
Selection of Gilts – Biomechanics

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Introduction

Sow longevity or sow productive lifetime as it is now sometimes called represents the sow's ability to stay and remain productive at an acceptable level within commercial swine breeding herds. Poor longevity challenges many commercial sow herds in the US and other countries worldwide (Engblom et al., 2007; Rodriguez-Zas et al., 2003). The majority of sows are removed in their early parities, and many times they are removed before they "pay for themselves". The parity where the sow is sufficiently productive such that a producer recovers his / her initial investment is somewhere between the 3rd and 4th parity under most economic and productivity situations (Lucia et al., 2000; Stalder et al., 2000; Stalder et al., 2003). The relatively high removal rates from early parities likely reduce commercial breeding herd production efficiency since litter size typically increases up to parity five. Today fewer than 50% of the US sows produce five litters. Poor sow longevity represents substantial costs to the commercial pork operation. Furthermore, 30% of the US sows are removed before parity 3. The high removal rates (voluntary culling, involuntary culling, and mortality) could be an indication for compromised animal well-being. Reducing high replacement costs due to high removal and poor

longevity are especially important when the pig production industry has been operating on very slim profit margins if any from 2008 and 2009. Improved sow productive lifetime will reduce replacement rates, the costs for replacement gilts, and improve downstream production because fewer offspring are produced from gilt litters (Moore, 2003) and thereby increases net income. The input cost for a replacement gilt including gilt development costs are the same regardless of the number of parities a sow produces. Gilts should therefore be considered as an investment, an investment which should be used as efficiently as possible.

Sow productive lifetime or sow longevity is a complex trait and it is determined by many genetic and environmental factors. In addition, culling breeding herd sows often involves a subjective decision by the sow manager and often influenced by cull sow market prices. When making culling decisions, breeding herd managers considers the sow's parity number, production, reproductive status, health status and herd structure, as well as access to replacement gilts of relevant reproductive status. Today, the majority of sow culling or removal is

unplanned (due to e.g. reproductive disorders and locomotor problems or what is often termed involuntary culling) and early, but if sow longevity would be improved would the proportion of sows getting removed due to old age and low production increase. This would not only increase productivity, ease planning at farm level but also improve production efficiency and profitability of piglet production.

Gilt traits influencing sow productive lifetime

In cooperation with Zinpro Performance Minerals, we have developed a Gilt Selection Guide showing the desirable feet and leg traits for a replacement gilt in order to improve lifetime productivity from individual gilts. Feet and leg soundness, lameness, or leg problems represent the second most identifiable reason that sows leave commercial breeding herds (Stalder et al., 2004). Evaluating feet and leg soundness is even more critical to evaluate in a commercial setting where internal multiplication is used to produce replacement breeding herd females.

Structural soundness is typically evaluated subjectively or visually by breeders supplying replacement gilts to pork producers or by producers themselves who use an internal multiplication program to produce replacement gilts for their herd. Pigs that are unsound display one or more of the following symptoms: 1. splay footed, 2. pigeon-toed, 3. buck-kneed, 4. post-legged, 5. sickle-hocked, 6. straight

pasterns, 7. uneven toes, 8. goose stepping. Research has demonstrated that genetic variation exists for many leg soundness traits, thus it can be improved through selection. Structural soundness has been shown to be low to moderately heritable.

Several feet and leg soundness traits have been shown to impact sow longevity or sow productive lifetime (Serenius et al., 2004, 2006, 2007; Serenius and Stalder, 2004). Gilts that have buck-kneed front legs leave the herd earlier than their sound counterparts. Figure 1 shows 3 example drawings of the front legs for a gilt. The far right drawing (Figure 3) represent buck kneed front legs which is an undesirable trait for a replacement gilt or sow to possess. Gilts that have front legs like this should be removed from further consideration as a potential replacement gilt.

The drawings on the left and in the middle of Figure 1 represent desirable front leg structure. Correctly or normal structure for front legs is shown in the left drawing of Figure 1. If replacement gilt candidates possessing front legs like those shown in the drawing on the left of Figure 1 should be selected or retained as a replacement for the gilt pool. Additionally, the middle drawing shown in Figure 1 shows a front leg from a pig that has “soft” or “weak” front pasterns. Research has demonstrated that sows that have this type of front leg structure are more likely

to remain in the breeding herd for a longer period of time. Said another way, sows with soft front pasterns will have better sow longevity or sow productive lifetime when compared to sows that have normal appearing front legs and especially when compared to sows that have buck kneed front legs.

