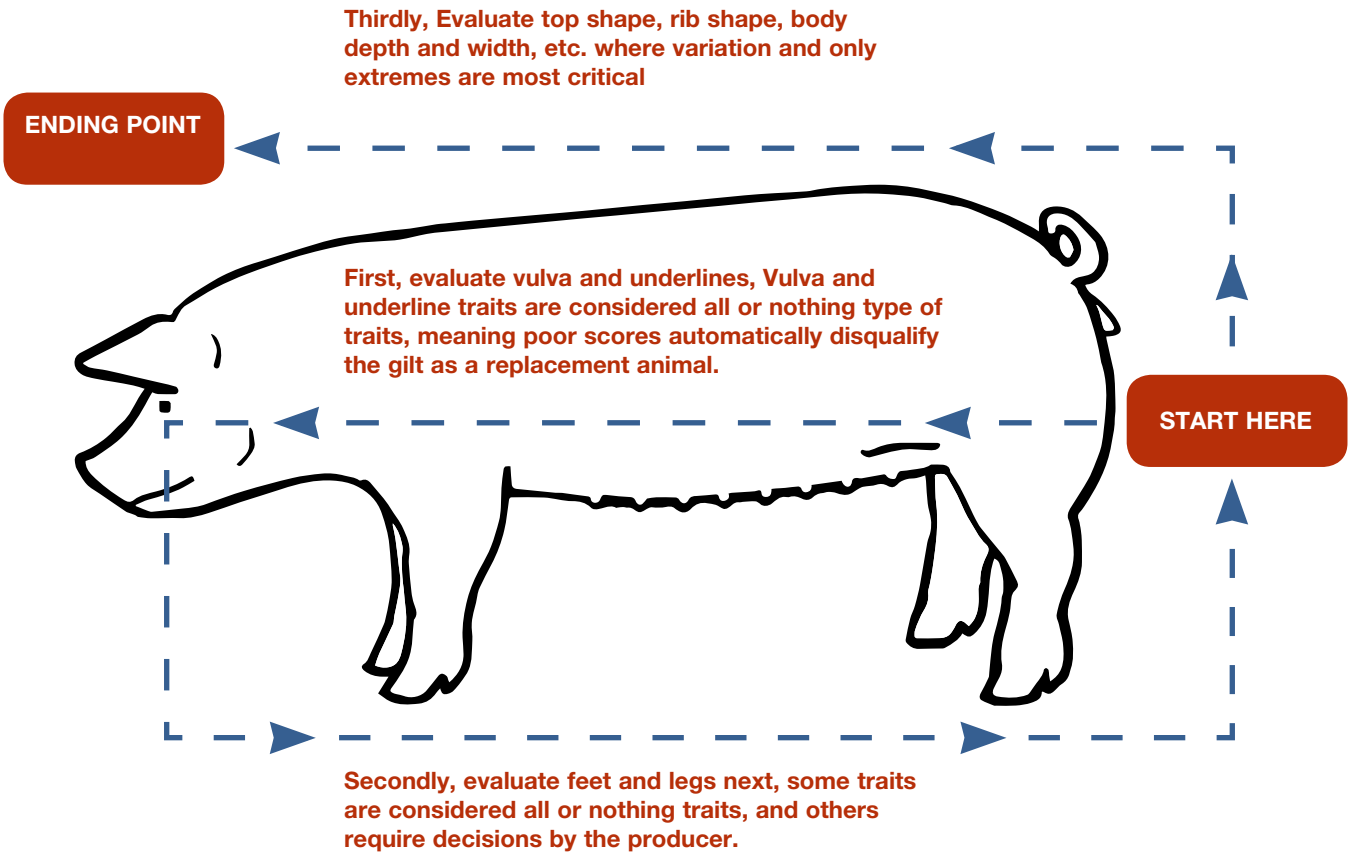
