SHOULD YOU USE ARTIFICIAL INSEMINATION AND/OR EMBRYO TRANSFER IN YOUR SWINE OPERATION?

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Summary and Conclusions

The use of AI and embryo transfer in swine herds will undoubtedly increase during the next decade. The techniques themselves will undergo refinement and improvements as swine producers learn to use them and to manage the genetic aspects of their herds. These techniques should not be viewed as useful tools only for large swine herds. In fact, the relative genetic advantage is probably greater for the medium-sized or small herd, since the superiority of the AI sires compared to boars otherwise available to these herds is relatively greater. Also, access to breeds that are not locally available is an important benefit. The only limitation is the individual producer's desire and abilities, since there is no expensive equipment that will improve results. In fact, AI could become an important equalizer in the distribution of genetic material in the swine industry.

In planning for the future, we should also realize that a genetic revolution is just beginning. The Swine Testing and Genetic Evaluation System (STAGES), which is just being implemented by the eight breed associations, will soon make possible comparisons of sires across farms for growth, feed efficiency, and carcass and maternal traits. STAGES will improve the accuracy of selecting superior sires and will provide a means of establishing a national sire listing similar to those presently available in the beef and dairy industries. Estimates of genetic merit will be expressed as predicted progeny deviation (PPD's), which are estimates of how the future progeny of an individual is expected to perform compared to that of an average individual. AI and embryo transfer will be important tools in providing access to the outstanding breeding animals developed with STAGES.

Introduction

Many swine producers have considered using artificial insemination (AI) and a sizable number have tried the procedure. Embryo transfer is considered a possible breeding tool by a much smaller group of swine producers but a steadily growing number also are using this technology. Both technologies have impacted significantly on the international trade of swine seed stock. However, the purpose of this article is to consider the potential impact of these two technologies on individual pig herds.

AI and embryo transfer can have a major impact for two reasons: potential genetic benefits and protection of herds from exposure to various diseases. Both of these benefits are attainable but failure to appreciate some basic principles leaves swine producers open to unnecessary herd health risks and unrealized genetic benefits. Therefore, these topics will be considered in some detail. It is also true that both techniques are merely academic exercises, unless fertility levels are adequate to provide the required number of progeny for breeding herd replacements. Finally, both techniques require managerial efforts well beyond those required for conventional swine farms. Scheduling is of the utmost importance, because replacement breeding stock (that is semen or embryos) must be purchased before or soon after conception rather than near the time of puberty, when new herd boars and gilts are usually purchased.

Potential Genetic Benefits

The relationships governing genetic benefits from AI or embryo transfer are summarized in the following equation:

$$\text{Rate of Genetic Change} = \frac{\text{Selection Differential x Heritability x Accuracy}}{\text{Generation Interval}}$$

Where: Selection Differential is the superiority of the selected parents.
Heritability is the relative importance of additive gene action for the trait.
Generation Interval is the average age of the parents when the offspring are born. Usually this is 1.5 to 2.0 years for pig herds.
Accuracy is a measure of how closely our estimation of an individual's worth agrees with his or her actual genetic worth.

AI Using Semen Collected "On-The-Farm"

In the simplest scheme, the genetic merits of an outstanding boar would enter a herd through his semen and the offspring sired, which received half their genetic information from the superior boar, would be marketed. This would be similar to the cow-calf operator who purchases semen, breeds his cows by AI, and markets the calves.

This also is similar to AI programs using semen collected "on-the-farm" and to swine seedstock producers who might market some AI offspring at a premium. In the first case, considerably more could be paid for superior boars because fewer (about one-fifth as many) would need to be purchased and five to 10 times as many offspring would be sired by each boar. In these situations, the genes of the sire are transmitted directly to the marketed offspring and if the AI sire is superior to sires that would otherwise be available, the rate of genetic change is increased because the daughter selected for replacement had a superior father.

This "genetic advantage" can be considerable. There can easily be a difference of $1,000 to $2,000 in the value of the best and the poorer boars offered for sale. This estimate takes into account the value of the boar's offspring and the value of the daughters he leaves in the herd. Extending the boar's service through AI introduces a multiplication factor of 5 to 10, resulting in a value difference of $5,000 to $20,000 between the best boars and their poorer contemporaries.