The third feet and leg soundness trait where research has shown a negative influence on sow productive lifetime is straight rear pasterns. Some producers also refer to this as upright rear pasterns. Figure 2 shows drawings for rear leg soundness. The middle drawing from Figure 2 shows a sow that has upright rear pasterns and a really straight or “post-legged” rear leg structure. This type of rear leg structure is undesirable and gilts having this type of rear leg structure should be eliminated from the gilt pool or group of gilt replacement candidates.

The drawing on the left in Figure 2 shows the proper position of the rear pasterns and the entire leg that is desirable for gilt replacement candidates to possess. The drawing on the far right of Figure 2 shows the rear legs of a gilt that are positioned in such a way that it would be termed sickle-hocked. This gives the appearance that the legs are up drawn up under the gilt or sow. Sows housed in gestation stalls that possess rear leg structure that are up under the animal or sickle-hocked appear to sit on their butt or sit like a dog and may

increase the risk of the animal becoming splay legged.

A fourth trait that research has demonstrated influence sow productive lifetime is swaying hind quarters. It is impossible to show this trait figuratively using still images. Producers that have really studied or evaluated sows as they walk likely have a clear image of this condition in their mind. To describe this verbally you need to imagine one of the longer sows that you have ever had in your herd that was also a bit narrow based, or the width between the animal’s front legs and the rear legs is relatively narrow. The sow or the replacement gilt that has the swaying hind quarters often have their rear feet cross or touch when they walk with their normal gait. Typically, sows with swaying hind quarters have poorer sow productive lifetime when compared to the gilt or sow that walks with a more normal gate (Van Steenbergen, 1990).

Identifying candidate replacement gilts that have one or more of the undesirable feet and legs conditions and culling them rather than allowing them to enter the sow herd may be one of the keys to improving breeding herd mortality and / or replacement rates. The lone trait shown to have a positive influence on sow productive life is soft or weak pasterns on the front legs which has been shown to be favorably associated with sow longevity and if given a choice between animals

preference should be given to those replacement gilts that have this trait.

There are several other traits that should be evaluated when examining feet and leg soundness among the gilt replacement candidates. Toe size, placement and positioning are important traits in maintaining foot health and integrity. The drawing on the far left of Figure 3 shows a desirable foot that has even toes that has sufficient spacing between the toes. This foot should be contrasted to the middle and far right drawings from Figure 3. Replacement gilt candidates that have relatively small feet with the toes positioned close together like those shown in the far right drawing from Figure 3 should be avoided. Uneven toes, specifically a small inside toe like that shown in the middle drawing from Figure 3 where the toe size difference is greater than 12.5 mm (1/2 inch), is a heritable trait or is under some genetic control. Uneven toes most often occurs on the rear feet in pigs and is associated with overgrown heels and / or heel lesions on the larger toe. The overgrown heels and heel lesions occur because the larger of the two toes carries a disproportionately greater amount of the animal's weight. If the toes were even, the gilt's or sow's weight would be more evenly distributed across the foot. When uneven toes are present and more of the sow's weight is on the larger outer toe, these toes are more susceptible to a variety of cracks that ultimately can lead to lameness. While not scientifically evaluated, feet problems may lead to a sow that is

uncomfortable standing for a sufficient amount of time to consume adequate feed during lactation and result in utilization of a large quantity of body reserves to produce milk for her piglets. This may in turn lead to a sow that does not consume enough feed throughout lactation to support piglet growth and hence the demands on the sow's body reserves become greater. A sow under this condition, once weaned, may have delayed onset of estrus if she cycles at all. When this occurs, the sow is often culled for reproductive failure or failure to cycle, while the real situation is that the entire group of events is the result of feet and leg problems. It may be that feet and leg or lameness problems are likely underestimated as a reason for culling sows from the breeding herd.

