11-1-1987

# Using Estimated Breeding Values for Swine Improvement

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AS-436

animal sciences swine

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# Using Estimated Breeding Values for Swine Improvement

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Accelerated genetic improvement of our swine herds will lead to more efficient swine production and improve pork's competitiveness with other protein sources. A computer program which calculates estimated breeding values (EBV's) has been developed to accomplish this goal.

## Estimated Breeding Values

Improvement of seedstock herds is dependent on genetically superior individuals being selected. However, it must be recognized that we don't know the true exact genetic merit of each individual but instead must estimate the animal's genetic merit from available performance data. Estimated breeding values (EBV's) are a prediction of genetic merit or, as the name implies, an estimate of the true breeding value.

There are different methods of predicting genetic merit. The formula you have previously been exposed to for individual performance is:

Predicted genetic merit (EBV) = heritability * ($P_{IND}$ - $\bar{P}$), where $P_{IND}$ = individual performance and $\bar{P}$ = herd average.

If, for example, a boar took eight days less to reach 230 pounds than the average boar tested and the heritability is .25, we would calculate the boar's estimated breeding value for days to 230 pounds to be -2.0 days. Because a boar transmits half of his genes to his offspring, his offspring would be expected to reach 230 pounds one day sooner than the offspring of the average of the other boars.

The identical concepts are true for estimated breeding values that include information from relatives. If a young boar has an EBV for litter size of +1.0; litter weight, +10.0; days to 230, -10.0; and backfat thickness, -.10; we would expect this boar's offspring to reach market weight five days sooner, with .05 inches less backfat than the average boar tested. Also, the daughters would be expected to have .50 more pigs born alive per litter and wean litters 5 pounds heavier than the average of the other boars tested.

## The Advantages of Estimated Breeding Values

In the past, seedstock producers have based their selection on the individual's performance. Estimated breeding (EBV's) that predict genetic merit are based on both the individual's performance and the performance of relatives. By including information on relatives, the genetic merit of an animal is predicted more accurately. This increase in accuracy is beneficial to commercial swine producers in two ways. The first is that EBV's will allow more rapid genetic progress within the seedstock herds. The rate of genetic improvement for a trait is directly proportional to the accuracy of selection. For example, if the accuracy of selection for a trait is improved by 50 percent, the rate of genetic improvement per generation would also increase by 50 percent. Any genetic improvement the seedstock herds make for economically important traits will later be passed on to the commercial producers and allow more profitable commercial swine production.

EBV's also allow commercial producers to be more confident that the animals are more correctly ranked relative to their true genetic merit. Animals highly ranked with EBV's are more likely to produce more productive commercial offspring than animals similarly ranked with only individual performance information.

EBV's are especially useful to improve traits with low heritabilities such as number born alive and 21-day litter weight. Figure 1 presents some of the data that could be included in the calculation of an EBV for litter size or litter weight. On the dam's side of the pedigree (lower half), records could be included for the dam, her full-sibs (sows with the same sire and dam), and paternal half-sibs (sows with the same sire but different dams). On the sire's side of the pedigree, data could be used from the paternal granddam, full-sibs, and possibly daughters of the sire.

Table 1 includes the accuracy of selection for litter size and litter weight with differing amounts of

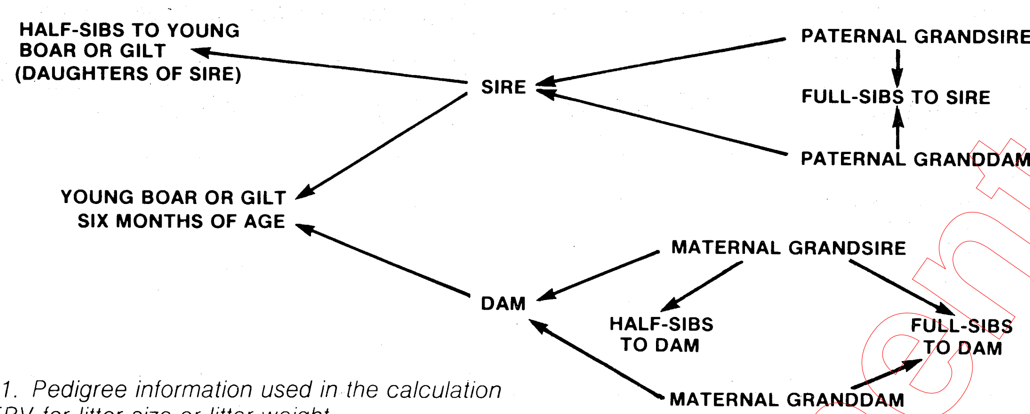


*Figure 1. Pedigree information used in the calculation of an EBV for litter size or litter weight.*