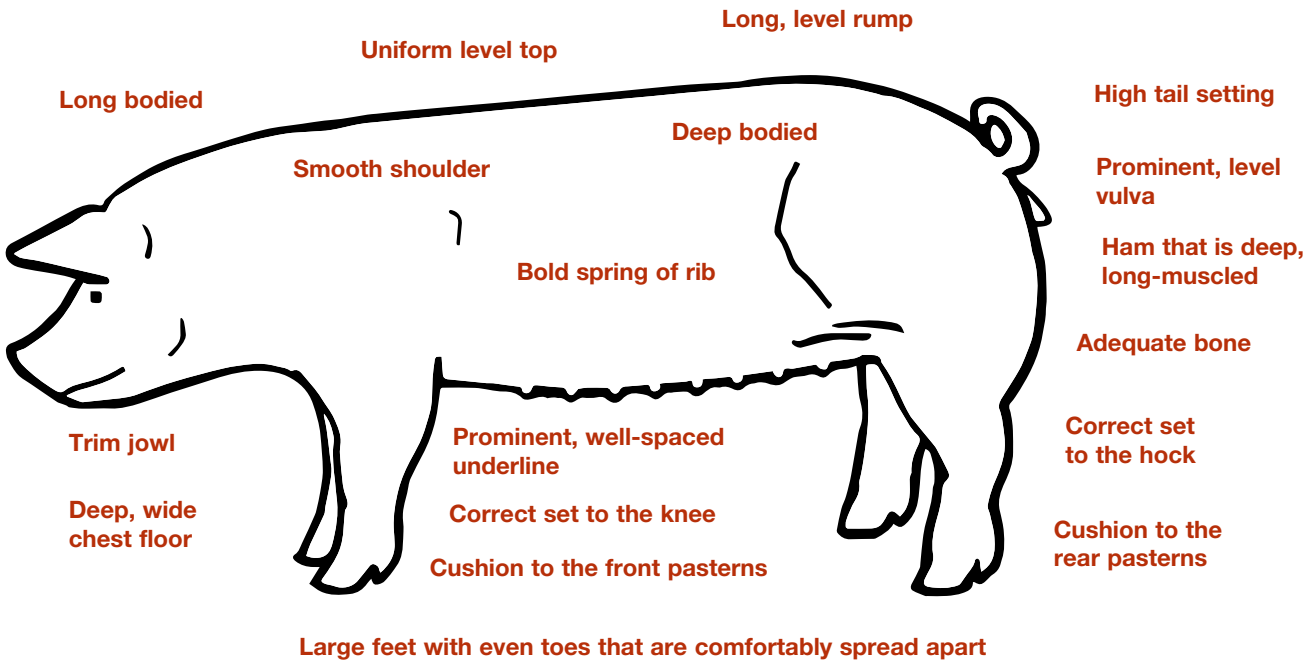