The feet from all replacement gilts should be carefully examined for the presence of cracks and other injuries that would result in the gilt being prematurely culled from the breeding herd. Research (Knauer et al., 2007) has reported that cull sows have a high prevalence of foot lesions. Numerous foot lesions are common among breeding herd sows and replacement gilts and are depicted in Figure 4. The drawing on the left of Figure 4 shows a normal foot that is the goal for all replacement gilts to have upon their entry into the sow herd. Gilts that have foot conditions like overgrown heel as shown in Figure 4 (middle drawing) should be avoided prior to a gilt's entry into the sow herd. Similarly Figure 5

shows additional foot problems that replacement gilts might possess. If a gilt is identified that has one or more of these foot problems, it should be culled from the replacement gilt candidate pool. The middle drawing in Figure 5 shows visible horizontal and vertical cracks that can occur among gilts in the replacement pool. The far right drawing shown in Figure 5 depicts a toe that is beginning to exhibit toe overgrowth. Replacement gilts that have visibly cracked or injured toes or that have toes that are already beginning to become overgrown should be culled from the replacement gilt candidate pool. These foot problems are more likely to become problematic as the animal gets older.

Figures 6, 7, and 8 depict proper front and rear feet / leg positioning for an ideal replacement gilt that enter the breeding herd. Cracked toes or uneven toes on the rear feet can cause the feet and / or the entire leg to be improperly positioned. For example, a replacement gilt with severely uneven rear toes (small inner toe) will result in a gilt that appears to toe out or when viewed from the rear they appear to have their hocks angled in an inward position. Proper leg position when viewing the animal from the front is shown in Figure 7. The drawing on the left shows desirable feet and leg positioning when viewing the pig from the front. The drawings in the middle and right show a pig that has its feet toed in and toed out, respectively. These conditions do not correctly distribute the pigs weight which may

result in a higher feet and leg problems and / or lameness occurrence when compared to a pig that has the front legs properly positioned.

Figure 8 shows similar rear leg conditions as described for the front legs in Figure 7. . The drawing on the right of Figure 8 shows the proper rear feet and leg position of the pig that track or are positioned straight forward. The middle drawing in Figure 8 shows a pig that has the rear feet that are angled inward or has rear feet that “toe in”. This can give the appearance that the animal has rear legs that are bowed. The drawing on the right in Figure 8 shows an animal that has rear feet that “toe outward” or that is what some call “cow-hocked”. Like the case with the front legs, these rear feet and leg conditions are undesirable because they do not achieve the correct weight distribution and ultimately may result in a higher occurrence of lameness when compared to the animal that has the front legs properly positioned. Finally, Figure 9 is a drawing of a replacement gilt that has all of the correct feet and leg features. When combined, these traits should provide the replacement gilt with greatest chance of having a long and productive life in the breeding herd.

Feet and leg evaluation

Evaluation of feet and leg soundness or lameness is currently visually or subjectively evaluated by breeders or stockpersons. There can be differences how individual animals are evaluated or score that is assigned to a given animal

because it is subjectively evaluated by a human. Many systems for scoring feet and leg soundness have been developed (Lundeheim, 1996; Andersen and Hansen, 1996; Grindflek and Sehested, 1996; Velandar and Holmstrom, 1996; Jorgensen, 1996).

Some systems have used a few as 3 categories (Grindflek and Sehested, 1996; Smith, 1966; Webb et al., 1983) while others have used a wider scale (Jorgensen, 1996a; NSIF, 1998; Jorgensen, 1996b). The National Swine Improvement Federation has recommended a scoring system for U.S. pork producers (NSIF, 1998). The scoring systems are composed a type of linear scoring which assigns values that describe various feet and leg conformations. For example a linear score of front leg soundness might be composed of scores from 1 to 5 with 1 being the poorest (buck-kneed) and 5 being normal or sound.

Many challenges exist with subjective scoring for feet and leg traits. Frequently the entire scale is not adequately used so the traits become more difficult to statistically evaluate. Use of a small number of categories, either purposefully or inadvertently, results in the trait becoming categorical in nature rather than a continuous trait which pose different constraints statistically. Finding people who really understand and know what they are evaluating can be challenging for many production systems. Moreover, many systems require more than one person

to perform evaluations. This can result in scorer differences within an organization in addition to the difficulty ensuring that each scorer performs the scoring procedures consistently every time gilts are evaluated. Additionally, turnover among evaluators can result in constant training of evaluators. This can result in significant variation among evaluators because of their differing levels of knowledge and ability with respect to conformation or soundness scoring. Ideally structural evaluation of replacement gilts and / or lameness could be evaluated by more objective measures or procedures. Authors of this paper have been working on objective means to evaluate lameness using a static force plate. This work appears to be promising in its ability to distinguish relatively small differences in lameness. Additionally, initial work is being to develop to automate gilt feet and leg evaluation.

