Guidelines for Choosing Replacement Females
Michigan State University
Cooperative Extension Service

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pork industry handbook

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Introduction

The swine industry has adopted advanced crossbreeding systems that utilize specialized maternal females for the entire herd. These females can be either purchased (parent systems), or produced within-herd from either purchased females (grandparent systems) or farm-raised sows within a maternal rotation (rotaterminal systems). See PIH-39, "Crossbreeding Systems for Commercial Pork Production", for more information regarding these crossbreeding systems.

This factsheet explores different replacement female acquisition options and describes development practices and selection criteria that can impact reproductive performance in the commercial herd.

Purchasing Females

The production schedule must be effectively and efficiently managed to introduce replacements into the herd. Traditionally, purchased females have been acquired near market weight and placed within an isolation facility for health monitoring before integration into the sow herd. However, newer methods have emerged and are gaining acceptance. Replacement females can be purchased as weaned pigs (10-21 days old), feeder pigs (40-60 lb), or as traditional market weight pigs.

Females purchased at a pre-market weight (weaned pigs, feeder pigs, etc.) should be isolated within a facility for a prescribed period of time dependent on the health protocol of the particular herd. Isolation should be long enough for sufficient health monitoring and testing to minimize risk to the health status of the herd.

After isolation, females can be moved into the production system with pigs of similar age and weight; however, sometimes they are reared in separate production facilities. It is imperative that adequate pen space be available within production groups in which these females are placed. Replacement females that are crowded during maturation can have their physical and reproductive development impaired. However, if contemporary pigs are crowded while replacement females are provided adequate pen space, reduced performance and subsequent earnings can be expected.

Near the time of marketing, purchased replacement females should be moved into another facility for the acclimation phase. During acclimation, females should be in contact with cull sows to further expose them to disease organisms endemic to the sow herd. Furthermore, females should be exposed to mature boars to stimulate pubertal estrus. The acclimation phase should last 30 to 45 days before entry into the breeding herd.

Careful planning is necessary when purchasing replacement females. The number purchased must be larger than the number needed. The number purchased is herd- and program-dependent and differs for different purchasing options. To illustrate the number of purchased females needed for a pre-market weight acquisition program, a 1240 sow farm with a parent female system that has 45% annual replacement rate is used as an example. This farm needs 558 replacement females on an annual basis. An estimation of the percentage of purchased pigs that will exhibit estrus, be mated, and farrow a litter is needed to calculate the number of females to purchase, typically 60% to 90%. Younger females at purchase often have a lower probability to express pubertal estrus, while market weight purchased females reach puberty at a higher rate.

The isolation facility should be appropriate for the age of females purchased. If, for example, purchased weaned pigs are isolated for four weeks, the isolation facility and management protocol should meet the environmental needs of that age of pig. A schedule is needed for cleaning and subsequent stocking of the isolation facility before another group of replacements are acquired. With this example, one week is allocated to clean and disinfect the isolation nursery and it is assumed 60% of purchased females will farrow. This dictates that there will be five weeks between arrival of each new group of females (four weeks of isolation plus one week for cleaning). There will be 10.4

Table 1. Replacement Gilt Scheduling Worksheet

Item		An Example
Average Sow Inventory	_____ (a)	1240
Annual Replacement Rate (decimal form)	_____ (b)	.45
Number Needed/Year	axb (c)	558
Number of Days in Isolation	_____ (d)	28
Percent of Number Purchased which farrow a litter	_____ (e)	.6
Time Needed to Clean Isolation Facility, days	_____ (f)	7
Number of Replacement to Purchase	c/e	558/.6=930
Number of Replacement Females Groups	365 days/(d+f)(h)	365/(28+7)=10.43
Number of Females Purchased per Group	g/h	930/10.43=**89.2**

groups of females brought in per year (365 days/35 days =10.4 groups). Calculated group size is 90 females (930 females needed, divided by 10.4 groups) (Table 1).

If females are purchased at market weight, they would enter an isolation facility immediately upon arrival. Acclimation would be similar to females purchased at a pre-market weight. However, isolation may be conducted simultaneously with acclimation depending on the health status of the originating and receiving herd. Solicit veterinary input to determine the health monitoring sequence of the isolation and acclimation phases.