Purchased Semen

Many pork producers are interested in purchasing semen from boar studs or other sources. The genetic implications of this procedure can impact on both seedstock and commercial producers. A word of caution is appropriate. The usual motivation for purchasing semen or embryos is to provide breeding herd replacements. We should realize that not all offspring produced by superior parents are themselves superior. There is a certain amount of chance in the equation and if we use all the offspring produced from AI semen or embryo transplants as breeding herd replacements, genetic progress may be nil. However, we can dramatically improve the situation by selecting among the offspring and culling inferior animals.

Seedstock producers. Several advantages can be realized by this group. The ability to sample from a large number of boars minimizes the risks of putting "all your eggs in one basket", which in effect happens when only one or two new sires are used heavily in a given year. The breeder gains the ability to sample several genetic lines and combinations under similar conditions on the same farm and choose those that excel. In addition, boars beyond the breeder's normal price range can be sampled relatively reasonably and even Canadian boars are available. Perhaps the primary advantage gained is the genetic diversity introduced into the herd through female offspring, which the breeder then can mate to other AI sires and from which future replacements can be selected.

If properly implemented, this approach can dramatically reduce disease risks compared to the conventional method of buying new breeding stock. A scheme that a seedstock producer might use is depicted in Figure 1.

Embryo transfer also can be used to sample other genetic stocks. Embryo transplants offer the advantage of providing completely new genetic packages as opposed to AI semen, which only provides one-half of the genes to the next generation. This can be a tremendous advantage for avoiding inbreeding and increasing genetic variation in closed herds. Embryo transplants also have been used to add new breeds to an existing herd.

On the negative side, the small number of embryos usually purchased limits the ability to select among the offspring, so the rate of genetic change may suffer. However, the purpose of embryo transfer is to introduce genetically unrelated animals and if the females are bred with semen from superior boars the two sources of genetic material complement each other and a system for producing superior replacement females and males is possible. Since fewer males are needed, it is possible to select among embryo transfer offspring to genetic advantage and produce superior herd boars directly. Several swine operations have taken this approach to maintain a "closed herd".

A current limitation for swine embryo transfer is the few laboratories where the procedure is performed. Kansans are fortunate in that Dr. Keith Beeman has recently established a swine embryo transfer facility in the Department of Surgery and Medicine at Kansas State University and its services are available for your use.

Commercial producers. Swine enterprises other than seedstock producers have developed schemes to close their herds to the introduction of 'foreign' pigs. In Figure 2, approximately 15-20% of the herd is devoted to emphasizing maternal traits and providing mothers of replacement gilts. In another 5% of the herd, emphasis is placed on carcass and growth traits and herd boars are produced by these sows. New genetic material is introduced with purchased semen and the producer must select within these lines to produce breeding herd replacements. If pig identification and/or records are inadequate, or sound genetic principles are not followed, this system will fail to capitalize on the superiority available from the stud boars and also may lead to reduced levels of heterosis. These problems can be circumvented to some extent by embryo transfer. The embryo transfer offspring in effect represent completely new genetic packages. In one version, the herd might rely exclusively on ET as a source of Star Sows. When the need for more Star Sows is anticipated, the producer would buy a set of embryos. The offspring produced would form a population from which the best half or third of females would become part of the Star Sows and when mated to an off-farm AI sire would produce sons that would be as genetically unique to the herd as any boars that might be purchased. The best perhaps 25% of the male pigs resulting from these embryos could serve as herd boars for producing market pigs. This scheme permits a producer to raise his own boars at a very low disease risk without the necessity of maintaining a self-propagating, mini-herd within the larger herd. A similar approach could be taken in the Super Mom herd.

Disease Risk

Swine producers know that their herds are at risk for the introduction of new diseases each time new animals are added. As a result, isolation and testing plans for replacement boars and gilts have been developed. Immunization programs are another aspect of managing disease risks. It is widely recognized that the proper use of AI or embryo transfer can reduce these risks still further. In fact, if semen-producing boars meet the guidelines established by the Livestock Conservation Institute (LCI), there is very little risk to herd health. Embryo transfers can be done in such a way that the risks are reduced even further. However, either procedure also can be done in ways that offer no advantage for disease protection. Because the proper methods are not familiar to all swine producers, they will be outlined briefly here, so that more intelligent purchasing decisions can be made. There are no federal guidelines or laws. However, a more detailed discussion of AI procedures is included in guidelines published by the LCI[1]. The LCI recommends an isolation and testing procedure before the boar is introduced to the stud and that the boar's herd of origin be free of certain diseases. The stud should be maintained as a pseudorabies-qualified and Brucellosis-validated herd. Boars should be tested annually for leptospirosis and tuberculosis and maintained on a herd health program supervised by a veterinarian. Breeder-owned boars should also meet these guidelines, if semen is to be sold off the farm. In addition, the boars should not have bred naturally for 60 days preceeding semen shipment.