Summary

Feet and leg evaluation is a key component of effective feet and leg evaluation of replacement gilt candidates. Once producers have a trained eye, they should be able to distinguish between sound and unsound replacement gilts for entry into the breeding herd. It is clear that genetic variability exists for feet and leg soundness and selection should be effective at improving feet and leg soundness when accurate evaluation

and selection is practice on boars and gilts that are used in the breeding herd. This selection will have multiple benefits. First the operation should experience fewer feet and leg injuries and reduced culling for feet and leg or lameness causes. Additionally, the offspring from sires and dams (that have been accurately evaluated for feet and leg soundness) should have fewer feet and leg problems, have better performance and reduced downers during transport and lairage when

marketed. Feet and leg soundness evaluation is even more important to commercial producers who utilized internal multiplication programs for producing replacement gilts within their herds. Finally, it could be argued that the single biggest reason to improve leg soundness is to increase the productive lifetime of breeding herd females. This is not only of economic importance and worker morale importance, but could also become a significant welfare issue.

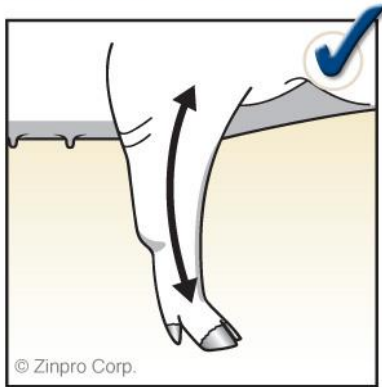
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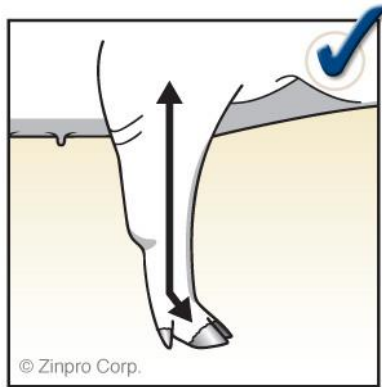
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Figure 1. Desirable and undesirable front leg structure drawings as an aid in the evaluation of feet and leg soundness for replacement gilt candidates.¹

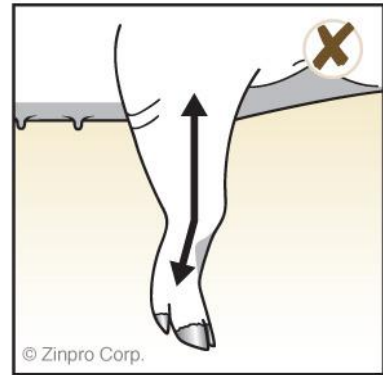
Angle of Front Legs



Leg aligns with ground



Leg aligns; dew claws nearly touch or even slightly touch the ground



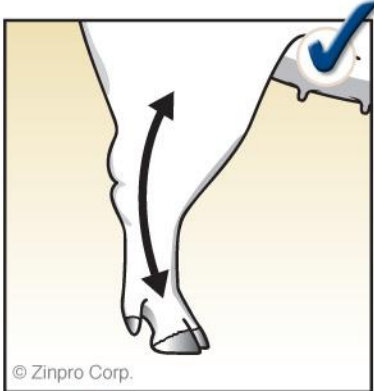
Buck kneed

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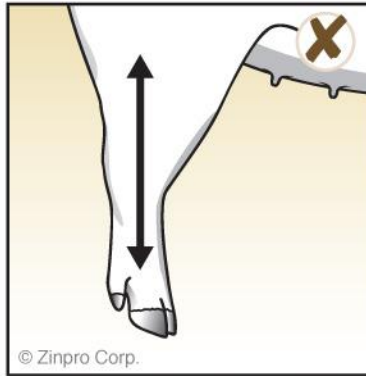
¹Drawing graciously supplied by Zinpro Performance Minerals, Eden Prairie, MN 55344 USA

Figure 2. Desirable and undesirable rear leg structure drawings as an aid in the evaluation of feet and leg soundness for replacement gilt candidates.¹