Figure 1. Traits that are desirable when evaluating replacement gilts for the breeding herd.



- Prominent, level vulva – vulva should be large and level to make sure breeding and farrowing are accomplished with ease and to avoid urine backflow which can contribute to infections of the reproductive and urinary tracts.
- Prominent, well-spaced underline – having an adequate number of functional, well- spaced teats is a key to raising large litters to weaning.
- Large feet – with even toes that have some width between them is most desirable in order to avoid cracked hooves and other injuries.
- Cushion to pasterns – is needed to provide correct rear leg structure and helps provide good, sound, fluid locomotion and the ability to get up and down with ease.
- Correct set to knee – indicative of correct front leg structure known to make animals sound so they have a long, productive life.
- Correct set of hock – key to rear leg structure and good locomotion. Improper set to the hock and / or swelling can lead to difficulty standing and getting up.
- Adequate bone – allows animals to withstand the rigors of production and make them sound to carrying their weight as they mature.
- Deep, long muscled ham – muscling over the entire body and the ham is a good place to evaluate degree of muscling. The ham should not be extremely expressive or very large and round shaped (like a basketball) as this can contribute to locomotion difficulty.
- High tail setting – indicates that the hip structure of the animal is correct; plays a role in properly positioning the rear legs.
- Long, level rump – plays a role in correct rear leg positioning and is important in keeping top line level.
- Uniform level top – important to avoid high-topped and sway-backed animals as they can pass this on to their offspring causing processing difficulties at harvest.
- Long bodied – important in allowing animals to attain heavier weights without becoming overly fat. Additionally, length of body helps ensure the teats apart when a sow is nursing large litters.
- Bold spring of rib – rib shape is thought to contribute to the ease of a sow getting up and lying down, particularly when housed in a farrowing or gestation stall.
- Deep bodied – like wide-chested gilts, deep-bodied gilts are thought to have greater body capacity contributing to the ability to eat larger quantities of feed and have a greater lung capacity.
- Deep wide chest floor – indicates degree of muscling; thought to indicate capacity to consume larger quantities of feed, as well as having good lung capacity.
- Smooth shoulder – important to evaluate the degree of fatness of a gilt. A shoulder that really “pops-out” may not have sufficient condition to have a long and productive life.
- Trim jowl – indicates degree of fatness; trim jowl means the animal is relatively lean.

Evaluating a Group of Replacement Gilt Candidates

Be sure to evaluate replacement gilts in groups of 10 to 20 because this number is typically easier to evaluate within a pen. Evaluation should occur in a place where various traits can be easily observed and where each gilt's locomotion can be adequately evaluated [12]. When evaluating replacement gilts, a scoring sheet should be developed and used in the evaluation process to have a written record for selection.

Figure 3. Demonstration of replacement gilt candidate evaluation.

Evaluation of replacement gilt candidates is a systematic process. First, be sure that each animal is adequately identified using ear notches, eat tags, tattoo, radio frequency identification (RFID), etc. Replacement gilt candidates should be evaluated in an area where the animals can spread out for easy evaluation (Figure 3) and have good lighting to see underlines, legs and toes. Traits should be evaluated in the same order on each replacement candidate. Figure 2 depicts a systematic approach to assessing feet and leg soundness, reproductive soundness, and body conformation traits on replacement gilt candidates. Be sure to evaluate every trait that is important in your operation. Be critical of each animal. You can always go back and alter the selection criteria if additional animals are needed. Always give preferential selection to the more docile animals. Long-term preferential selection for more docile animals will lead to more consistent production of animals with similar behavioral patterns.

The "Ideal" Replacement Gilt

The gilt pictured in Figure 4 a, b, and c is considered ideal because she has big feet (even toes size on all four feet), good flex to her pasterns (front and rear) (Figure 4c), and possesses adequate base width (Figure 4b) and body depth (Figure 4a, b). Additionally, she is ideal in her composition being long bodied, level in her top line, appears to be lean, and has the proper degree of muscling (Figure 4c). This gilt has high quality, evenly spaced teats of adequate size and placement. Her vulva is prominent and level (Figure 4a, b). This gilt performed in the top 75% of her contemporary group for growth rate. Because of these attributes, this gilt is balanced and productive looking.

Evaluating Reproductive Soundness

When producers assess the underlines on all replacement gilt candidates, they should remember that modern sows often have 12 to 16 piglets born alive. For a sow to raise this many piglets to weaning, they must have sufficient teats to feed all of them at the same time.

Based on sow productivity, the ideal underline should have a minimum of 7 or 8 evenly spaced, prominent, functional teats per side. The teats should start far forward on the underline, and the underline should be free of pin nipples and inverted nipples. An inverted nipple is where the end of the nipple is held up in the body of the mammary gland and, thus, is termed "inverted". Some of the inverted nipples can pop out when the sow farrows; however, gilts with inverted nipples should be culled because a large majority of inverted nipples are non-functioning teats (Figure 6a, b, c, and d). Pin nipples never become functional (Figure 6a). Heritability estimates for teat number would be considered moderate to high (0.35 to 0.40) [13] and the genetic correlation for the number of teats on each side is extremely high [14].