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[1]Health Guidelines for Boar Studs, published by: Livestock Conservation Institute, 239 Livestock Exchange Building, South St. Paul, MN 55075.

There have been no guidelines established for pig embryos, but many of the recommendations for semen apply. When embryo transfer is used for international shipments of swine breeding stock, the importing country frequently requires that embryo recipients be quarantined apart from other pigs for one or two months, and then test negative for the diseases of concern before they are allowed to associate with other pigs. When this approach is taken, it is considered by many as the safest way to import genetic stocks. Individual swine producers could develop similar procedures for their herd with the help of their herd veterinarian. This would represent the ultimate in safety from disease risk. Of course, diseases can also be transmitted by animals other than pigs and by humans and absolute safety from infectious diseases cannot be garaunteed.

Will I Be Successful?[2]

A prominent scientist observed several years ago that success with AI (or embryo transfer) requires the three p's: pigs, patience, and persistence. The need for pigs is obvious.

Patience. These techniques require attention to details. Not just during the learning phase but from now on. It is impossible to provide a cookbook recipe for the implementation of swine AI or embryo transfer. What is required is a sound background in reproductive physiology and genetics and the attitude that each step, from selecting sires through scheduling estrus, heat detection, and insemination is the most important use of your time. For example, there is more to heat detection than just knowing what a sow in heat looks like. Is she coming in or going out of heat? Did you know: That a sow in the early stages of estrus will quit standing if the boar is taken away? That a gilt's vulva is most swollen one to two days before estrus? That uterine contractions, which move semen up the reproductive tract to the site of fertilization, can be blocked if the sow is in pain or frightened? The physiology of the pig is the ultimate authority and we have only a limited ability to bend it to our convenience.

Persistence. If it was worth trying in the first place, it's worth trying again. Perhaps the most important advice that could be given is to start slowly, learn from each mistake, and develop a reliable formula for your herd and conditions.

Management. Although it doesn't begin with p, its an essential part of each of the above. A lot of the management can be summarized as Schedule, Schedule, Schedule. First the gilts and sows must come in heat on the date you select. Of course, they really select the date, you only try to predict it. Then, if you're using liquid semen, you have room for only perhaps a one day margin for error. You are wise to start with extra sows and gilts and use only the ones that fit your schedule most closely. Schedule time to do the job right.

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[2] Space does not permit a discussion of procedures and equipment. Refer to the Pork Industry Handbook fact sheet PIH-64, Artificial Insemination in Swine. This and other information on artificial insemination and embryo transfer is available from the Cooperative Extensive Service, Call Hall, Kansas State University, Manhattan 66506.

Another point to consider: third to fifth parity sows usually have the largest litters, are the most fertile, and the most reliable in returning to estrus promptly after their pigs are weaned. Therefore, they make ideal candidates for artificial insemination or embryo transplants.

What Can You Expect?

The surest way to fail is to have unrealistic expectations. Results with AI vary from herd to herd, but it is clear that AI is not therapy for poor fertility. In many herds, the use of liquid semen results in fertility equivalent to handmating but farrowing rate or litter size may be slightly depressed, particularly in the initial stages of developing an AI program. A good initial goal might be to attain a level that is 90% of that currently observed for the herd and once that goal is realized, to work on improving to the levels resulting from natural service.

Use of frozen boar semen usually sharply reduces fertility. Although some herds attain near normal levels, most herds experience lower farrowing rates, and smaller litters after insemination with semen stored in the frozen state. Results indicate that a farrowing rate of 50% and a one to two pig reduction in litter size are attainable and these would be realistic goals for an initial program using frozen boar semen.