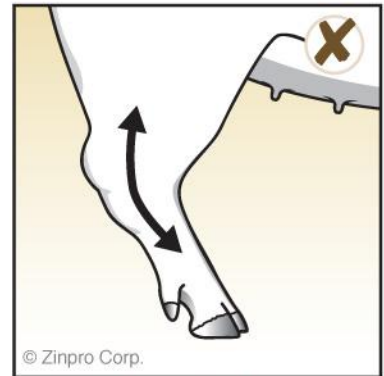
Angle of Rear Legs



*Good flex in pastern,
straight leg*



*Post legged, indicated by
nearly straight line from
the pastern through the
hock to the hip*



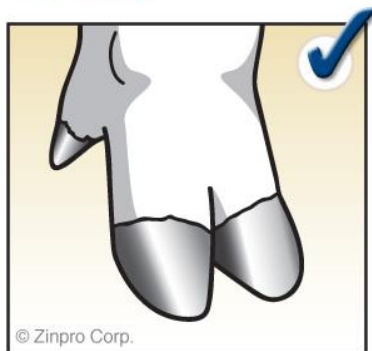
*Sickle hocked - legs up
under the animal*

Footnote:

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Figure 3. Desirable and undesirable rear toe size drawings as an aid in the evaluation of feet and leg soundness for replacement gilt candidates.¹

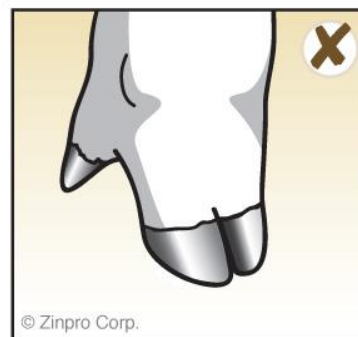
Toe Size



Equal size and length is desirable



Uneven length



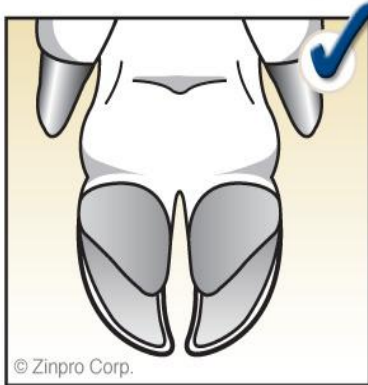
Toes too small and close together

Footnote:

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Figure 4. Drawings of the underside of a pig's foot showing soft tissue and white line cracks that producers should avoid when selecting replacement gilts for the breeding herd.¹

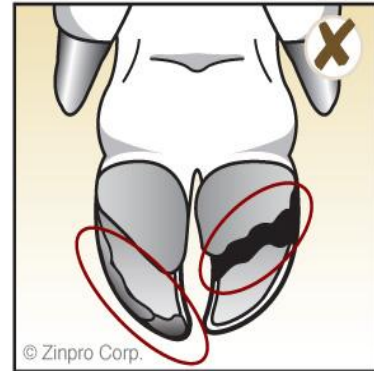
Horn Tissue Integrity



No visible lesions



Heel overgrowth



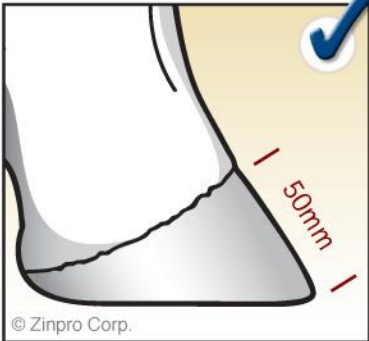
White line and heel/sole cracks

Footnote:

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Figure 5. Drawings of outer toe where horizontal and vertical cracks can develop as well as toe over growth that should be avoided when selecting replacement gilts for the breeding herd.¹