Figure 4. The "ideal" gilt

A.

B.

C.

Figure 5. Underline evaluation demonstration at various ages in pigs.

a. Underline evaluation occurring in the farrowing stall

b. Underline evaluation occurring at weaning

c. Underline evaluation occurring at the end of the nursery phase

Figure 6. Poor underline examples in swine.

a. Notice the poor position and spacing on this gilt

b. This gilt has fewer than 7 teats per side

c. The spacing and teat quality both are undesirable from the underline of this gilt pictured.

d. The teats on the underline pictured below are not prominent and may even be blind or non-functioning.

Underline evaluation can occur at any age including birth (Figure 5a), weaning (Figure 5b), near the end of the nursery phase (Figure 5c). Once an unacceptable underline has been identified, the gilt should be identified as a "non-select" animal. This is an important step so you do not reevaluate animals that have already been determined to be unacceptable. A final evaluation of underlines should be made when gilts are being selected from the replacement gilt pool (Figure 6).

Replacement gilt candidates that have underlines that are poorly positioned and / or spaced should be avoided. Examples of poorly spaced improperly positioned underlines and an underline with too few teats are shown in Figure 6. When evaluating teats, it may be necessary to use your finger to pull back loose skin that may be folding over a teat making it appear to be inverted.

Producers may choose to use some sort of scoring system to evaluate underlines. Any number of scoring systems can be used. An example underline scoring system follows [10].

1. **Unacceptable** (1-3 points). Fewer than six or seven functional nipples on each side or one or more inverted nipples or poor spacing and prominence.
2. **Good** (4-7 points). Seven or more functional nipples on each side with adequate spacing and prominence.
3. **Excellent** (8-10 points). Seven or more functional nipples on each side, well-spaced and well-developed with no pin or blind nipples.

Figure 7. Replacement gilt vulva evaluation

a. An example of good vulva

b. An example of an infantile vulva

Evaluating External Genitalia

External genitalia should be evaluated on all replacement gilt candidates. Gilts should have a well-developed vulva that is not tipped up (Figure 7a). Tipped vulvas may cause flow back of urine into the reproductive tract and contribute to a higher incidence of metritis and cystitis.

Caution should be taken to avoid gilts with a small vulva. These gilts could have difficulty mating in a natural mating setting and may have difficulty farrowing. Additionally, gilts with an infantile vulva should be culled (Figure 7b). These animals frequently have an under-developed internal reproductive tract.

Gilts that have injured vulvas should be avoided as they may impair mating. Once injuries are healed, scar tissue can develop that could cause farrowing difficulties. An option is to let the injury heal and make an assessment at a later date, although caution is advised.

Evaluating feet and leg soundness

Feet and leg problems are a major reason for sow culling, particularly in parity 1, 2, and 3 females [15]. Thus, understanding how to evaluate for ideal feet and leg structure is critical. Figure 8 shows a replacement gilt that has ideal feet and leg soundness traits. Because she has more cushion and flexion to the joint, whether you look at the shoulder angle (M), the real leg angle (N), or at individual joint like the knee (C), hock (G), front pastern (D) or the rear pastern (D).

Toe size

Leg conformation tends to be driven by the shape and size of the toes, so this is an important step in the evaluation process. The ideal foot has big, evenly sized toes that are spread apart (Figure 9a). Large, well-spaced toes provide a larger surface area for the animal's weight to be distributed. Toes should be the same size on each foot. A foot having small toes and little to no spacing between them is undesirable (Figure 9b). If toes are small, the weight of the animal is concentrated on a smaller surface area. This increases the risk of developing cracked hooves and foot pad lesions as the animal matures to heavier weights.