Embryo transfer is still a more exacting procedure than AI, but under good conditions of field application, farrowing rates of 70-80% can be expected with normal litter size for the breeds and existing conditions. About 40-50% of embryos transferred survive to term. This is not much less than the embryo survival rate of 60% normally expected. If the embryos must be held in test tubes several hours before being transplanted, a farrowing rate of 50-60% may be expected and only about 25% of the transferred embryos survive. Donors and recipients should be separated for health reasons but clearly it is best to have both groups at the same location so that transplantation can be accomplished soon after the embryos are removed from the donor sow.

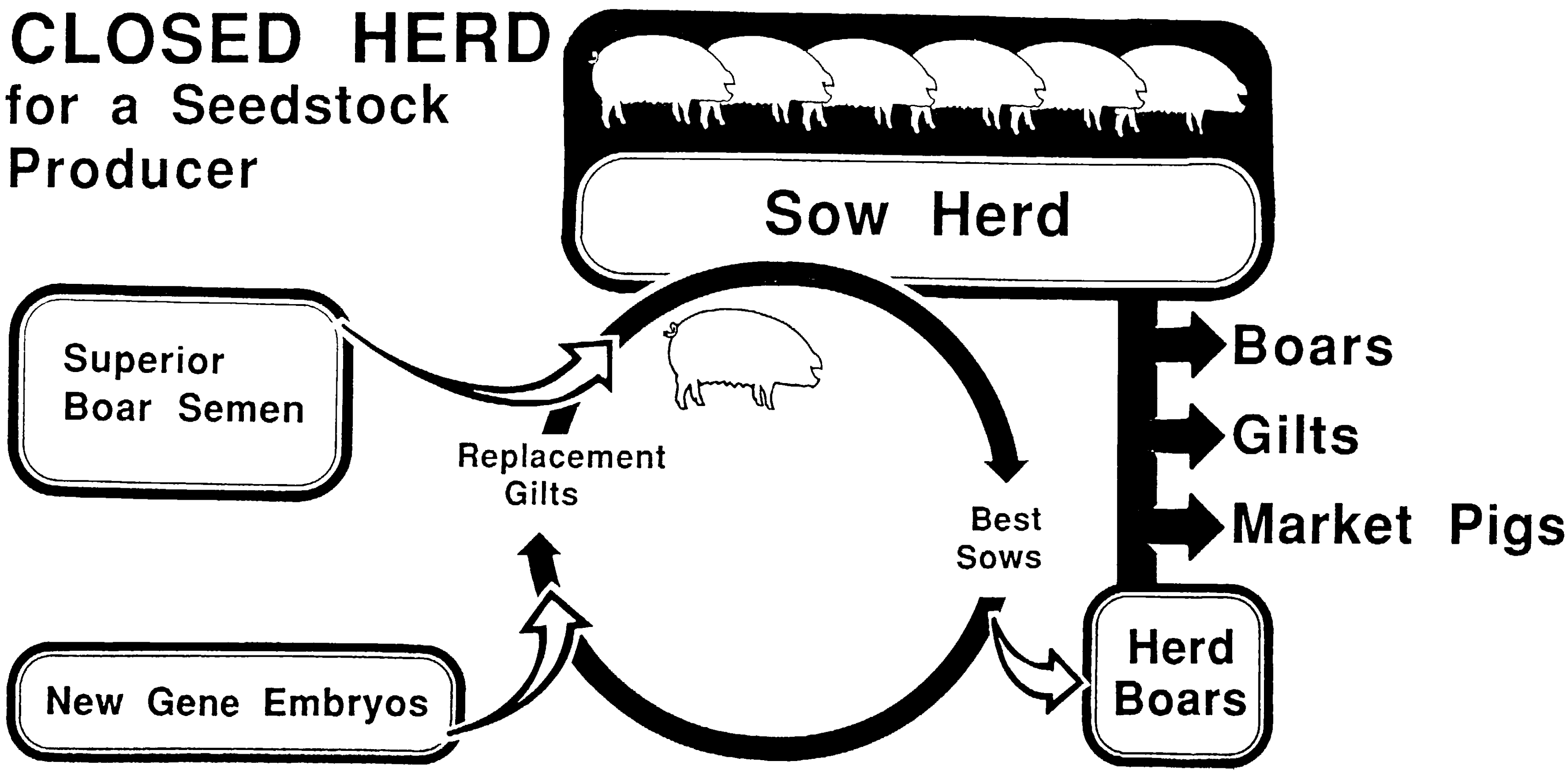

Figure 1. A possible scheme for introducing new genetic material into a seedstock herd using AI and/or embryo transfer.