**Table 1. Relative accuracy of selection for litter size and 21-day weight when the amount of available information differs.***

| Available information (no. litters) | Litter size (no. born alive) Accuracy | Litter size Rel. acc. (%) | 21-day litter weight Accuracy | 21-day litter weight Rel. acc. (%) |
|---|---|---|---|---|
| 1 record on the dam | .158 | 100 | .223 | 100 |
| 2 records on the dam | .204 | 129 | .283 | 126 |
| 3 records on the dam | .231 | 146 | .316 | 141 |
| 4 records on the dam | .250 | 158 | .339 | 152 |
| 3 records on the dam; 2 FS, 12 HS with an average of 2.5 records | .264 | 167 | .340 | 153 |
| 2 records on the dam; 2 FS, 12 HS with an average of 1.5 records; 3 on the dam of the sire | .267 | 169 | .351 | 157 |
| 3 records on the dam; 2 FS, 12 HS of the dam with an average of 2.5 records 10 daughters for the sire, each 1 record | .353 | 223 | .449 | 201 |

*The heritabilities of litter size and litter weight used in calculations were .10 and .20, respectively. The repeatabilities used were .20 and .25 for litter size and weight, respectively.

available information. The past recommendation, to select replacement boars and gilts based on the litter size and weight of the litter from which they came, was assigned a relative accuracy of 100 percent. If two to three litter records are available on the dam, the accuracy of selection can increase from 29 to 46 percent. The accuracy of selection for litter size and litter weight can be improved if information from full-sibs (FS, sows with the same sire and dam) and paternal half-sibs (HS, sows with the same sire but different dams) are included. The additional information from full and half-sibs is especially useful in herds with young sows (2 to 3 litters/sow) and short generation intervals. If data are included for the sire of the young individual, the accuracy of selection can be increased further. If two or more records are available on the dam and the sire of an individual that has 10 daughters with one record each, the accuracy of selection is more than doubled for litter size and litter weight.

The use of EBV's can also improve the accuracy of selection for growth rate (days to 230 lb.) and backfat thickness. By weighing and probing littermate gilts of an individual, this information can be added to the calculation of the EBV. Table 2 presents the accuracy of selection for days to 230 pounds and backfat probe when differing amounts of information are available. If an individual has 4 littermates (barrows or gilts), and 20 barrows or gilts by the same sire (half-sibs), the accuracy of selection increases 22 percent for days to 230 pounds and 11 percent for backfat probe.

## Selection Indexes

To meet the needs of commercial producers, the seedstock industry should select for a combination of economically important traits. To maximize the return of genetic improvement to commercial produc-

**Table 2. Relative accuracy of selection for days to 230 pounds and backfat thickness with differing amounts of available information.***

| Available information | Days to 230 lb. Accuracy | Days to 230 lb. Rel. acc. (%) | Backfat thickness Accuracy | Backfat thickness Rel. acc. (%) |
|---|---|---|---|---|
| Individual | .50 | 100 | .63 | 100 |
| Individual and 4 littermates | .57 | 114 | .68 | 105 |
| Individual, 4 littermates and 20 HS | .61 | 122 | .70 | 111 |
| Individual, 4 littermates and 40 HS | .62 | 124 | .71 | 113 |

*Calculations used a heritability of .25 for days to 230 lb. and .40 for backfat probe.

ers, three indexes were calculated which include EBV's for litter size (number born alive), litter weight, days to 230 pounds and backfat thickness. The indexes weight the traits relative to their economic importance in commercial swine production and take into consideration the genetic relationships between the traits. Although feed efficiency was not included in the selection indexes, it was considered in the economic objective.

The indexes are presented in Table 3. The indexes correctly rank the individuals relative to their intended use in crossbreeding systems. The average (mean) index value for a herd is 100; i.e., an individual that is average for each trait will have index of 100. Individuals above average will have index values above 100, and boars below average will have index values below 100. The index units also were calculated so that they would have an economic meaning to commercial producers. The economic values of each trait for the boars were calculated with consideration not only of first generation offspring but also offspring of later generations. For example, a boar used in a rotational crossbreeding system is responsible for ½ of the genetic merit of his first generation offspring, ¼ for the second generation, ⅛ for the third generation, and so on. After accounting for discount rate (the interest cost of investment equal to interest rate minus inflation rate), the real value of superior boars who produce female replacements is 60-70 percent greater than the past estimates which only accounted for the first generation offspring.

The maternal index is for animals that will be used for the production of female replacements in rotaterminal or specific crossbreeding systems. Each index unit is worth approximately $100.00 for boars used for gilt production in specific crossbreeding systems and $175.00 for boars used in rotaterminal crossbreeding systems (Figs. 2 and 3). The maternal index places greater emphasis on litter size and litter weight than the other indexes.

The general or rotational index appropriately ranks the individuals for use in a rotational crossbreeding system. It places an intermediate emphasis on litter size and litter weight. Each unit of the rotational index has an economic value of $100.00 for a commercial producer, assuming 48 litters produced per boar.

