

# BREEDING FIRE & ICE

*Don't let misconceptions interfere with making smart breeding decisions.*

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## Breeding For Reduced Variation

A common term used in cattle breeding is stacked pedigrees, which basically means having as many ancestors as possible in a pedigree with similar expected progeny differences (EPDs) for a particular trait. In other words, breeding like to like.

It is thought by many that these matings will produce more consistent offspring. Because of this theory, many breeders are afraid to make corrective selection decisions because of concerns over increased variation. This article will explain why this theory is unfounded and false.

The theory is simple and even seems to follow common sense. If you breed a sire and dam with similar EPDs then their offspring will be "truer" breeders. In other words, the progeny of these combinations

will produce offspring with less variation than progeny of parents with differing EPDs. It is also thought that a bull produced by this mating will have EPDs that are more reliable and less likely to change.

For the situation depicted in diagram 1, most breeders would prefer Bull A. This is because they think that, although both bulls will produce progeny with the same average birth weight, Bull B will sire progeny expressing greater birth weight variability, as shown in diagram 2. Based on recent scientific research and basic genetic theory, this assumption is incorrect.

## Variation Research Project

A research project was conducted at the University of Kentucky with cooperation and funding provided by the American Angus Association. The researchers involved in

the study were the author, Fred Thrift, Debra Aaron of the University of Kentucky and Keith Bertrand of the University of Georgia. Data used were the complete field records and EPD information from the American Angus Association.

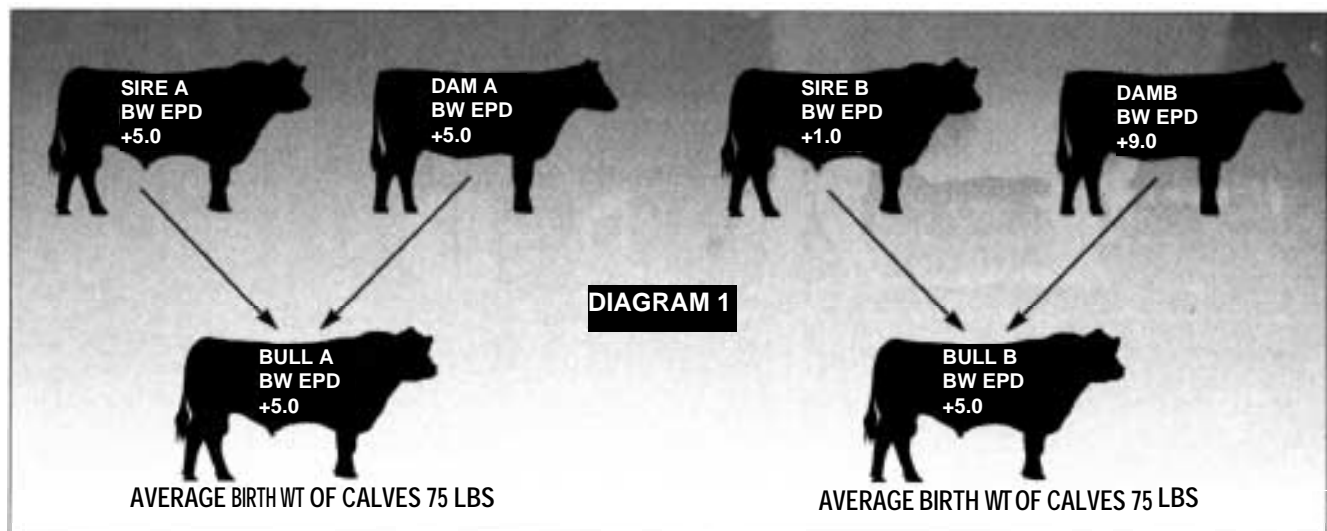
The steps involved in the projects were as follows:

1. Identify bulls that had 25 or more progeny with EPDs calculated for both parents (see diagram 3).
2. Calculate the difference between the sire's and dam's EPDs.
3. Determine the Mendelian sampling for each bull. In a perfect world, a bull's EPD would be the average of his parents' EPDs, but as we all know this is not usually the case. Mendelian sampling is the difference between the parents' average EPD and their offspring's calculated EPD. This value indicates the reliability of the bull's EPD or how much a bull's EPD changes from a pedigree estimate,

as more information is gathered.