Purchased parent female programs. Parent females are mated to terminal boars and all progeny go to market. These females should be of breed or line composition such that maternal heterosis is 100%. If part of the breed ancestry of the sire and dam is similar, maternal heterosis is less than 100% and maternal performance (e.g., litter size, litter weight, rebreeding performance, etc.) is compromised. For example, a female which is $^1/_2$ Yorkshire (Y) and $^1/_2$ Landrace (L), and had pure breed parents, will exhibit 100% maternal heterosis. However if the $^1/_2$Y:$^1/_2$L female was mated to a Yorkshire boar resulting progeny would be $^3/_4$Y:$^1/_4$L. These $^3/_4$Y:$^1/_4$L females exhibit 50% less maternal heterosis when mated and farrowed. Figure 1 demonstrates the performance reduction potential when maternal heterosis is compromised. For instance, having 100% maternal heterosis improves litter size at 21 days by 8.7%. When maternal heterosis is only 50%, improvement in litter size is only 4.35%. When evaluating potential prospects for replacement females, it is important that maternal heterosis not be compromised. For further information regarding heterosis, review PIH-39, "Crossbreeding Systems for Commercial Pork Production" and PIH-106, "Genetic Principles and Their Application".

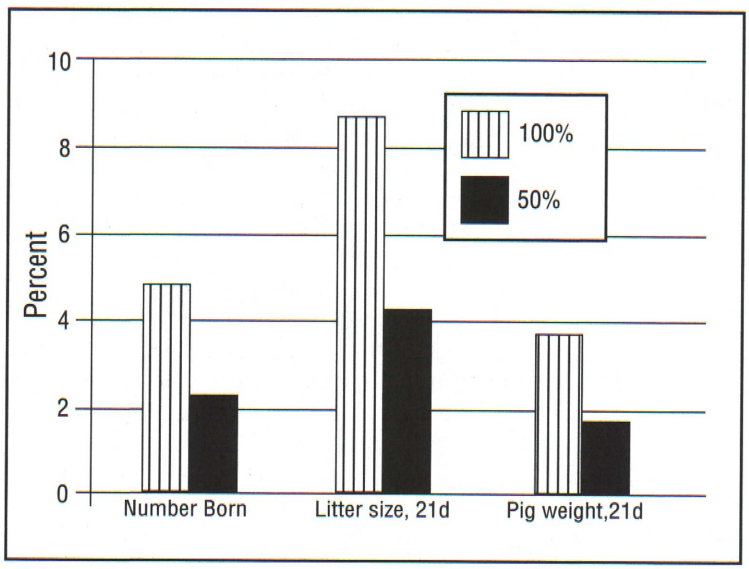

Figure 1. Maternal Heterosis (%) for selected traits

Specification guidelines. The genetic potential of purchased females should be understood before acquisition. Purchased crossbred females should be from distinct breeds or lines that excel for maternal performance and exhibit 100% maternal heterosis. Postweaning performance should be better than average, since the female will pass one-half of her genetic potential onto her offspring. Thus, when mated to superior terminal sires, offspring will be above average for postweaning performance and carcass merit. However, if the purchased female's genetic merit for postweaning performance is below average, subsequent performance of offspring, even though mated to superior terminal sires, may be just average.

Documentation of genetic improvement within the pure breeds or lines that compose replacement females should be provided by seedstock suppliers. Measurable improvement over time for both maternal and postweaning performance should be confirmed. Furthermore, selection of parents used within the multiplication scheme in which commercial females originate should be inspected. Females chosen for use within the multiplication scheme should be above average while boars should be within the top 5% to 10% of their selection group.

The physical attributes of purchased females are important and should be critically scrutinized. Females should be within the top three-fourths of their group for body size and weight for their age. Feet and leg soundness and conformation should be acceptable to minimize subsequent culling for locomotor problems. The number, size, and spacing of teats should be reasonable with six prominent, well-spaced teats per side as a minimum standard. External reproductive genitalia should be of sufficient size and shape to prevent mating problems and not hinder the subsequent birthing process (Figure 2). It is recommended that upon delivery, every female be examined for these phenotypic conditions and those which are not acceptable be rejected. Discussion of phenotypic soundness can be found in PIH 101, "Selection for Feet and Leg Soundness".

Figure 2. Select gilts with normally developed external genitalia (left). Gilts with small infantile (center) or abnormal (right) vulvas should not be kept.

Isolation and acclimation. Isolation of incoming breeding animals may be the most important part of a herd health program. The isolation program should be developed with your herd veterinarian to minimize the risk of introducing new disease organisms.

Acclimation allows exposure of new females to disease organisms endemic within the herd to minimize risk of sickness. The acclimation process should also allow for exposure to mature boars to stimulate the onset of pubertal estrus. The acclimation process can be conducted in conjunction with isolation under the advisement of the veterinarian.

