factsheet
Pork Information Gateway

Across-Herd Genetic Evaluation of Swine

Authors
Donna L. Lofgren, Purdue University, W. Lafayette, IN
Cindy M. Wood, Virginia Tech, Blacksburg, VA

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Reviewers
John W. Mabry, Iowa State University, Ames, IA
Gordon Jones, W. Kentucky University, Bowling Green, KY

Introduction

One way to improve performance in a herd is through selection of genetically superior animals, with the selection based on an estimate of the genetic merit of the animals. How well this genetic merit is estimated (accuracy) is important, because accuracy predicts the potential rate of genetic progress. The higher the accuracy, the more genetic progress is possible, assuming that the genetically superior animals have been selected.

Across-herd genetic evaluation programs are used to predict the genetic merit of animals for specific traits. These programs combine records on the individual with information on relatives in an in-depth analysis, resulting in very accurate estimates of genetic merit. The programs typically express the genetic merit of an individual for a trait as an Expected Progeny Difference (EPD), or half of the animal's breeding value.

Across-herd genetic evaluation is the comparison of sires, dams, and pigs based on the analysis of performance information collected on pigs of the same breed in different herds at many different times. This may include onfarm records, national breed test information, and progeny test data. Across-herd evaluations can be used to accurately compare animals in different herds.

Across-herd evaluations are used routinely by the dairy and beef industries in the U.S. to identify the very best genetic material in each breed. Canadian pork producers use an across-herd program to select breeding stock. In the U.S., the STAGES program began using an across-herd evaluation in 1991, and has done nightly across-herd evaluations for Yorkshire, Hampshire, Duroc, and Landrace breeds since 1998. There are separate evaluations for each breed.

Why Use Across-Herd Genetic Evaluation?

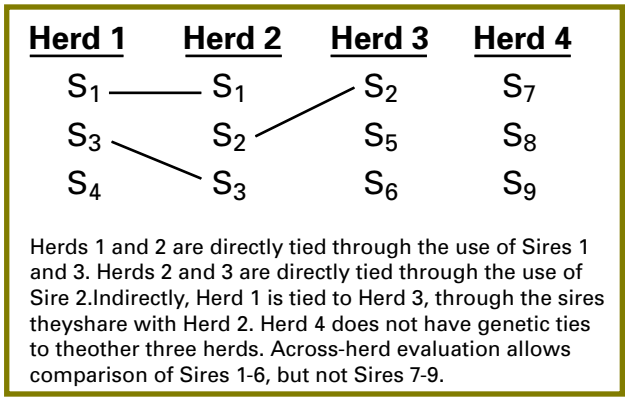
A major goal of seedstock breeders is to increase the rate of genetic progress to better meet the needs of commercial operations producing high-quality pork for consumers. Accurate, timely information is vital in making selection decisions to meet that need. Across-herd genetic evaluations offer several advantages over other evaluation methods.

1. All available performance information about an animal and its relatives (parents, sibs, offspring, etc.), collected in many different herds, is used to obtain the most accurate estimate possible of the genetic merit of each animal. The resulting EPDs predict how the offspring of each animal will perform when compared to other animals within that breed.

2. Fair comparison of animals in different herds is possible with acrossherd EPDs. Comparing raw data on animals in different herds is tempting, but such comparisons may result in poor selection decisions, because performance differences may be environmental, not just genetic. Across-herd EPDs estimate the genetic differences between pigs in different herds. Because EPDs are deviations, they may be positive or negative. All animals within a herd could be better than the average of the breed, or all could be worse than the average. In practical terms, neither extreme is very likely; the vast majority of herds will have some animals above the breed average and some below.
3. Use of across-herd EPDs to select breeding animals should speed up genetic change within a breed. A large number of animals in many herds are evaluated, and the best of all of these should be chosen as parents of the next generation.
4. Across-herd evaluations offer the opportunity to effectively test for traits which are difficult or expensive to measure, or which cannot be measured on live animals. For example, traditional carcass traits require the slaughter of animals, so fewer records are collected in an individual herd. Combining information across many herds can improve the accuracy of the resulting EPDs.

Genetic Principles of Across-Herd Evaluations

Across-herd genetic evaluations employ the same genetic principles as within-herd genetic evaluations, extended to include differences between herds. The goal is to identify the genetically superior animals, so they can be selected, and thereby increase the rate of genetic progress in traits of economic importance. What follows is information on aspects specific to across-herd genetic evaluations. Detailed information about genetic principles may be found in NSIF-FS9 "Application of Selection Concepts for Genetic Improvement."



Herds 1 and 2 are directly tied through the use of Sires 1 and 3. Herds 2 and 3 are directly tied through the use of Sire 2.Indirectly, Herd 1 is tied to Herd 3, through the sires theyshare with Herd 2. Herd 4 does not have genetic ties to theother three herds. Across-herd evaluation allows comparison of Sires 1-6, but not Sires 7-9.

Figure 1. Connecting herds with genetic links.