Dorsal Wall Integrity



Wall is free from cracks



Horizontal or vertical wall cracks visible



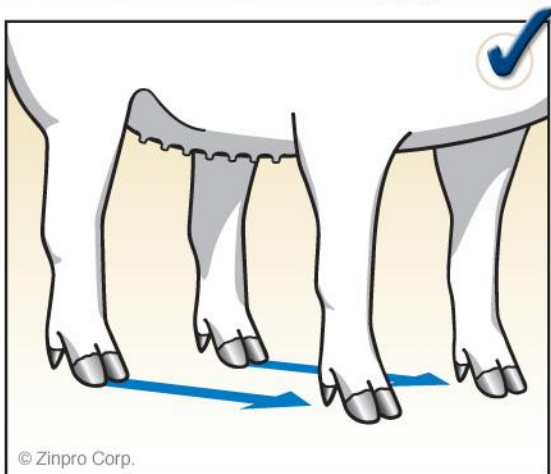
Toe is elongated

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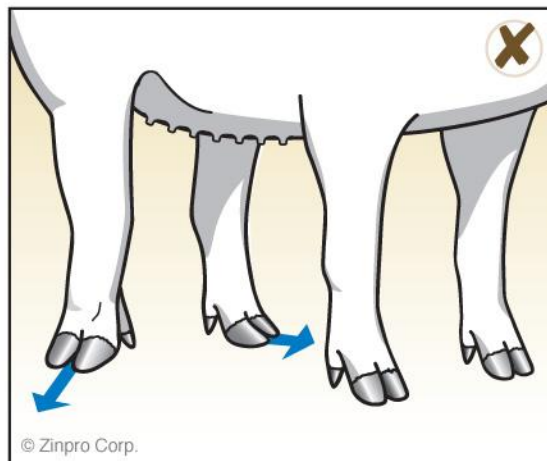
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Figure 6. Drawings of properly and improperly positioned feet and legs in the pig.¹

Front and Rear Feet Alignment



Front and back feet parallel



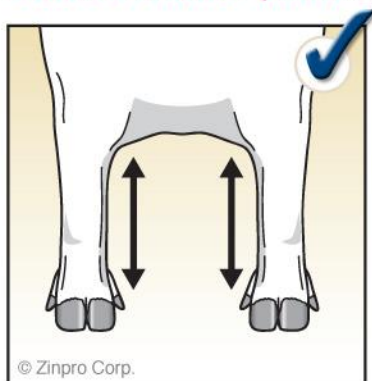
Feet do not align from front to rear

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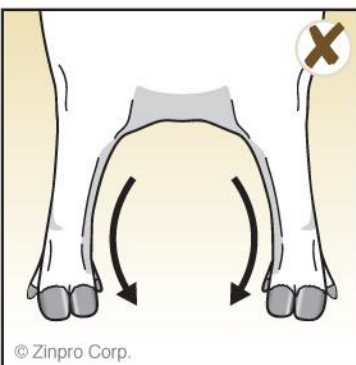
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Figure 7. Front view drawings of properly and improperly positioned front feet and legs in the pig.¹

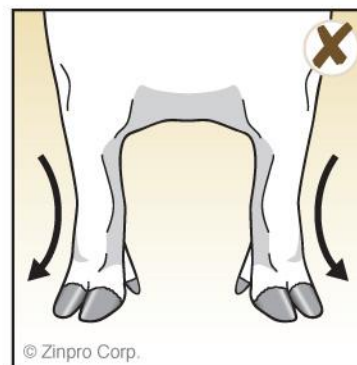
Foot Position (front legs)



Square and sturdy stance



Toes turn in, bow-legged



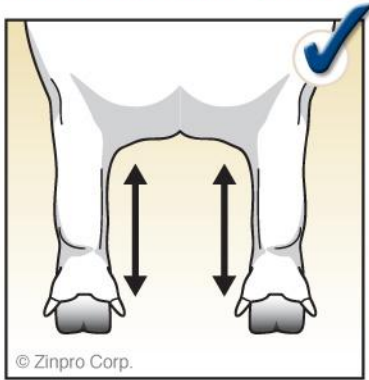
Toes turn out, pigeon-toed

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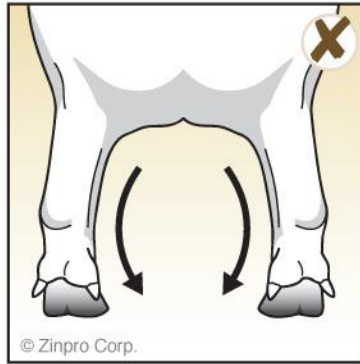
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Figure 8. Rear or hind view drawings of properly and improperly positioned feet and legs in the pig.¹

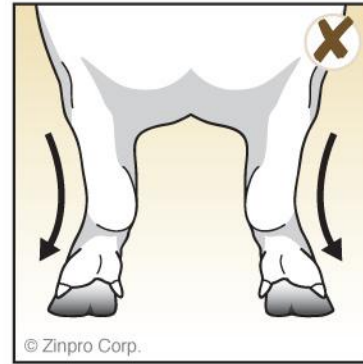
Foot Position (hind legs)



