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How a Boar Test Station Can Enhance Genetic Progress

Allan Schinckel, Swine Breeding and Genetics, Department of Animal Sciences

When discussing the role of the central test stations, it is important to keep in perspective the relative importance of on-farm and central testing. Without on-farm performance testing, central boar test stations can generate only limited genetic progress since the number of superior, centrally tested boars is 2 percent of that needed by seedstock producers. Also, test stations cannot measure reproductive traits such as litter size and 21-day litter weight which are easily obtained on seedstock producer farms. On-farm performance testing and selection of superior replacement animals are essential for genetic improvement to occur at any appreciable rate.

Depending upon (1) the traits measured, (2) completeness of testing, and (3) method of genetic evaluation, on-farm performance testing and selection could generate 166-259 times more genetic improvement annually (dollar improvement in profit-potential/hog/year) than current boar test stations alone. Central test stations must complement on-farm testing and never be considered as substitutes for within-herd on-farm testing programs.

When used in conjunction with on-farm testing, the boar test station fulfills a valuable role by directly evaluating boars from different herds and many different sires. Participants of the central test stations involved in on-farm performance testing and selection programs can be confident that the higher-ranking boars will improve the genetic merit of the seedstock herds for the traits measured.

Procedural Guidelines

Transporting boars to a central location and collecting performance test information will not improve the genetic merit of seedstock herds. There are certain procedures essential for the boar test station to enhance genetic progress. These procedures are:

1. Participants must collect on-farm performance data and select superior boars and gilts as replacements. Two procedures must occur if any long-term genetic progress is to be made in the swine industry: (a) performance testing and selection must occur within the seedstock herds and (b) the seedstock herds must use a high percentage of superior performance tested boars either from their own herd or from other herds with sound performance testing and selection programs. These procedures will guarantee that the average genetic merit of the centrally-tested boars will improve over time.

2. Central test stations must measure economically important traits such as average daily gain, backfat thickness, and feed efficiency in a consistent, uniform manner. The National Swine Improvement Federation has suggested guidelines for the collection of data.

3. Purebred boars must be evaluated within each breed. The goal in performance testing is to improve the genetic merit of each breed, not to compare a boar of breed A with a boar of breed B. Boars of some breeds may be superior in traits not measured at test stations (litter size or 21-day litter weight) but only have average postweaning performance.

Also, the indexes are based on within-breed parameters (genetic and phenotypic correlations and variances) and are not designed to rank boars of different breeds. The goal of the test station is to improve the postweaning performance of all breeds and not discriminate against any particular breed.

4. To evaluate boars within a breed, each boar's performance must be compared with the average performance of an adequate number of boars (contemporaries) of the same breed. Twenty boars representing at least four farms would constitute a minimum contemporary group size. Twenty boars per breed are
necessary before one has confidence that the higher-indexing boars are in fact genetically above breed average.

5. The higher-indexing boars must return to seedstock herds so that their genetic superiority can be multiplied. In 1983-84, boars purchased by seedstock producers from the Indiana Boar Test Station were only slightly above average with an average index value of 112.5. This same trend was true for other test stations. If boars were selected from only the top 15 percent of those tested, the average index value would be 135. This would result in almost three times more genetic progress for the traits measured.

Difficulties in Evaluating Genetic Differences Between Herds

It can be shown that the boar test station cannot accurately evaluate genetic differences between seedstock herds. In Table 1, the seedstock producer currently has young boars completing test by sires 1, 2, and 3. The three sires significantly differ in their breeding value (true genetic merit) for days to 230 pounds. Because a boar transmits a sample one-half of his genes to his offspring, a sire's expected progeny difference (EPD) is equal to one-half his breeding value. The average genetic merit of a seedstock herd is a weighted mean of the EPD's of the sires and dams. In this example, assume the sow herd is breed average. The expected performance of a sire's offspring is the average performance of the herd (160 days in this example) plus the expected progeny difference. The average performance of the herd is a weighed mean of the sire's progeny performance.

Sire 1 is a superior sire with a breeding value of -14 days. This would rank him in the top 2.5 percent of the sires within a breed. Sire 2 is breed average and sire 3 is below breed average since his offspring are expected to take 7 days longer to reach 230 pounds than progeny of an average sire of the same breed. Let's assume that the seedstock producer has young boars coming off-test in equal numbers (one-third) for sires 1, 2, and 3.

If 12 boars were randomly sampled from the this herd, their expected genetic merit would be representative of the average of the herd. This expectation would be true if the sampling was repeated, because each sire would be expected to be responsible for the same percentage of boars in the central test station as those tested on-farm (Table 2). However, the flaw in this assumption is that only one sample is taken. With one random sample, it is unlikely that one-third (4 out of 12) of the boars were by each sire. It is just as likely that the sample contained boars only from sire 1, in which case the herd would be falsely considered highly superior, or by sire 3, in which case the herd would be falsely considered inferior. Test stations cannot evaluate genetic differences between herds because the test station must take into account the percentage of matings by each sire, both on-farm and in the test station, and the relative predicted genetic merit of the sires.