Purchased grandparent females. Grandparent females are purchased to be mated to another maternal breed (line) and produce parent females that are reared within the herd. Typically grandparent females make up 10% to 15% of the sow herd. Grandparent females are either purebred (pureline) or crossbred females. Reports from Europe suggest that purebred grandparents have higher herd removal rates than crossbred females. Crossbred YL females were reported to have 0.6 to 1.2 more parities per lifetime than either Landrace or Yorkshire purebred females. This suggests that when purebred grandparent females are used they constitute a higher proportion of the total herd than when crossbred grandparent females are used. Commonly, crossbred grandparents will comprise 10% of the sow herd, while purebred grandparents will be 15% of the sow herd.

Mate selection. Mate selection of grandparent females is critical to the continued success of this breeding system. Typically, maternal boars of a different breed background to the grandparent females are supplied by the breeding stock supplier. Often the supplier selects the maternal boars to be mated to grandparent females. However, herd supervisors should supply input to those selection decisions since they know the strengths and weaknesses of the herd.

Boars chosen for use as sires of parent females should come from a maternal breed or line distinct from the grandparent females. This allows for maintenance of 100% maternal heterosis. For example, a Hampshire-Landrace F_1 grandparent mated to a Yorkshire boar would maintain 100% maternal heterosis. However, females from the mating of a Yorkshire-Landrace F_1 female to either a Yorkshire or Landrace boar would not exhibit 100% maternal heterosis when retained within the breeding herd.

Boars mated to grandparent females should be from sow families that excel for maternal performance. This will be most easily documented through EPDs (Expected Progeny Differences) on young sires. The supplier should provide sufficient documentation that purchased maternal boar(s) or semen are superior. This evidence should be more than individual sow performance records or herd averages. Ideally, documentation should consist either of EBVs (Estimated Breeding Values) or EPDs from within-herd or across-herd genetic evaluation programs. Selected boars should also be at least herd or line average for postweaning performance.

Physical features of boars mated to grandparent females are important. Typically, just a few boars are used for parent female production. Physical faults of a boar can commonly be observed in his progeny. Boars should be better than average for leg soundness, be level in their hip and be free of underline deformities such as pin teats or extreme poor teat spacing.

Rota-terminal systems. Rotaterminal systems produce females from a within-herd maternal rotation. All females within the herd are eligible to produce replacement females. Among newly weaned sows retained for subsequent breeding 10% to 15% are mated to produce replacement females.

Selection of maternal sires for use within the maternal rotation of a rotaterminal program is similar to mate selection of grandparent females. Since all females are available to produce replacement females within a rotaterminal system, some discretion is prudent in choosing females to be mated to maternal boars. Females mated to maternal boars should be structurally correct with few physical faults, including both feet and legs and underlines. These females should have an acceptable performance history, which should include number born alive and weaned and preferably litter weight at birth and weaning. Females mated to maternal sires should express estrus sooner than the average of the group and not have a history of recycling. Genetic influence of return to estrus after farrowing is moderate in nature. Females that express estrus within four to five days after weaning or soon after exposure to boars (in the case of gilts) may be more apt to produce female progeny that return to estrus quickly.

Rearing and selection of parent females. The management protocol used for rearing of potential replacement females can impact their subsequent productivity record. Management for improved reproductive performance begins at birth and continues through their entire lifetime.

Females and younger sows should be fed to continue bodily development while older sows should be fed to achieve optimum subsequent milk production.

The sex ratio of a female's birth litter can impact her subsequent fertility. Research has shown that females from

litters with a high frequency of boars (2/3 boars or more) have a greater risk of failing to conceive and should not be selected as replacements.

The number of nursing pigs in the litter impacts subsequent reproductive success. Females reared in larger litters will have smaller subsequent litter size compared to those nursed in smaller litters. Potential replacement females should be nursed in below average size litters (≤9). Within 48 hours after birth, crossfostering should be completed to standardize litter size. Potential replacement females should be reared in their birth litter with fewer than average nurse mates. For example, if average litter size born alive for a group of sows is 10.5, it is better if potential replacement females were nursed in litters of nine or less.

Potential replacement females should be identified before weaning so they can be followed through the production system. Ear notching can be used and is a successful identification system. However, proper ear notching technique is critical in maintaining proper identification (ID). See PIH 18, "Baby Pig Management - Birth to Weaning" for more information on ear notching techniques.

Ear tags can also be used. Small tags can be placed into the pig's ear after three to four days of age with a high retention rate. Maintaining identification through the production system and back into the breeding herd allows retention of females with the correct breed background. It further allows farm management to maintain dam and sire information within the replacement female's herd record. This can be very useful in troubleshooting defects that may have a genetic influence.

There are electronic identification (EID) systems now available for swine identification. These systems are primarily used with visual identification systems (ear tags) and do not require placement under the skin. Hand-held EID readers can be used for electronic data recording. This streamlines the process of maintaining replacement female identification and minimizes errors in recordkeeping. Pork producers must determine if hand-held readers and data retrieval devices are compatible with the herd production record software and production benefits justify the cost of these systems.