If the toes are different sized and the difference in size is greater than ½ inch (12 mm), the gilt should be culled (Figure 9c). It is believed that the small inside toe condition is under some genetic control but the exact mechanisms are not known [16]. These gilts tend to easily develop foot injuries including cracked hooves, foot pad lesions and other foot maladies more easily as they distribute their weight in an uneven manner. Ultimately, toe size impacts mobility or locomotion of the animal. Uneven toes and associated problems often will result in lameness.

Feet and Leg Injuries

Examine each foot for a variety of injuries including cracked hooves, dew claw injuries, and any other injuries that will likely inhibit their productivity and longevity in the breeding herd. Some of these injuries might heal, but if there is an adequate gilt supply, the best decision is to cull those animals.

A producer may choose to treat gilts with injuries and wait to see if the injury improves or even completely heals. If the injury does not improve, retaining the female(s) is not recommended. Injuries unrelated to feet and leg soundness, will not be passed to offspring because they are not genetically related, but the productivity of the female could be limited.

Figure 8. The "Ideal" replacement gilt skeletal structure diagram [19].

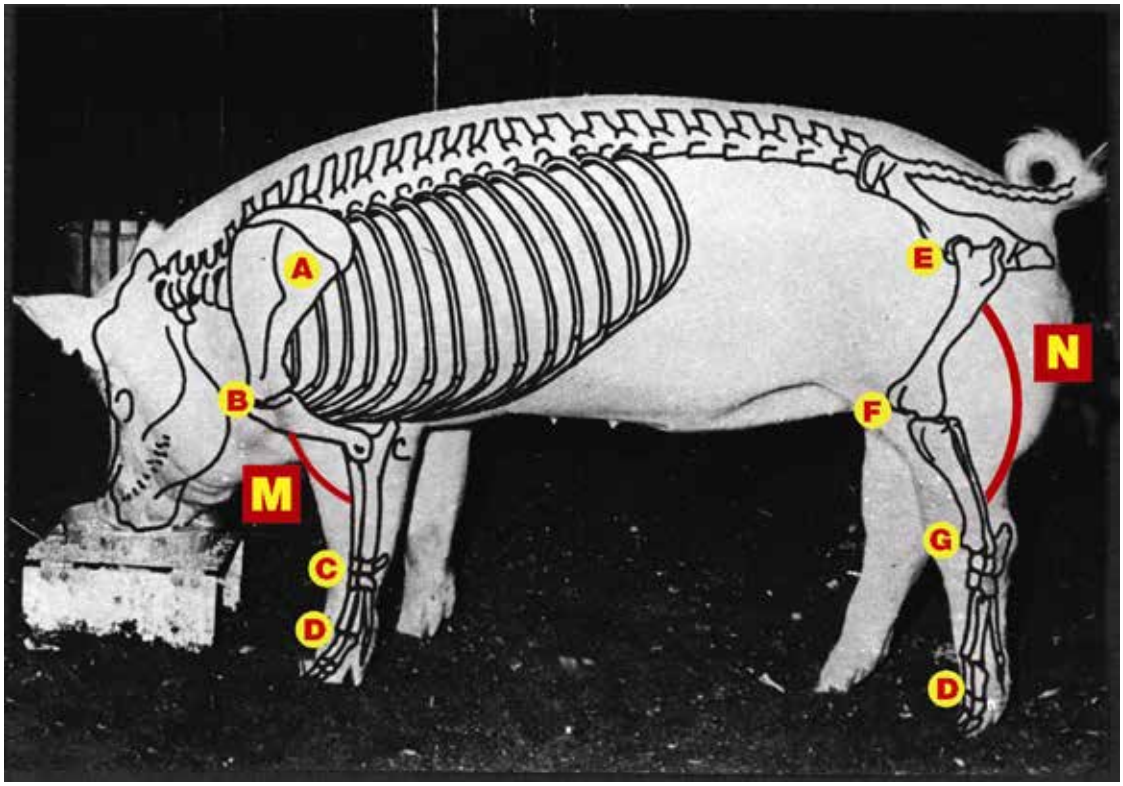


Figure 9. Various foot problems to avoid when selecting replacement gilts for the breeding herd.

a. Replacement gilts should have big feet with even toes that are spread apart to provide a large surface area

b. Even though the toe size is even, the small foot which has very little spacing between the toes is undesirable.

c. Notice the difference in toe size on the foot of the gilt pictured below.

