

Learn to Predict

INHERITANCE OF BREEDING HERDS

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How to FIND ANIMALS with Superior BREEDING ABILITY

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How much of their advantage for a particular trait do superior animals transmit to their offspring? Heritability estimates help us answer this important question. It is the purpose here to explain the meaning of heritability estimates, how they are calculated, and how they may be used for the improvement of livestock through breeding.

What Are Heritability Estimates?

A heritability estimate is a figure which shows the amount of variation in a trait such as weaning weight that is due to heredity. This figure is usually expressed in percentage. A table of heritability percentages for cattle traits is included with the example at right and a table for hogs is on the back page.

If you subtract the heritability percentage estimate from 100, the remainder is the percentage due to environment (feed, climate, disease and etc.). The heritable portion of the variation is transmitted by parents to their offspring. The environmental portion is not.

To figure the amount of improvement in a trait that the parents will transmit to their offspring you also have to figure the herd or group average for that trait and the amount that the parents vary from the average. For example, here are the average daily gains in a test where 13 bull calves were full fed for 154 days.

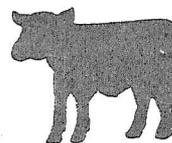
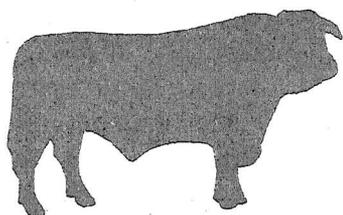
TABLE 1--DAILY RATE OF GAIN IN BULLS FULL FED FOR A PERIOD OF 154 DAYS

Number of Bull	Average Daily Gain
808	2.10
819	2.75
822	2.25
823	1.79
826	2.35
829	2.58
845	2.72
852	2.59
858	2.42
864	2.38
891	2.38
892	2.73
898	2.34
Average	2.41

The average rate of gain for the 13 bulls was 2.41 pounds. Bull 819 gained 2.75 pounds per day which was 0.34 pounds above the average.

The question now is: How much of this 0.34 pound daily rate of gain advantage can bull 819 transmit to his offspring? Heritability estimates help answer this question.

Note in the table of heritability estimates for cattle that rate of gain in the feed lot averages about 57 percent heritable. This means that approximately 57 percent of this 0.34 pound advantage, or 0.19 pound per day should be transmitted due to his superior genes.



*A scientific breeding program
brings faster improvement, more
profit from your herd . . .*

TABLE 2--HERITABILITY ESTIMATES FOR ECONOMIC TRAITS IN BEEF CATTLE

Trait	Percent Heritable
Fertility	10
Weaning weight	25
Type score at weaning	33
Rate of gain in feed lot	57
Efficiency of gain in feed lot	36
Slaughter grade	47
Carcass items:	
Dressing percent	46
Carcass grade	48
Thickness of fat	38
Area of loin eye muscle	70

This still does not mean that this bull's calves will average 0.19 pound per day over the average for calves of the 13 bulls. Half of the inheritance also comes from the mother. This leaves about 0.10 pound advantage of inheritance from the sire. Thus, if the dams used were all average in rate of gain, we would expect the calves of bull 819 to gain 0.10 pound per day faster than the average of the calves sired by the 13 bulls.

How Are Heritability Estimates Calculated?

Estimates given in the tables used here are averages of numerous studies in college experiment stations of many states. The stations calculate their estimates by determining the resemblance between relatives for a particular trait. The resemblance between half brothers and sisters, full brothers and

sisters, identical twins, or parents and their offspring may be used for this purpose.

Experiment stations try to equalize environmental factors as much as possible and adjust for other non-genetic factors that might cause variation in animal performance. For instance, if they are determining the correlation between the weaning weights of cows and their calves, they adjust for age of calf at weaning, age of dam of each calf, sex of calf and possibly the season when the calf was born. All of these conditions are non-inheritance factors which make a difference in weaning weights and tend to mask the influence of heredity.

How to Use Heritability Estimates

Heritability estimates can be used to estimate the progress and set-backs in different traits that can be expected from different matings. For example, a particular mating may bring improvement in rate of gain if the parents are superior. If they are inferior, however, they may cause a decline in rate of gain in their offspring.

To illustrate how to figure expected progress from a particular mating, let us assume that from a herd in which the average daily gain in the feed lot is 2.40 pounds per day, bulls which gained 3.20 pounds and heifers which gained 2.80 pounds per day were kept for breeding purposes.

How much gain in genetic improvement would be expected in the progeny of these selected parents?

To answer this question, we must first calculate just how superior these parents were to the average in the herd and something should be known about the heritability estimate for rate of gain in the feed lot.

The superiority of the breeding animals may be calculated as follows:

$$\begin{aligned} \text{Superiority of dams} &= 2.80 - 2.40 \text{ or } 0.40 \text{ pound per day.} \\ \text{Superiority of sires} &= 3.20 - 2.40 \text{ or } 0.80 \text{ pound per day.} \\ \text{Superiority of parents} &= \frac{0.40 + 0.80}{2} = 0.60 \text{ pound per day.} \end{aligned}$$

The next question is how much of this 0.60 pound advantage of the parents is transmitted to the offspring. The heritability of rate of gain of beef cattle in the feed lot is about 57 percent (see table of heritability estimates).

$$\text{Expected genetic gain} = 0.60 \times 57\% \text{ or } 0.34 \text{ lb./day}$$

The advantage of the parents (0.60 pound) times the heritability estimate (57 percent) gives the genetic gain (0.34) expected in the offspring.

The herd average was 2.40 pounds feed lot gain per day. With all other things being equal, we would expect the offspring of the selected parents mentioned to gain an average of:

$$2.40 + 0.34 = 2.74 \text{ pounds per day}$$

This is the average of the herd from which the parents were selected plus the genetic advantage transmitted by the parents.

When to Use Heritability Estimates

The calculations made above illustrate two important points. First, if the selected parents had not

been superior in rate of gain over the average of the herd, there would have been no genetic improvement in the rate of gain of their offspring, regardless of the degree of heritability of the trait.

Second, the amount of genetic progress is also dependent upon how highly heritable the trait in question is. Though the parents had an advantage over the average of the herd from which they came of 0.60 pound per day in gain, they would not have transmitted any of this advantage to their offspring if the trait had been of zero heritability.

The general conclusion, then, is that the greater the superiority of the individuals selected for breeding purposes and the higher the heritability of the trait, the more progress will be made in selection.

The size of the heritability estimates also gives us some indication of the kind of selection that should be practiced for genetic improvement.

When the trait is highly heritable, we must find the best and mate the best to the best. On the other hand, when the trait is very low in heritability, little progress will be made by this kind of selection. More improvement in such a trait will be made by forming inbred lines and selecting between them to find those that combine or "nick" to the greatest advantage.

In other words, when traits are very lowly heritable, they seem to be more subject to hybrid vigor, which is obtained only by crossing lines with good combining ability. When they are highly heritable, this is less likely to be true and emphasis should be placed on selection of individuals with superior performance for the breeding herd.

TABLE 3--HERITABILITY ESTIMATES FOR ECONOMIC TRAITS IN SWINE

Trait	Percent Heritable
Number of pigs farrowed	15
Number of pigs weaned	19
Litter weight at weaning	17
Weight of pig at five months	21
Growth rate (weaning to 200 lbs.)	30
Efficiency of gain	38
Carcass items:	
Carcass length	61
Thickness of backfat	46
Area of loin eye	48
Percent of ham	58
Percent of shoulder	47
Percent of fat cuts	60
Percent of lean cuts	34