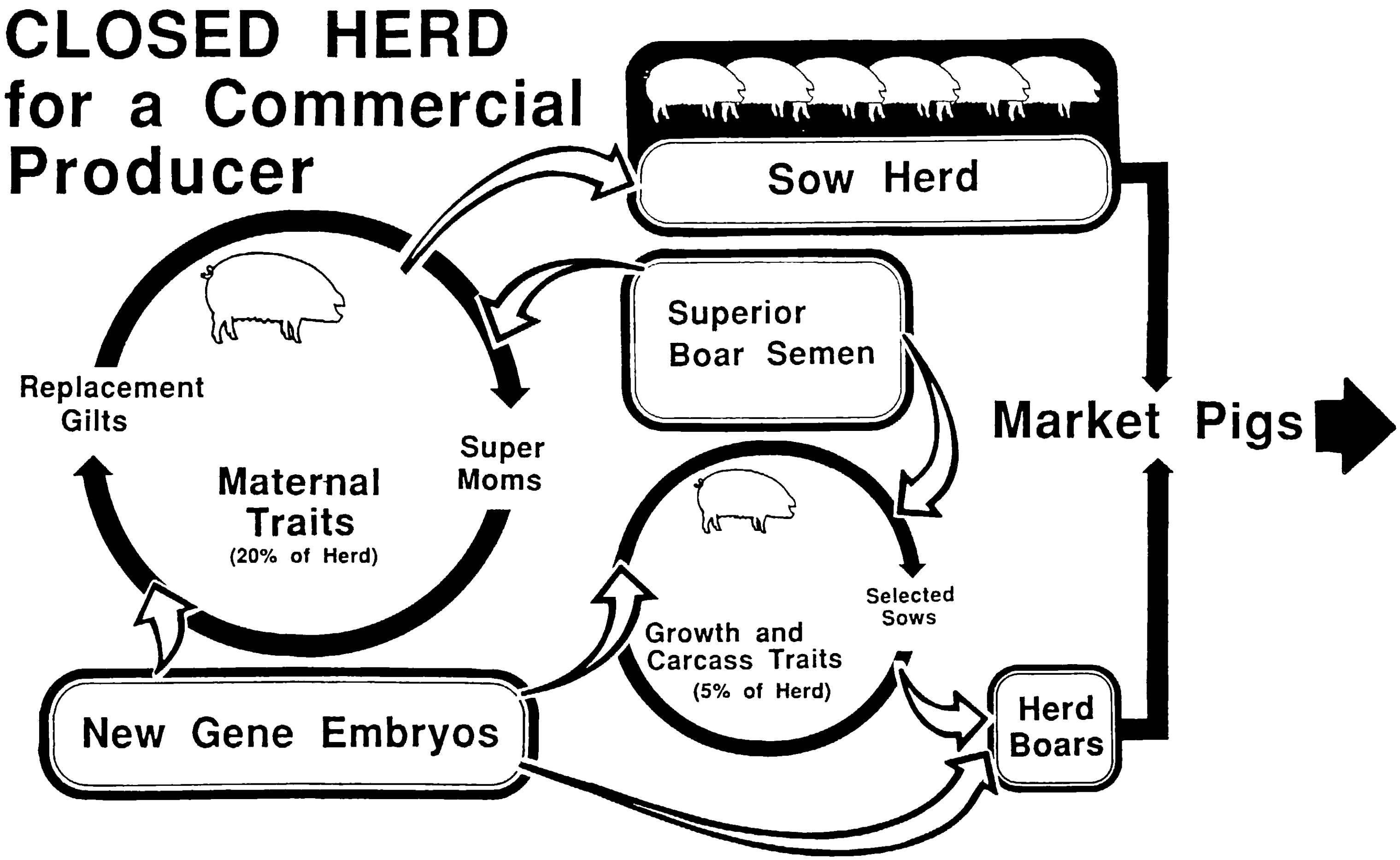

Figure 2. A possible scheme for introducing new genetic material into a commercial herd using AI and/or embryo transfer.