If gilts are not selected for proper foot development it can lead to problems, such as excessive toe growth. Treating lameness and associated problems is one of the most costly issues in the breeding herd. Lameness results in poor well-being and poor sow productivity and must be treated. Treating animals often affects workload and adds to stress placed on employees.

Figure 10. Front leg positions that have been shown to impact the ability of a replacement gilt to remain in the breeding herd for a long and productive herd life.

a. Buck-kneed front legs negatively impacts sow productive lifetime.

b. Soft or weak front pasterns are positively associated with sow productive lifetime.

Leg evaluation

Figure 8 shows a replacement gilt with ideal positioning of the front and rear legs, pasterns, knee, and top line. Notice the angles (M and N) provide cushion to the legs which will also make it easier for a gilt or sow to get up and lie down. These types of animals will walk more fluidly and be less susceptible to stiff joints and arthritis as a result of constant stress on the joints.

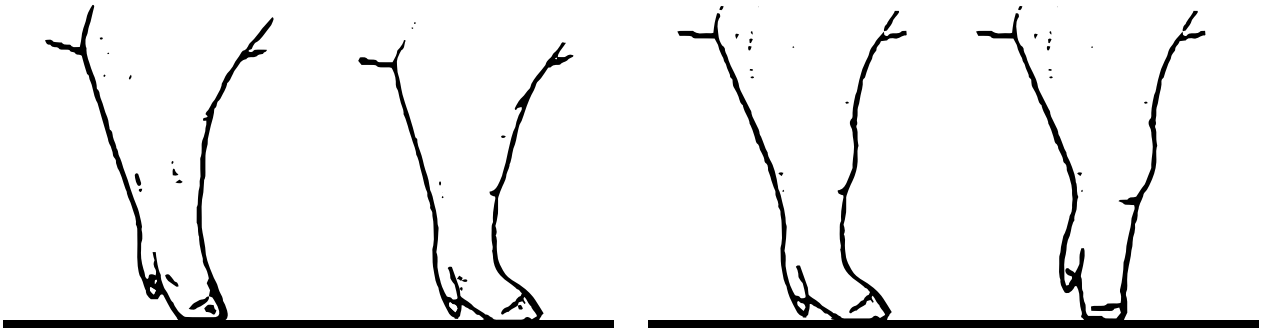
Replacement gilts should move freely with legs stationed soundly at the four corners of their body with adequate width between them. Several feet and leg traits have been shown to be associated with the ability of replacement gilts to have a long and productive life in the breeding herd. Research has shown that gilts with buck kneed front legs [17] (Figure 10a) will not remain in the breeding herd as long when compared to their counterparts with front legs that are structurally correct. However, gilts with soft or weak pasterns [18] (Figure 10b) have consistently been shown to be associated with a sow's ability to remain in the breeding herd for more parities when compared to sows with normal or upright pasterns. Figure 11 offers guidelines to help determine which diagram most closely resembles the actual front leg structure of the replacement gilt candidate being evaluated [19].

Straight rear pasterns (Figure 12a) on the rear legs have been shown [17] to negatively impact the length of time a sow remains in the breeding herd. Straight rear pasterns are commonly seen with gilts that have very straight or post-legged rear legs. These animals do not have the cushion needed to allow fluid movement and often have swollen joints. Additionally, it is thought that sows with their legs positioned up under their body too far, commonly called "sickle hocked" do not remain in the breeding herd as long as their normal counter-parts (Figure 12c).