4. Compute the progeny variation in adjusted weights for each bull,
5. Compute the average Mendelian sampling of each bull's progeny. Take the average of the difference between each progeny's calculated EPD and their parental average EPD (the parental average being the average between the bull's EPD and each of the dams he is mated to).

Correlations were computed to determine if differences in parents' EPDs have any effect on their progeny or on their bull progeny's offspring. A correlation simply shows how two traits respond together. The value can be between -1.0 and 1.0. If the correlation is -1.0, then as one trait increases (or decreases) the other trait decreases (or increases) in an equal relationship. As a correlation approaches 1.0, then as one trait increases (or decreases) the other trait



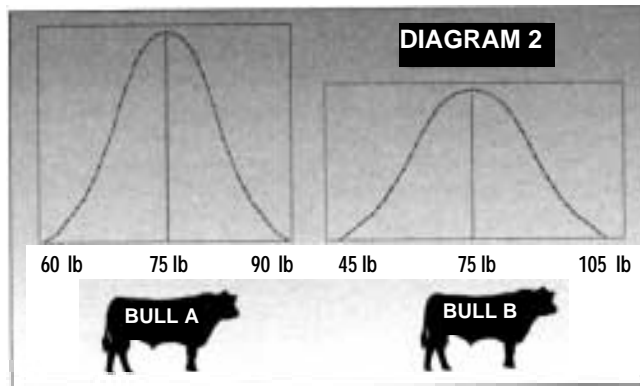
increases (or decreases) in an equal relationship. If the correlation is 0.0, then no relationship exists between the traits.

The correlations computed for this study are summarized in Table 1. The correlations are the parental difference in EPDs for birth weight, weaning weight and yearling weight (BDIF, WDIF, and YDIF) with the bull's Mendelian sampling, the bull's offspring's adjusted weight variation, and the average Mendelian sampling of the bull's offspring. The top number indicates the correlation and the bottom number represents how many bulls were used in the calculation of each correlation.

Remember, to be included in the analysis, a bull must have at least 25 progeny with records and both of his parents must have a calculated EPD for that trait.

In general, most correlations were close to zero, indicating little relationship between parental EPD differences and progeny reliability or variability. The correlations between the parental EPD differences and mean Mendelian sampling of the bull's progeny were the highest for each trait. This means that as the difference in a bull's parents' EPDs increases there tends to be a slight increase in the amount his progeny's EPDs change as more information is used in the calculation of their EPDs. However, the highest correlation observed was .087 for weaning weight Mendelian sampling, which is considered a low correlation. The correlations between parental EPD differences and the Mendelian sampling of the bull or the weight variation of his calves were low for all traits.

Since producers are most concerned with calf weight variation we wanted to be completely certain that the low correlations between parental differences and weight



variation were correct. Therefore, we calculated the correlations for each bull in the Angus breed that had at least 500 progeny with actual weight measurements. There were approximately 100 bulls that qualified under these constraints and once again the correlations were extremely low (the correlation for birth weight was even negative).

The low correlations found in this study suggest that no benefits, in terms of minimized variation, are realized when mating bulls and cows with similar EPDs.

#### Why is There No Reduction in Variation?

Based on Mendel's theory of random segregation, we would expect these results (Mendel considered the "Father" of genetics and he described many of the basic laws and theories

of genetics that are still in application today.) In order to understand why breeding "like to like" doesn't reduce future progeny variation or reliability it is necessary to have an understanding of basic genetics.

The traits that we deal with in livestock are broken down into two types, qualitative and quantitative. Qualitative traits are controlled by genes at one locus (two genes that connect at a particular location) and are affected little by the environment. They usually separate into distinct differences: such as blood type, coat color, polled or horned. Quantitative traits are thought to be controlled by genes at several loci and environmental effects cause variation in these traits, such as weight traits. In animal breeding, we are concerned primarily with quantitative traits, because these are

usually the traits of economic importance.