The terminal index is to be used for boars that will be terminal sires. The index is almost entirely based on days to 230 pounds and backfat thickness. The small value the index places on litter size is due to the desirable genetic relationship between growth rate and litter size. Each index unit of the terminal sire index has an economic value of $100.00, assuming 70 matings per boar.

## Value of Superior Boars

The increased value of a superior boar in each crossbreeding system is shown in Table 4. Regardless of the intended use, superior boars within any seedstock producer's herd are much more valuable than an average boar. Boars below average are to some extent less valuable than an average boar. Thus, the difference in value between two boars at the upper and lower 16th percentile is approximately $5,000, $2,900, and $1,500 for the rotaterminal, specific, and rotational crosbreeding systems, respectively. For this reason commercial producers purchase only performance tested boars. Without performance records, commercial producers won't

**Table 3. The selection indexes for different production objectives.***

Maternal : I = 100 + 37.4 (EBVLS) + 2.1 (EBVLW) - 2.9 (EBVD) - 45.1 EBVBF;
General or rotational : I = 100 + 15.4 (EBVLS) + .80 (EBVLW) - 1.56 (EBVD) -29.5 (EBVBF);
Terminal : I = 100 + 2.46 (EBVLS) - 1.06 (EBVD) - 28.6 (EBVBF);

*EBVLS = estimated breeding value for litter size (number born alive).
EBVLW = estimated breeding value for 21-day litter weight
EBVD = estimated breeding value for days to 230 lbs.
EBVBF = estimated breeding value for backfat thickness

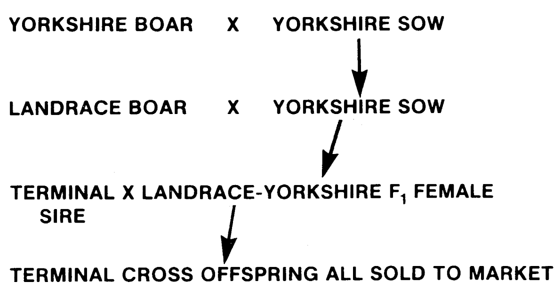


*Figure 2. Example of a specific crossbreeding system.*

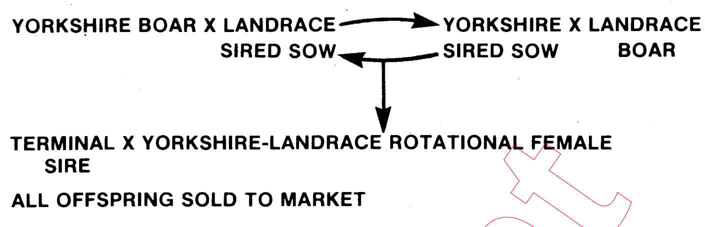


*Figure 3. Example of a rotaterminal crossbreeding system.*

know which boar they've purchased, a superior or inferior boar, until after the commercial offspring are born.

Superior boars are especially valuable when they are to be used in either specific or rotaterminal crossbreeding systems to sire replacement females. This is because these maternal boars will produce many daughters with many offspring.

Commercial producers should examine the index values which correctly rank the boars relative to their intended use. These index values are both a merchandising tool for the seedstock producer and a measure of value to the commercial producer. Commercial producers should be willing to pay a premium for the superior boars for two reasons. First, the purchase of superior boars will result in large returns through improved production effeciency. Second, the seedstock producers must receive a premium for the superior animals to offset performance testing costs and culling of boars of low performance.

One possibility is that seedstock producers use the indexes to group boars into different price categories. For example, the seedstock producer might charge a base price for all boars below average (100 index) and then increase the price of the boars a fraction of the increased value (20 to 30 dollars per index point) to the commercial producer. It is to the advantage of the commercial producer to pay more for superior seedstock when they have the records to support their increased value and know that they are going to receive more than a 3 to 1 return on their investment. For any long term genetic progress to be made in the swine industry, genetically superior animals must be selected within our seedstock herds. It is for this reason that commercial producers should purchase animals from seedstock producers who are concerned about the genetic merit of their herds and are selecting the superior animals as replacements. Also, the seedstock producer should make an effort to collect the performance information as completely and accurately as possible.

**Table 4. Increased dollar value of boars ranking above average for their respective indexes.**

| Crossbreeding system | Upper percentile rank 30 | 16 | 2.5 |
|---|---|---|---|
| Rotaterminal | $1272 | $2544 | $5089 |
| Specific | 727 | 1454 | 2908 |
| Rotational | 376 | 751 | 1503 |
| Terminal sire | 206 | 413 | 826 |



RR 11/87 (6M)

Cooperative Extension work in Agriculture and Home Economics, state of Indiana, Purdue University, and U.S. Department of Agriculture cooperating; H. A. Wadsworth, Director, West Lafayette, IN. Issued in furtherance of the acts of May 8 and June 30, 1914. The Cooperative Extension Service of Purdue University is an affirmative action/equal opportunity institution.