Gilt rearing impacts on sow performance and longevity – a review

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Summary
Lifetime performance and longevity are very important parameters of profitability in sow breeding. Opportunity to improve lifetime performance and longevity may be found in the rearing period and preparation of gilts for their future reproductive role. With the aim to prevent premature culling, it is possible to influence body condition, limb condition, mammary gland development, and proper function of the reproductive tract through nutrition, technology, and rearing strategies. Nutrition plays a very important role, as it can affect all the basic requirements for achieving satisfactory gilt performance. Selecting the most effective rearing strategy can be difficult because there are many factors affecting performance and longevity. The aim of this literature review is to provide up-to-date information on how sow longevity and performance can be influenced through choice of gilt rearing strategies and the important area of nutrition.

Keywords: swine, gilt, nutrition, performance, longevity

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In addition to litter size and weight, longevity is a crucial indicator of sow herd profitability. Therefore, it is important to create optimal conditions for sows in the individual phases of their reproductive cycles. Even as producers can choose gilts in optimal physical condition, with a sufficient number of teats, and place them into a near-optimal environment, this still is no guarantee of achieving breeding success and longevity. It is important to begin giving special attention to gilts much earlier as they are being reared before inclusion into the breeding herd to ensure appropriate body development and onset of reproductive functions. Longevity is associated with the level of culled sows. Although yearly replacement of 40% of sows is considered economically advisable, it varies within a wide range (62% for some US farms in 2019) and depends upon the conditions and management of each herd. Even higher yearly replacement levels can be economically acceptable if breeding herd females are sufficiently productive, however, animal welfare and long-term economic viability may be concerns when replacement levels are above 50%.

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In a 2018 summary for the United States, PigCHAMP reported a mean culling rate of 43.06%. The total culling rate included voluntary and involuntary culling. For voluntary culling, Mote et al recommended obtaining at least three litters from each sow to return the investment in the sow. Selecting sows that can remain in the breeding herd for a longer time is beneficial for reproductive performance. The authors assume that the main reasons for culling do not change substantially over time, and this has been documented by publications over the years. Friendship et al cited reproductive disorders (43%), limb problems (12%), and low performance (7%) among the most frequent causes for culling. Stupka et al reported the most frequent causes for culling from farms to be reproductive issues (44%), musculoskeletal issues (19%), and other reasons such as milk production, health condition, and age (28%). Hadaš et al performed an evaluation according to parity order and found the highest levels of culling were reached after the first and second parities, with 22% or 21% of sows culled from the sow herd, respectively, with reproductive failures (34%), musculoskeletal disorders (27%), and poor performance (18%) being the most frequent causes of culling. Poor mammary gland condition and health condition each represented less than 10% of the cases. The percentage of sows culled and reason for culling are listed in Table 1. These reasons for culling indicate the areas that present room for improvement during the rearing and preparation of gilts. However, high level of involuntary culling can also be an indicator of poor staff skill or poor sow welfare.

**Birth weight**

Selection for improved prolificacy has resulted in larger litter sizes and thereby increased the proportion of low birth weight (LBW) piglets. It is documented that LBW piglets have poorer grow-finish performance and carcass quality. Birth weight also has a relationship with subsequent reproductive performance in gilts. Almeida et al investigated the effects of birth weight on reproductive tract and ovarian follicle development in 150-day-old gilts. Twenty-eight female pigs of different birth weight ranges (high birth weight [HBW]: 1.8–2.2 kg; LBW: 0.8–1.2 kg) from higher-parity commercial sows were reared until 150 days of age. Their body weights (BW) were recorded at weaning, end of nursery, and end of grower–finisher phases. The gilts with LBW showed significantly lower BW and slower average daily gain during all phases of production compared to those in the HBW group (P < .01). Most biometrical measurements of the reproductive tract were similar between the experimental groups except vaginal length and the gonadosomatic index (relative ovarian weight) were affected by birth weight class (P < .05). The LBW females also showed fewer medium size (3–5 mm; P < .01) ovarian follicles, tended to have fewer pre-antral follicles (P < .07), and more atretic follicles per ovarian cortex area (P < .05). Therefore, in addition to affecting postnatal growth performance, birth weight influenced vaginal length and the follicular dynamics, which may impair the reproductive performance of replacement gilts.

Similarly, Vallet et al found that total uterine length was positively associated with birth weights. Their results indicate that colostrum consumption, birth weights, preweaning growth rate, number weaned, and parity were associated with gilt development traits during later life.

Knauer found that greater piglet birth weight was related to the proportion of gilts farrowing a litter. Greater piglet preweaning growth was related to the proportion of gilts that farrowed a litter and lifetime reproductive throughput. Hence, management strategies that improve colostrum production, milk production, and preweaning piglet growth should enhance subsequent lifetime productivity. Increased weaning age by 1 day added to a gilt’s subsequent reproduction by 0.185 piglets/year, and gilts that were crossfostered were 2.45% less likely to farrow a litter.