For this example, birth weight will be the trait that we examine. If birth weight were controlled by genes at one locus then our job would be much easier. The two genotypes for birth weight would be **B** for heavy birth weight and **b** for light birth weight. There would be three possible genotypes (the genetic make-up) for each calf **BB**, **Bb** and **bb**. If a calf's genotype were **BB** it would be heavy at birth, **Bb** would have an intermediate birth weight and **bb** would have a light birth weight.

So far so good, but birth weight is actually controlled by genes at several loci. Even though the number is likely much higher, we will assume only 3 loci (**A**, **B** and **D**) are involved in birth weight. For further simplification, we will also assume each loci contributes equally to the weight of the calf (**A=B=D=20** pounds, **a=b=d=10** pounds) and environment does not affect it.

In the example in diagram 4, Calf 1 would be the heaviest calf possible (120 pounds), Calf 2 would be intermediate in weight (90 pounds) and Calf 3 would be the lightest calf possible (60 pounds). These are not the only genotype possibilities since you can change an upper for a lower case letter, or vice versa, at any location.

When three loci are involved there are 21 different genetic combinations (genotypes) and seven different weights (phenotypes) possible. The combination of genes that a calf has represents its genetic potential and this is what an EPD measures.

From diagram 5, it's easy to see that animals can have the same genetic potential or EPD with different genotypes. If you were to mate Calf 2 to Calf 3, there are 12 possible genotypes and five different phenotypes (actual weights) that are possible in their offspring. When you break that

**TABLE 1** Correlation and number of observations between parental EPD differences and other traits.

TRAIT	Mendelian Sampling of the Bull	Actual Weight Variation	Mendelian Sampling Mean of the Progeny
BDIF			
Angus	.024 6694	.015 6694	.029 6654
WDIF			
Angus	-.036 8833	.041 8890	.087 8760
YDIF			
Angus	-.071 3851	-.056 4147	.071 3736

BDIF WDIF and YDIF = Difference between the parents EPDs for birth weight weaning weight direct and yearling weight respectively. The top number is the correlation and the bottom number is the number of bulls represented for each category

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down into percentages, the resulting offspring would have a 12.5 percent chance of weighing 80 pounds, 18.75 percent chance of weighing 90 pounds, 37.5 percent chance of weighing 100 pounds, 25 percent chance of weighing 110 pounds and 6.25 percent chance of weighing 120 pounds. This represents tremendous potential variation from two parents with the same EPD, 100 percent accuracy and no environmental influences on the calf's weight.

This example is not out of the ordinary and does not exhibit as much variation as could be shown with other examples.

When working with basic genetics it's easy to get confused and frustrated. In this example we were working with a perfect situation. We were only dealing with three loci that were equivalent in their influence on birth weight, we knew the exact genotype of each animal (which is the same as having 100 percent accuracy), and the environment had no effect on calf weights. In reality there are probably thousands of possible genotypes for birth weight although the EPD spread for birth weight is less than 25 pounds in the Angus population.

Therefore, there are likely many genotypes within each birth weight EPD, making the likelihood of two identical EPDs with the same genotype remote. Reality is further complicated by the fact that we rarely approach 100 percent accuracy and environment actually plays a very large role on the birth weight of a calf.

### The Bottom Line

There is one known way to reduce variation in a bull's offspring and that is through inbreeding. The higher the inbreeding coefficient of a bull, the less variation his offspring

will exhibit. Therefore, stacked pedigrees with a level of inbreeding will produce calves with less variation. You should be cautioned, however, that this reduction in variation is likely small and, on the average, there are some drawbacks to using inbred bulls.

If you are concerned about trait variation in the bulls you are buying or producing, you should probably take two aspirin and read this article again. Start with an open mind take your time, and work through the examples. Unfortunately basic genetics is one area where initial intuition or common sense can lead you in the wrong direction.

If you have sold or bought bulls under this concept don't feel bad or cheated because many great cattlemen have done the same. This information should be good news to most breeders. If you need rapid improvement in a particular trait, or if a bull and

cow complement each other, you can make "Fire and Ice" matings without adverse con-

sequences in reliability or variation.

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