

What Genetic Principles Should Be Used For Herd Improvement?

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The key to the genetic improvement of swine is the aggressive collection of performance information and their utilization. This means that the entire herd (ALL PIGS) must be tested and not only a highly selected pen or two for the central testing station. If the animal with the extremely superior performance record is to be found, then all animals must be tested and allowed to express their superior, mediocre or inferior performance.

The field of swine breeding is a field that must collect and summarize large amounts of performance information. To do this with more speed, accuracy and efficiency a computer or advanced calculator can be very helpful. To be competitive and progressive, seedstock producers and central testing stations should have access to a computer to adjust the data, calculate the indices recommended by NSIF, rank the individuals from top to bottom and calculate the average performance of the animals tested contemporaneously to the animals evaluated. The computer definitely can be useful and pay for itself by enabling you to acquire summarized performance information which then will enable the seedstock producer to make wiser decisions to raise a more efficient pig.

The pig, in each individual cell, has 19 pairs of chromosomes, the material which is made up of genes. Genes come in pairs (2's) and only one of the two genes is passed from parent to offspring, not both. Thus that good boar or sow will not have all good offsprings as some of the inferior genes that the parent carries will be passed on to his offspring at times. Likewise at times the desirable genes will be passed on to his offspring. If the boar has more desirable genes than inferior

genes, then he will pass them on more frequently than the inferior genes. This passing of only one of the two genes along with the recombining of this gene with another from the other parent allows some animals to be better and some to be worse than the average performance of the parents with most being fairly average genetically. However, the average of many offspring will be the same as the genetic (breeding value) average of the parents.

This passing of only one gene in each pair along with environment gives us a natural variation in performance that is normally found in most traits. We find this for litter sizes at birth, at 21 days, 21 day litter weights, 154 day wts., days to 230 lb., loin eye area, pounds of fat corrected muscle (FCM), and days to 85 lb. of fat corrected muscle. If the minimum sized loin eye area wanted is 5 sq. in., your herd or breed must average 6.5 to 7.0 sq. in. and you should expect to have pigs over 8 sq. in. of loin eye area if you achieve the minimum of 5 sq. in.

The performance information which we gather is made up of a combination of the heredity portion plus the environmental portion or

$$\text{Performance} = \text{Heredity} + \text{Environment}$$

and the variation (the differences) we see between two animals' performance is also a combination of the variation in heredity plus the variation in environment or

$$\text{Var (Performance)} = \text{Var (Heredity)} + \text{Var (Environment)}$$

or in symbolic terms



In the symbolic terminology

$$\text{Heritability} = \frac{\text{Heredity Variation}}{\text{Performance Variation}}$$

The heritabilities for the economic traits in swine are given in table 1.

Table 1. Heritability of Economic Traits in Swine

Trait	Heritability	
Reproductive		
Conception Rate		
Litter Size Farrowed	0--20%	Low
Litter Size Weaned		
Production		
Average Daily Gain(60-220 lb)	20--40%	Moderate
Feed Efficiency		
Carcass		
Backfat		
Loin Eye Area	40--60%	High
Percent Lean Cuts		
Miscellaneous		
Pig Weight at Weaning	15%	Low
Number of Nipples	30%	Moderate
Muscle Quality (Color & Marbling)	30%	Moderate

From this table the reproduction traits are expected to change but not as rapidly as the carcass traits have changed.

As seedstock producers, the idea is to select animals with better genotypes or breeding values. This is what the NSIF indexes set out to do taking account the economic value of each individual trait. To estimate the breeding value of an animal we use the following formula where

$$\text{Estimated Breeding Value} = H (\text{Performance}_I - \text{Performance}_C)$$

where H is heritability of the trait or index

Performance_I is the performance record of the individual under consideration

and Performance_C is the average performance of the contemporary group

The average performance of the contemporary group is always subtracted from the performance of the individual to adjust the level of management that the pigs were given. Everything in this evaluation of a pig is relative, and so the right question to be asked is how did he perform relative to the other pigs fed together not how did he perform, end of question. To illustrate this concept take two boars

Boar A's average daily gain was 2.4 lb/day while Boar B's average daily gain was 2.2 lb/day. If the contemporary group averages for the two boars were 2.4 lb/day for Boar A and 1.8 lb/day for Boar B it follows that Boar A is just an average boar while Boar B's performance is .4 lb/day above the contemporary group average. Thus Boar B is the better of the two boars with a EBV of .12 while the EBV of Boar A is 0 assuming a heritability of .3 for average daily gain.

However, the most important item to be considered is the genetic improvement per year in your herd. This can be determined by the following formula:

$$H \frac{(\text{Performance}_S - \text{Performance}_G)}{\text{Generation Interval}}$$

where H is heritability of the trait

Performance_S is the average performance of the selected animals

and Performance_G is the average performance of the contemporary group.

The generation interval is the average age of the parents (boars and sows) of the individuals that we keep for replacement stock when they are born.

With all things remaining the same except the generation interval the younger the parents from which we select our replacement stock, the more genetic improvement per year. If your breeding program is good, some of the offspring of a boar will be better genetically than the old boar himself. Thus get rid of him and use the young animal. This is one of the quickest and easiest ways to increase the amount of genetic improvement per year.

Although a progeny test does increase the knowledge and "heritability" of an animal, it also increases the generation interval, thereby, possibly decreasing the genetic im-

provement per year. Individual performance testing and evaluation is the method of acquiring the most genetic improvement per year.

There are many traits to be considered in a breeding program. Reproduction which includes conception, farrowing a large litter with ease and raising them to weaning, is the most important trait economically. Although difficult to change, individual performance of the females along with the performance of full sisters can raise the heritability of the trait. The sow needs to be made into a pig-producing machine. That is her only reason for existing.

The second most important trait economically is feed conversion. Theoretically, testing in groups of 2, 3, 4 or 5 littermates is as accurate as testing individually. However, testing in groups should only include full-sib littermates to keep the heritability as high as possible. Testing in sire groups (different litters) can lose as much as 25% on the accuracy of estimating the breeding value, therefore the central testing stations should require only full-sib littermates in a test pen. More than one sire's progeny in a test pen makes some of the information on feed efficiency almost worthless.

Weight for age or average daily gain is a trait that is economically important but to a lesser degree than the previous two traits. We of the full-sibs performance along with the individual performance enables the seedstock producer to raise the heritability of the trait by as much as 50% with 7 full sibs.

Although backfat does not have a large direct economic impart, indirectly it is probably the most important trait. The demand for pork is very important for the viability and growth of the swine industry. The consumer demands a lean product for her table, thus emphasis should still be placed on this trait.

Feet and leg soundness is an important trait. Our lack of an objective measurement has hindered our improvement in this trait. However, it is a problem that increases the labor requirements, decreases the reproductive performance and limits the selection pressure that can be applied thus emphasis needs to be exerted on this trait.

As the cost of testing increases and to better provide crossbred breeding stock to commercial pork producers, seedstock producers need to multiply the genetic improvement made in a nucleus to a larger number of pigs. This will enable him to decrease the costs of testing per pig and also provide a larger number of replacement stock to the commercial pork producer.

The key to herd improvement by genetics is not limited by the lack of knowledge of animal breeding, but by lack of application of the principles. Utilization of performance records is the method of herd advancement. The commercial pork producer depends on you, the seedstock producer, to do your job adequately. If you let him down he will go to the person or company that fulfills this need.