**Mineral nutrition**

It is well understood that nutrition plays an integral role in the development of a gilt. Gilts are to be bred rather than fattened so diets designed for finisher pigs may not meet the physiological needs of the replacement gilt. Replacement gilts in the grower–finisher phase should receive specifically designed diets. Modern maternal line genotypes are more sensitive to nutritional management because their appetites are lower and they have exceptional lean growth potential. Today’s gilts are therefore more susceptible to deficiencies in nutrition, environment, and management.

To achieve better rearing performance in sows and improved growth of their pigs requires an adequate mineral supply, including trace elements. Foundation and skeletal development, birth weights, milk yield, and growth can be negatively influenced when minerals do not meet the animal’s needs. Sow requirements for calcium (Ca), phosphorus (P), sodium, and chlorine, as well as zinc, iodine, and selenium are not met by feeding natural plant feeds, and so it is necessary that these be supplemented.

One of the primary goals of replacement gilt nutrition is to increase mineral stores by maximizing bone mineralization. Finisher pig diets may not supply

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<th>Table 1: The percentage of sows culled and reason for culling</th>
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NA = not available
the correct balance of minerals to satisfy the nutritional requirements for reproductive performance and for cartilage and bone formation and integrity.\textsuperscript{20,21} It is generally recommended that Ca and P be provided at levels greater than typically found in the grower–finisher diets in order to prevent females from experiencing locomotion problems later on due to excessive depletion of mineral stores during lactation periods.\textsuperscript{22} Johnston\textsuperscript{23} states that increasing bone mineralization has been shown to boost longevity of sows.

In gilt development diets, a minimum digestible Ca:P ratio of 1:1 is needed, and it varies depending on the P level. For example, it may be 1.25:1 if P meets the recommendations for 50 to 80 kg of live weight.\textsuperscript{24} Also, Ca recommendations to maximize bone mineralization are greater than for growth (less than 1.35:1 if the concentration of P is at the requirement).\textsuperscript{25} Even though growing gilts are generally provided ad libitum access to feed, the rapid growth rates in current genetic lines and high incidence of leg problems can lead to lameness. Lameness disorders account for 22.5% of sow problems can lead to lameness. Lame gilts are exposed to high levels of noise and its effect on sow milk yield.\textsuperscript{32} Therefore, amino acids such as methionine and tryptophan are needed in the diet to support growth and bone formation and integrity.\textsuperscript{20,21} It is generally recommended that Ca and P be provided at levels greater than typically found in the grower–finisher diets in order to prevent females from experiencing locomotion problems later on due to excessive depletion of mineral stores during lactation periods.\textsuperscript{22} Johnston\textsuperscript{23} states that increasing bone mineralization has been shown to boost longevity of sows.

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remains to be learned before the best nutritional strategy to enhance mammary development can be formulated. Feeding certain plant extracts with estrogenic or hyperprolactinaemic properties may also prove beneficial in stimulating mammary development within specific physiological periods. An attempt was made to stimulate mammary development in gilts by providing a dietary source of estrogen. When 2.3 g/day of the phytoestrogen genistein was added to a standard soybean meal-based diet of growing gilts from 90 to 183 days of age, there was a 44% increase in mammary parenchymal cells at the end of the treatment period. Genistein is an isoflavone found in legumes, especially soybeans.

In another study, Farmer et al. used the plant extract silymarin (from *Silybum marianum*, generally known as milk thistle). Four grams of silymarin was fed twice daily to gilts from 90 to 110 days of gestation, at which time animals were slaughtered to collect their mammary glands. Even though feeding silymarin led to a 51.8% increase in circulating prolactin concentrations 4 days after the onset of treatment, this increase was transient and was not large enough to elicit beneficial effects on mammary development.

Feed mycotoxins can impact mammary gland and reproductive tract development most likely through their estrogen-like activities. Stephan et al. found mycotoxins were passed via milk from sows to piglets on the basis of zearalenone/α-zearalenol-concentration in piglet bile. Mycotoxins were associated with a greater number of teats on the dam and fed in groups, it is difficult to ensure that slower growing gilts had a lower risk of being culled in their study.

Energy and amino acid density of diets for each phase of growth will depend on lean growth potential of the gilt and voluntary feed intake. Replacement gilts are typically provided ad libitum access to a diet lower in energy, protein, or both than those diets fed to slaughter pigs to avoid excessive body fat. This also allows for slightly slower growth, which limits mature body size thereby preventing feet and leg problems and excessive fat gain. Long et al. reported that sow fed a high energy, high protein diet ad libitum from 120 to 180 days of age had significantly poorer longevity through four parities than did gilts fed a high energy, low protein diet ad libitum or a restricted-fed high protein diet (35% vs 56% and 55%, respectively). Similarly, Hoge and Bates found that slower growing gilts had a lower risk of being culled in their study.