Contemporary groups. Contemporary groups form the basis of all evaluation programs, and the importance of the proper definition of contemporary groups by the breeder cannot be overemphasized. It is important to avoid single-sire groups, but producers also need to balance the size of each group with uniformity within the group. A good rule of thumb is to include offspring of at least three sires in each group, with offspring from several litters per sire. In general, the more progeny per sire the better, as long as they can be managed uniformly. The pigs in the group need to have an equal opportunity to express their genetic potential. In the genetic evaluation, each animal's performance is compared to the average of the contemporary group. This accounts for the common environment of the pigs in the group, so the remaining differences between the pigs are primarily due to genetics.

Connectedness. Animals within a contemporary group can be compared because of their common environment. To compare different groups, in different environments, there needs to be genetic links between the groups. For example, some animals in each group may be offspring of a common sire. As shown in Figure 1, once this genetic link is established between groups of animals, all animals in those groups can be compared, whether they are related or not. Genetic links tie together groups within a herd and also groups in different herds, tested at different times. Just as a rope is made stronger by braiding the strands together, the more genetic links (connectedness) there are between groups, the more accurate the EPDs will be. Therefore, it is important that enough links be present to make an across-herd evaluation worth the effort.

Many herds within a breed are linked by exchange of breeding stock as well as through artificial insemination (AI), embryo transfer (ET), and potentially cloning. The most practical way to strengthen genetic ties, is through AI, which can make superior sires available to more producers. With the proliferation of boar studs and increased AI use, connectedness is not usually the limiting factor to successful across-herd evaluations.

Genetic base. The genetic base is a group of animals that is used as a point of reference in the genetic evaluation. The average EPD for this group is set to zero, and all other EPDs are expressed as deviations from this average. The base may be defined as all animals born during a specific time period, or all animals in all herds during a specific time period. The specific time period used to define the base may remain constant, or it may be redefined for later genetic evaluations.

However it is defined, it is important to know which animals make up the genetic base so that the EPDs can

be interpreted, because these animals are the ones whose average EPD is zero. If the base animals were born 20 years ago, then an EPD of zero represents an average animal of 20 years ago. If the breed has made genetic progress for the trait, EPDs may have changed substantially over time, and an EPD of zero would be poor compared to today's average animal. Often, across-herd genetic evaluations will list the current average EPDs and percentile tables for the traits. These statistics can help with the interpretation of how good a particular EPD is, compared to all animals that are active today.

Accuracy. The EPD is usually reported with its accuracy, which is a measure of the reliability of the EPD. Accuracy ranges from 0.01 (low) when no information is available, to 0.99 (high) if there is a large amount of performance information on the individual and its relatives. The accuracy can be used for risk management. The closer the accuracy is to 1.0, the more likely that the average performance of offspring will be close to the parent's EPD, and the less likely the EPD will change when more information is added to the evaluation. A sire with a large number of tested progeny will have EPDs with high accuracies. A young boar may have excellent EPDs but a lower accuracy; his offspring may be much better or worse than expected, and his EPD may go much higher or lower when he has more information. A producer can use the accuracy of the EPD to weigh the risks when deciding among several boars with similar EPDs.

Interpreting Across-Herd Evaluations

Across-herd evaluation is a tool that will help in making selection decisions. Therefore it is critical that a producer know how to make the best use of this tool.

Know which animals can be compared. In general, EPDs for animals in different breeds cannot be compared, because different breeds have separate across-herd evaluations. In addition, EPDs generated by different programs cannot be compared, because different animals are in each evaluation and different genetic parameters may be used. For the same reasons, EPDs published at different times should not be compared. The bottom line is that only EPDs from the same genetic evaluation can be compared. Percentile tables are helpful, to see which animals have EPDs that are among the best of the breed.

Know how traits are reported. EPDs can be positive or negative; which direction is favorable depends on the trait. Days to market and average daily gain both are measures of growth potential. However, negative EPDs are favorable for days to market, while positive EPDs are favorable for average daily gain.

Balance multiple traits. Producers are generally interested in more than one trait. However, in most cases, animals will have better EPDs for some traits than for others, and will rarely be outstanding for all traits. The importance of each trait will have to be determined to make selection decisions. Some programs offer indexes that combine EPDs of several traits into a single value, based on their relative economic importance and the relative accuracy of the estimates. Individual producers must decide whether the indexes fit their situations. If indexes are not reported or are not useful, producers must make their own weighting decisions.

Application of Across-Herd Evaluations

In addition to knowing how to interpret EPDs from across-herd evaluations, it is important to realize that EPDs may play different roles in different herds. Purebred breeders and commercial producers will probably use EPDs somewhat differently.

Seedstock producers. Seedstock producers need to make timely selection decisions. Across-herd EPDs for the animals in a seedstock herd will be the most accurate information available to make selection decisions. Reports for contemporary groups allow these decisions to be made in a timely manner, shortly after the pigs come off test or the litters are weaned.
Across-herd evaluations allow a producer to compare potential breeding stock within the herd to pigs in other herds. Breeders can identify herds and lines that are genetically superior for the traits in which they are interested, and then evaluate the sons and daughters that are currently available.