<table>
<thead>
<tr>
<th>Sire</th>
<th>Expected progeny difference (EPD)</th>
<th>% of matings for each sire</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3 months later</td>
</tr>
<tr>
<td>1</td>
<td>-7 days</td>
<td>33.3</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>33.3</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>33.3</td>
</tr>
<tr>
<td>4</td>
<td>-4</td>
<td>--</td>
</tr>
<tr>
<td>Average genetic merit, days</td>
<td>0.0</td>
<td>--</td>
</tr>
<tr>
<td>Average performance, days</td>
<td>160</td>
<td>155.1</td>
</tr>
</tbody>
</table>

It must also be realized that each herd's average genetic merit is constantly changing. Let's assume three months later that 70 percent of the boars are sired by sire 1 and 30 percent by sire 2. In three months, the herd's genetic merit has drastically changed. Assume that in six months, sire 2 is replaced by a new sire (number 4). Again, the average genetic merit and performance level of the seedstock herd has changed. Even if a large number of boars have been sampled from the current contemporary group, this estimate is almost immediately out of date because the seedstock herd's genetic merit is constantly changing, especially when herd sires are replaced.

Evaluating Sires from Different Herds

Some boar test station participants enter boars in the test station to evaluate their herd sire's genetic merit with sires from other herds. However,
it can be shown that unless boar test stations are used in conjunction with on-farm performance testing and advanced genetic evaluation procedures, they cannot provide accurate across-herd sire evaluations. In Figure 1, there is a comparison of two sires from different herds. In herd A, sire 1 was mated to three sows. In herd B, sire 2 was mated to two sows. Two boars per litter were tested at a central test station.

Initially, it would seem that the differences in performance between the boars sired by sire 1 and sire 2 would be an accurate indicator of the sires' relative genetic merits. However, it must be realized that the dams also provide one-half of the genetic merit of the boars tested.

The average genetic merit of the sows varies from herd to herd. Thus even if 25 litters were tested per sire, differences between the average merit in herd A and herd B would be partially responsible for the differences observed between the offspring of sire 1 and sire 2. The second source of variation is the variability in genetic merit among sows within a herd. Assume that sire 1 and sire 2 are equal in genetic merit and that the sow herds are equal in average genetic merit. With only three litters represented by sire 1 and two litters for sire 2, considerable random variation would exist between the small number of sows sampled. Sometimes the dams are selected. For example, assume that in herd A young boars were selected from dams whose offspring from sire 1 had performed well in the past. Assume that herd B is a small herd and only had two litters available from dams of unknown, possibly below average genetic merit. In this case, the differences between the sire's progeny reflects the variability among sows within herds which was utilized by herd A.

The variation between the genetic merit of the sows can be accounted for if on-farm performance records are analyzed as a part of an across-herd genetic evaluation program. The genetic merit of each of the sows is estimated by the gilt's individual performance and the performance of her relatives (half-sibs, full-sibs, offspring, and others) in the same and in other herds. Each sire's predicted genetic merit then is adjusted for the predicted genetic merit of the sows mated to him. For this reason, at least 18-24 months of on-farm performance data are necessary before an accurate across-herd sire evaluation can be made. Without on-farm performance testing and advanced genetic evaluation procedures, genetic differences between sows, both between and within herds is confounded with true genetic differences between the sires.

Figure 1. Comparison of two sires from different herds based on their progeny performance in a central test station.
Advanced Genetic Evaluation Programs

It is likely that a form of estimated breeding value (EBV) program which ranks the boars both within and across central test stations will be implemented in the near future. The EBV calculations will take into account the boar's individual performance and the performance of his relatives (half- and full-sibs) within the same test group and in other contemporary groups. Boar test station contemporary groups will be "tied" together by an evaluation of the genetic relationship between the boars. This method of ranking boars was initially advanced by John Carlson. His research involving almost 10,000 boars from five test stations showed that the procedure was feasible and yielded a more precise genetic evaluation than only using individual performance. John Mabry, in cooperation with the American Yorkshire Club, is evaluating the use of this EBV program on a nationwide basis. Twenty-four central test stations have tested sons of a Yorkshire reference sire.

The usefulness of test stations will increase when nationwide, comprehensive genetic evaluation programs are implemented. Such a program has been proposed by researchers at Purdue University. The program will include the analysis of data from several sources such as on-farm testing, boar test stations, barrow tests, and special progeny test herds. The program will estimate on a nationwide basis the genetic merit of replacement boars, replacement gilts, sires, and dams utilizing the individual's performance and the performance of their relatives.

In this type of program, the boar test station will allow more complete across-herd sire evaluation as the male progeny of sires from several herds are directly compared. An example of this situation is shown in Figure 2. Boars that are progeny of sires 3, 4, and 8 are tested at a central test station. The genetic merit of the sires within each herd is estimated from the progeny performance information obtained as part of the on-farm performance program. In this example, the central test station data and on-farm performance data improve the completeness of the across-herd sire evaluation. For an accurate across-herd sire evaluation, it is necessary that the boars at central test stations come from herds participating in the nationwide genetic evaluation program.