After weaning, replacement females should be fed diets that meet the requirement for their age and weight. Grower and finisher diets should be 0.1% higher in both calcium and phosphorus than recommended for growing-finishing pigs. See PIH 52, "Minerals for Swine" for further information. Floor space allocation impacts pig growth and development and should be no less than what is recommended in PIH 55, "Space Requirements for Swine".

Attainment of puberty and return to estrus after weaning is antagonistic with genetic change for improved backfat and loin muscle area. Maternal lines selected for reduced fatness and increased muscle content tend to reach puberty later, and when subsequently farrowed have a longer return to estrus interval.

It is important to know the relative merit of replacement females for lean growth. Improper management of high lean females can lead to poor subsequent reproductive performance and a reduction in potential profit. Investigations of different nutritional management strategies for the growing replacement female have yielded mixed results. One emerging pattern has been improved subsequent reproductive potential and reduced culling rates when females consumed higher levels of energy and lower levels of protein than recommended for finishing pigs.

This strategy has also shown promise during gestation. A European study compared feeding lower protein levels (11.3% crude protein) to replacement females after acquisition and during acclimation and gestation. These females were compared to females fed 16% crude protein (CP) diets after acquisition and through gestation. After farrowing those fed 16% CP rations were fed the same ration while those females fed the 11.3% diets were offered a 18% CP diet. Longevity through three parities was improved 18.6% (83% vs 70%) when gestating females of high lean potential were fed diets with lower protein content after acquisition and through gestation. At initiation of the study, females were 170 days old at 230 lb with 0.51 in. of backfat. At first farrowing, females fed lower protein levels during acclimation, breeding, and gestation were 8.5% fatter (0.77 vs 0.71 in. respectively), even though both treated and control sows weighed 440 lb. This study suggests that increasing body energy stores of high lean growth potential replacement females during finishing or during acclimation and gestation could improve longevity.

Care should be taken when modifying the nutritional program of replacement females, either during finishing or gestation. Females that are too fat at farrowing suffer from reduced lactation feed intake and have poorer lactation and re-breeding performance. Input from a swine nutrition specialist should be sought for diets fed to growing replacement females.

Near market weight, selection of replacements should be expediently completed for non-selected animals to be marketed with their contemporaries. Selection of replacement females from all available females should involve some scrutiny. If thorough evaluation of sires and dams was practiced, simple screening procedures can be utilized; however, if that were not the case, a more detailed protocol may be necessary.

Listed below are example procedures that can be implemented based on the needs of the farm and past history of replacement female performance. Pork producers should choose screening procedures that best fit their situation;

1) Growth. Replacement females should have acceptable growth rate(top three fourths of their group) in comparison to their contemporaries. Adequate growth is necessary to increase the probability of proper development of reproductive systems. Poor reproductive function (lack of heat, not in pig, etc.) is usually the top reason for sow culling.
2) Feet and leg soundness. Locomotor problems are either the second or third most typical reason for sow culling. Females should be scored for front and back feet and leg soundness. Those that score poorly should be marketed.
3) Underline soundness. Underlines should be visually evaluated and those with less than six teats per side or exhibiting more than two pin or blind teats per side should be eliminated.
4) External genitalia. Females with extremely small vulvas should be avoided. If these females are chosen as replacements, their reproductive outcome should be monitored and this information used to aid culling decisions.
5). Backfat measurement. Selection for reduced backfat in commercial females does not yield enough benefit to justify estimating and adjusting backfat measurements. Reduction in fat levels is most economically accomplished when selecting prospective sires. However, if pooled maternal semen is used from boars that vary widely for growth and backfat EPDs or if a backfat evaluation program is deemed necessary, consult National Swine Improvement Federation guidelines for on-farm testing. If backfat measurements are collected, females should be weighed and measured for backfat

near the 10th rib, two inches off the midline. These measurements should be adjusted to a common weight (e.g., 250 lb) to allow unbiased comparisons among contemporary females. These backfat estimates can be used by themselves or in an index with growth rate (assuming birth dates are known). However, selection on backfat alone can cause antagonistic response for onset of puberty and return to estrus after weaning.

Conclusion

Introduction of replacement females is an important process for a commercial swine farm. The protocol followed is contingent on the crossbreeding system implemented and the health, production, and monetary costs associated with the introduction of new breeding stock to the farm. Pork producers should have a well-documented and written protocol for introduction and management of replacement females. This plan should be regularly reviewed and revised with the assistance of the herd veterinarian and with nutritional and genetic specialists.

Further References

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