When comparing the middle picture (Figure 11b) showing a replacement gilt candidate that has ideal rear leg structure with the other pictures (Figure 12a and c), it easy to see the differences in rear leg soundness. Figure 13 may help determine which diagram most closely resembles the rear leg structure of replacement gilt candidates [19].

Producers should use the diagrams to identify the rear leg structure that most closely matches the replacement gilt that is being evaluated and make a decision whether to keep or cull the animal. Replacement gilts that stand with their hocks close together, a condition known as "cow-hocked" should be avoided. This rear

Figure 11. Summary of front leg knee and pastern position and structure for comparing commonly observed front leg positions [10].



Normal

Desirable - Retain

Weak pastern

Desirable – Retain Not usually a problem if weakness is slight or moderate

Buck-kneed

Undesirable – Buck-kneed & soft pasterns – CULL!

Buck-kneed

Undesirable – Buck-kneed – CULL!

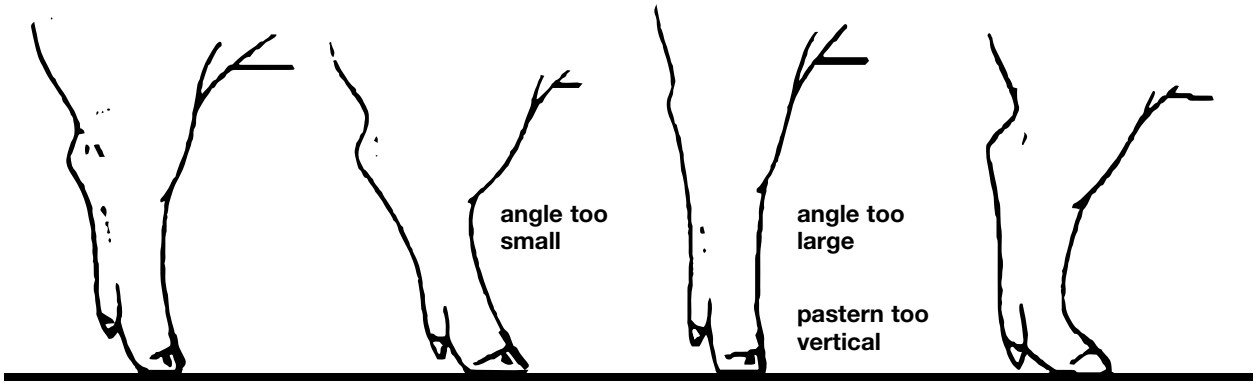
Figure 12. Rear leg positions that have been shown to impact the ability of a replacement gilt to remain in the breeding herd for a long and productive herd life.

a. This gilt has a straight rear pastern and the entire leg is straight or "post" legged.

b. This gilt has rear legs that are ideally positioned.

c. This gilt has rear legs that sickle-hocked or positioned up under her body which is undersirable.

Figure 13. Summary of rear leg positions and set to the hock to compare four commonly observed rear leg positions [10].



leg position is frequently observed with pigs that have small inside toes on the rear feet and / or pigs that are sickle-hocked, a condition where the legs are positioned up under the body too far. Pigs with this type of rear leg structure frequently spend much time sitting on their hams and are in danger of becoming splay legged. Pigs with this type of rear leg structure should be culled. There are a variety of feet and leg scoring systems that can be used to score feet and leg soundness.

Top shape, rib shape, body depth and width, and other body conformation traits to evaluate

For these traits only extremes are most critical. For example, a replacement gilt needs adequate muscling. Gilts with too little muscle do not have adequate body width while gilts with too much muscle may have impaired movement. Similarly, when evaluating body depth, gilts with extremely shallow body depth can indicate she does not have an adequate appetite to sustain her body reserves and produce heavy litter weaning weights without risk of being excessively thin at weaning. Conversely, the replacement gilt that is extremely deep bodied at selection may in reality be excessively fat, unable to produce a heavy litter at weaning, and her offspring may have increased body fat.