When the boar test station is used in conjunction with on-farm performance testing and advanced genetic evaluation programs, structured young sire evaluation programs can be developed. The evaluation programs would have two steps. Step 1 identifies the top young boars, which have just completed on-farm or central test station performance tests at age 6-8 months, and are ready to undergo further evaluation. It is important that

![Diagram showing how the boar test station can increase the completeness of an across-herd sire evaluation program.]

*S₁ = offspring of sire 1 and so forth. With on-farm testing, only the sires within each herd can be compared. Within the test station only sires 3, 7, and 8 can be compared. With a complete program, sires 1 through 10 can be evaluated through a combination of direct and indirect comparisons.
these young boars come from herds with on-farm performance testing and selection programs, and are participating in the national evaluation programs. To achieve a more accurate evaluation of the young sire’s genetic merit, the boar should be used in several herds with on-farm performance testing and have sons in central test stations. The central test stations allow the young sire’s sons to be compared with boars from several herds and numerous sires. Step 2, the top 3-5 percent of the progeny tested sires then could be used as reference sires and become the standard by which the next generation of young sires are compared.

If genetic progress is being made, the top young sires will be superior to the reference sires. This combination of young sire evaluation and selection has been successful in the dairy industry.

Comparison of Performance Test Programs

The performance test programs are compared in Table 3. Currently, the test station boars which return to seedstock herds are only 12.5 index points above average (12.5 selection differential or S.D.). With a 12.5 S.D., the returns of the current test stations to the swine industry are $470,000 per year. With 5,000 boars tested per year at an average cost of $175 per boar, the test stations are not returning their costs ($875,000) to the swine industry. If only boars indexing in the top 15 percent returned to the seedstock herds, the amount of genetic progress would increase by 2.8 times. If estimated breeding value programs were implemented to “tie” test stations together and boars were selected from the top 15 percent, the relative progress would increase to approximately 3.2 times the current level.

On-farm testing will greatly increase the rate of genetic progress. In each of the on-farm test examples, it is assumed that seedstock producers select replacement boars from those indexing in the upper 10 percent and replacement gilts from those in the upper 35 percent of the herd. Since most seedstock producers need only one replacement boar for each 100 raised, this would allow the seedstock producer to select the top boar out of the top ten indexing boars based on soundness and underlines.

On-farm selection for days to 230 pounds and backfat thickness will result in 166 times more progress than the test station alone. Including the record in which the animal was born for litter size and 21-day litter weight will increase the relative progress to 181 times that of the test stations. The use of EBVs will increase the accuracy of selection as compared to individual records. Within-herd EBVs will increase the accuracy and rate of genetic selection by 27 percent over individual selection. The proposed program which utilizes additional relatives and advanced statistical evaluation pro-

<table>
<thead>
<tr>
<th>Selection program</th>
<th>$/pig/year</th>
<th>Value to swine industry ($ million)</th>
<th>Estimated progress relative to current program</th>
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<tr>
<td><strong>Test station only</strong></td>
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<tr>
<td>Current 12.5 S.D.*</td>
<td>.0055</td>
<td>.47</td>
<td>1.0</td>
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<td>Possible 35 S.D. (Top 15%)</td>
<td>.015</td>
<td>1.32</td>
<td>2.8</td>
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<tr>
<td>35 S.D. and test station ties</td>
<td>.017</td>
<td>1.52</td>
<td>3.2</td>
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<tr>
<td><strong>On-farm selection-boars 10%, gilts top 35%</strong></td>
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<td></td>
<td></td>
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<tr>
<td><strong>Individual performance only</strong></td>
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<tr>
<td>Days to 230 lb. and backfat</td>
<td>.92</td>
<td>78.2</td>
<td>166</td>
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<td>Litter size, 21-day litter weight, days and bracket</td>
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<td><strong>Estimated breeding values</strong></td>
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<td>Within herd for litter size, 21-day litter weight,</td>
<td>1.27</td>
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<td>days and backfat</td>
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<td>Proposed industry wide program within herd BLUP,</td>
<td>1.43</td>
<td>121.5</td>
<td>259</td>
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<tr>
<td>ties across herds</td>
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</table>

*S.D is selection differential, the difference in index units between the selected individuals and the average.
cedures in a combination within and across-herd
program will further increase the potential rate of
genetic progress to 259 times that of test stations.

It is important that the swine industry realizes
the relative importance of on-farm and central boar
testing. Boar test station participants must collect
performance data and select superior replacement
boars and gilts for any significant genetic progress
to occur. The test station participants should utilize
advanced genetic evaluation procedures when
available. It is the responsibility of the boar test sta-
tion coordinators, managers, and advisory boards to
communicate these concepts to their participants
and re-evaluate their current procedures.

References
Uniform Swine Improvement Program, Program Aid

Related Publications
For more information contact your county
Extension office, or write the Publications Mailing
Room, 301 South Second Street, Lafayette, IN
47905-1092, for the following related publications:
AS-435 The Purdue Swine Improvement Program
AS-436 Using Estimated Breeding Values
for Swine Improvement