Toes forward, legs straight



Toes in, bow-legged

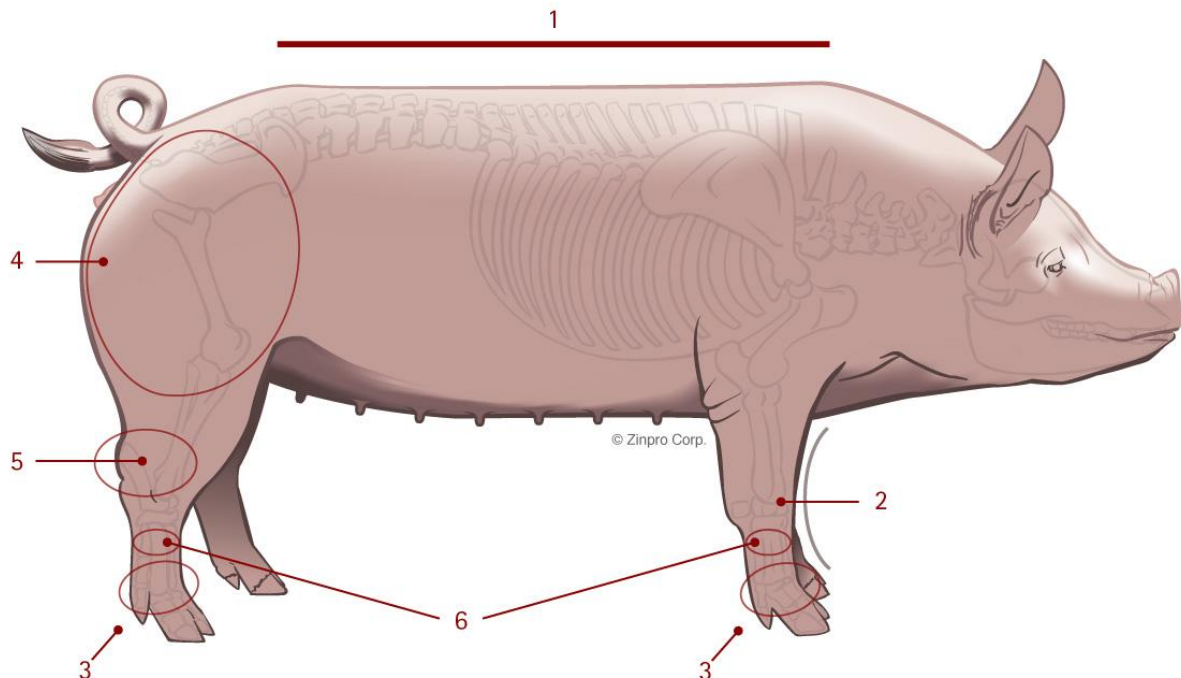


Toes out, cow-hocked

Footnote:

¹Drawing graciously supplied by Zinpro Performance Minerals, Eden Prairie, MN 55344 USA

Figure 9. Drawing of the entire pig showing a composite of the desirable traits that replacement gilts should possess.¹



1. **Straight, level back** – Select against high-topped and sway-backed animals, as these traits can be passed on to offspring causing locomotion problems. Also avoid selecting gilts with a steep rump or short neck as these attributes can cause poor posture and eventual leg problems.
2. **Correct position of knee** – Some curvature in the front legs, in the shape of an elongated “C” from the shoulder to the foot, is desirable to provide flexibility to the animal’s movement.
3. **Flexible pasterns** – Research has clearly identified that this trait is associated with a long life. When the pasterns have an adequate amount of flex to them, it helps provide good fluid locomotion and the ability to get up and down with ease.
4. **Smooth muscled ham** – Muscling should be consistent over the entire body, and the ham is a good place to evaluate the 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.
5. **Correct position of hock** – The hock is key to rear leg structure and good locomotion. When hock is improperly positioned, it can lead to swelling and difficulty standing and getting up.
6. **Large diameter leg** – This allows animals to withstand the rigors of production and help them to carry additional weight as they mature. This location on the leg is a good place to assess the size of the animal’s bone structure.

Footnote:

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