Rib shape is one of the hardest traits to evaluate and is difficult to illustrate using photos. However, rib shape has been shown to impact whether a gilt exhibits estrus [20] and the length of productive life of crossbred females [21]. Animals with little or no rib shape are often described as being "slab-sided" or "flat sided". If replacement gilts have little or no rib shape, they are at higher risk

of developing shoulder sores. Their shape and the tendency of flat sided animals to have little backfat to protect the shoulder makes them more prone to developing shoulder sores. Replacement gilts that have good rib shape or ribs - more barrel shaped - have a much easier time getting up from the lying position, especially during farrowing and lactation, which reduces the risk of developing shoulder sores.

Other Factors Contributing to Feet and Leg Soundness

There are many other factors that can affect soundness and the development of feet and leg injuries among sows housed in a variety of situations, including diseases, floor surface, use of bedding, nutritional deficiencies, etc. Many of these topics will be addressed within other fact sheets in this series.

Monitoring Replacement Gilts for the Presence of Genetic defects

Females that produce piglets with any one of the following traits, or are from litters where a defect was present, should not be selected as replacements.

- *Scrotal hernia* – commonly called a rupture. This is a hernia occurring in the scrotum of male pigs and should not be confused with belly ruptures or navel hernias.
- *Atresia ani* – missing the anus.
- *Cryptorchidism* – a male pig that has at least one testicle that has not descended into the scrotum.
- *Hermaphrodite* – has both female (vulva) and male (penis) reproductive organs.
- *Tremors* – pigs that shake uncontrollably.
- *Splayleg* – at birth, legs are spraddled to the sides and the animal cannot stand on its own.
- *Bent legs* – pigs that have legs that have grown in an abnormal direction; condition can be caused by genetics or nutrition.
- *Polydactyl* – pig is born with extra feet, legs and / or dew claws.
- *Syndactyl* – (mule foot) pig is born with one or more of its toes fused together
- *Thickened forelegs* – pig is born with one or both front legs that are unusually thick (approximately twice as thick as normal).

Summary

There is no scientific evidence to suggest that the feet and leg soundness requirements for sows housed in groups is any different than sows housed individually. As is the case with many traits, the management provided to the animal more than any other one item, is most likely to determine the level of success when sows are housed in groups. If replacement gilts come from maternally productive lines that also grew well and that have desirable feet and legs soundness, reproductive soundness, and do not have previous injuries they are more likely to be productive regardless of the type of gestational housing system utilized.

To see the series of three Replacement Gilt Selection Guidelines posters and photo galleries,* see the following Web site links: **"Conformation and Structural Soundness Guidelines for Replacement Gilts,"** see: http://nationalhogfarmer.com/site-files/nationalhogfarmer.com/files/archive/nationalhogfarmer.com/posters/ConformationGiltsPosterJan09Eng.pdf.

"Selecting for Feet and Leg Soundness in Replacement Gilts," see: http://nationalhogfarmer.com/site-files/nationalhogfarmer.com/files/archive/nationalhogfarmer.com/posters/200902NHFpostereng1.pdf

"Selecting for Reproductive Trait Soundness in Replacement Gilts," see: http://nationalhogfarmer.com/site-files/nationalhogfarmer.com/files/archive/nationalhogfarmer.com/posters/200903NHFrepropostereng.pdf

**The three Replacement Gilt posters are available in English, Spanish Japanese, Chinese and Finnish on the National Hog Farmer Web site: www.nationalhogfarmer.com. Print versions of the posters are available from the National Pork Board at: www.pork.org.*

In addition, see: **"Sow Body Condition Scoring Guidelines*"** at: http://nationalhogfarmer.com/site-files/nationalhogfarmer.com/files/archive/nationalhogfarmer.com/posters/BodyConditionScorePoster.pdf.

** Sow Body Condition Scoring Guidelines" available in English and Spanish on the National Hog Farmer Web site: www.nationalhogfarmer.com. Print versions of the poster are available from the National Pork Board at: www.pork.org.*

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