Feeding modern high-lean gilts *ad libitum* is most practical for most production systems, particularly when gilts are housed in groups. Limit feeding may be more appropriate for low- and medium-lean maternal gilts. Limit feeding involves providing replacement gilts *ad libitum* access to a diet until a month or two before breeding. The *ad libitum* diets are similar to grow–finish diets, allowing maximum expression of the animal’s genetic potential for growth rate and backfat. Feed intake is then restricted to approximately 85% to 90% of *ad libitum* until 10 to 14 days before mating. When restricting the diet, energy should be restricted but not amino acids, vitamins, or minerals. Therefore, concentrations of these nutrients need to be adjusted upwards in the diets accordingly. Facility design may make it difficult for producers to feed a restricted diet to replacement females. When gilts are housed and fed in groups, it is difficult to ensure the correct amount of feed is ingested on an individual basis because all gilts do not consume feed at the same rate. Unless producers have individual stalls or an electronic feeding system available for potential breeding herd replacement females, it will be difficult to implement a restricted feeding program. Feeding a high-fiber diet that is lower in energy concentration is an alternative that allows for a daily feed intake closer to *ad libitum* levels. The effects of increased consumption time, gut fill, and satiety may partially alleviate competition and variability in individual feed intake in group feeding situations, but it also may present challenges related to feed delivery systems and manure handling.

The dietary fiber content is significant because of satiety, proper digestion, and effect on intestinal microflora, and it affects sow longevity too. Koketsu et al. found evidence that adding fiber to gestation diets may improve sow longevity.

**BF and body condition**

Backfat thickness is important in gilts and primiparous sows, as it is related to sow longevity. Some authors suggest that the ideal BF range of gilts would be between 16 and 20 mm, although this range may vary and is clearly influenced by sow genetics. Fislar et al. found that gilts with thicker backfat had smaller litters in the first three parities. Sows with 10 mm thicker backfat farrowed more litters (0.41 on average) per lifetime and were culled 50 days later.

Farmer et al. found it beneficial for primiparous sows to have greater BF (ie, 20 to 26 mm) at the end of gestation to achieve optimal mammary development and greater litter body weight gain in the subsequent lactation. The results indicate that greater BF in late gestation of primiparous sows tends to increase litter weight gain due to higher milk production possibly related to better development and preparation of the mammary glands. Given the improvement in piglet weight gain was modest (8.5%), fatter sows lost more BF for the same piglet live weight, and that the strongest correlation between BF and those parameters measured in the udder occurred with nonparenchymal tissue, it is recommended to keep primiparous sows at the end of gestation in a BF range between 15 and 26 mm.

The primary goal in the final part of rearing is to encourage early expression of pubertal estrus and successfully mate gilts while they continue to grow towards their mature body size. Various strategies are possible. The specific approach may vary from farm to farm depending upon genetics and management practices. Although severe protein restrictions or imbalanced intake of essential amino acids have been demonstrated to delay the onset of puberty, moderate protein
Conclusion
Nutrition during gilt rearing plays an important role as it can affect growth rate, optimal body condition, early heat onset, reproductive tract and mammary gland development, and good limb condition. It is important to focus on welfare and fitness and to create good environmental conditions from the time of a gilt’s birth and continue all through rearing. As reproductive failures are the most common cause of culling, it would be appropriate to further investigate the effect of nutrition and feeding strategy on the development and functionality of the reproductive tract during rearing and its relationship to the lifetime performance of the sow. Due to the increased number of piglets born per litter, it is also appropriate to focus on a nutritional strategy that enhances mammary development to achieve increased milk production during lactation.

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Conflict of interest
None reported.

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References

Management
Management of the gilt up to when the first litter is weaned has a major influence on lifetime productivity and, consequently, weaning capacity. Size of the first litter has a strong correlation with subsequent litter sizes, so achieving a large first litter can be a good indicator of more piglets born and weaned in a sow’s lifetime. Correct management during gilt rearing will positively influence longevity, thereby increasing litters per sow lifetime, which is a key factor in maximizing weaning capacity. The current criteria for selecting replacement gilts for breeding are excellently described in the review by Malopolska et al. 56

Restriction during the rearing period does not appear to influence age at first estrus in sows. Older literature indicates that selected replacement gilts should be limited fed energy from 100 to 104 kg of BW or until 2 weeks prior to mating so they will not become too fat. Nevertheless, Foxcroft et al, Williams et al, and Gill presented evidence that fatness is not an issue with modern lean maternal line genotypes, which deposit and mobilize lean tissue with little impact on fat tissue deposits. Development of ultra-lean genotypes has had negative effects on longevity and lifetime productivity of replacement gilts. This has led to a need for enhancing and conserving fatness in gilts by feeding a low protein diet (11.3% crude protein, 0.45% lysine, 13.0 MJ digestible energy/kg) before and during pregnancy to restrict lean gain and increase fat deposition. In medium- or low-lean genotypes, gilts will tend to consume more energy than is needed to achieve ideal body condition, thus becoming too fat. Therefore, limited feeding is advised with those genotypes after selection has occurred.

Gill found that increases in fatness achieved by diet during rearing are transient. Any residual effects had disappeared by the time the first litter was weaned. The potential protective benefits to sow longevity from feeding a low protein diet during gilt rearing probably result from long-term reduction in sow BW and, in turn, reduced risk of foot and leg injury. A more holistic approach would be to consider how to improve the overall welfare and fitness of gilts and sows.


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* Non-refereed references.