Across-herd EPDs provide seedstock producers with a better idea of the strengths of their own animals, relative to other herds in the breed, and can alert them to areas that need improvement. The EPDs can help with culling decisions, deciding how boars should be used in the breeding program, and determining the value of animals offered for sale.

Commercial producers. Across-herd evaluations can be used to improve commercial operations. Although crossbreeding is economically critical for commercial operations because of heterosis (hybrid vigor), it does not in itself result in permanent genetic change. Continual genetic progress in commercial herds is directly dependent on progress made in the seedstock operations from which breeding animals are obtained. Commercial producers should choose seedstock sources with similar goals and management, and with positive genetic trends, then purchase animals with the best EPDs possible, given budget and health constraints.

The choice of which breeds to use should be based on their use in the breeding program (as a sire or dam breed), breed averages, maternal effects, and heterosis. Once the choice of breed is made, then individual animals within each breed should be chosen based on EPDs. A commercial producer can use the across-herd analyses to locate superior sire and dam lines, and then select among the available sons, including AI sires, and daughters.

Sire	NBA	LWT	DAYS	BF	MLI
JMF6 Latino 89-6	0.66	1.84	-5.52	-0.01	122.2
JRS6 Saturn 164-11	0.15	0.33	-7.23	-0.06	118.1
NAY4 Linkage 112-1	1.15	8.79	5.05	-0.07	117.7

Table 1. EPDs of three Yorkshire sires evaluated by STAGES in July 2001.

For example, Table 1 contains EPDs for number born alive (NBA), 21-day litter weight (LWT), days to 250lbs (DAYS), and backfat depth (BF) for three Yorkshire boars evaluated in July 2001. All three are among the top 10 active Yorkshire sires for Maternal Line Index (MLI). This index is designed for animals used to produce replacement gilts. It includes EPDs for all traits, but puts twice as much emphasis on reproductive traits (NBA, LWT) as on postweaning traits (DAYS, BF). Although they have similar MLI, the three boars are quite different for the individual traits. If a producer is interested in one trait, say NBA, then EPDs for NBA are the most important in making selection decisions. In that case, the Linkage boar has the most desirable EPD for NBA, and Saturn the least desirable (although still positive), while Latino is intermediate. However, producers should also consider the other traits, because the progeny of the selected boar will receive those genes also. All three have favorable EPDs for LWT (positive) and BF (negative), but DAYS has a very different story: favorable for Latino and Saturn, but unfavorable for Linkage. In selecting among these three boars, producers must determine the relative importance of the individual traits. If growth and leanness are very important, a producer might want to consider Saturn or his progeny. The EPDs for NBA and LWT are lower than for the other two boars, but they are still positive. The indexes produced by STAGES can be helpful in making decisions, but producers need to understand how these indexes are formulated, and realize that boars with very similar indexes can have very different EPDs for individual traits. The National Swine Registry (http://www.nationalswine.com/) can provide additional information about the indexes and how to use them.

Industry structure. Across-herd evaluations enable breed associations to implement true national breed evaluations while maintaining pigs on association members' farms. This allows for EPDs of animals to be compared across farms. It should be noted, however, that EPDs will not replace a critical assessment of physical and reproductive soundness, breed type, and conformation.

For small herds, across-herd EPDs allow more accurate comparisons of small groups of pigs. If the only information came from animals within the herd, accuracy would be low because of small numbers. However, with genetic ties, the performance of relatives in many other herds will be included in the evaluation, and will increase the accuracy of the EPDs.

For larger operations concerned about the risk of disease, across-herd evaluations permit the evaluation of all breeding stock in each of several nucleus herds, and could allow for the incorporation of data from multiplier herds to increase the accuracy of evaluation. Cooperative arrangements among independent breeders with herds made up of animals of similar genetic backgrounds could work in the same manner. Such arrangements would allow participating producers to take advantage of having large numbers of performance tested animals to merchandise, without relinquishing individual ownership.

To fully realize the potential of across-herd evaluations, a viable AI industry is vital, whether that includes independent boar studs, AI centers, or a combination of these. Embryo transfer and exchange of breeding stock among seedstock producers will also contribute to the success of across-herd evaluation programs. In all cases, accurate identification of semen, embryos, and animals is essential, as well as complete performance records on resulting offspring. The National Swine Improvement Federation's "Guidelines for Uniform Swine Improvement Programs" (1997) contains information on standardization of records, the use of which is essential to improve the efficiency of genetic evaluations.

Summary

Across-herd genetic evaluations can significantly increase the rate of genetic progress in traits of economic importance to the swine industry. To fully realize the potential of across-herd evaluations, seedstock producers, breed associations, AI companies, and others interested in genetic improvement must work together to obtain complete, accurate performance data.

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