

Across-Breed Matings: How They Work

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Across-breed matings, or crossbreeding, have been made for centuries by dairy producers to introduce desirable genes and traits into the cattle that provided their livelihoods. It is only in the last century that it has become a taboo subject in purebred circles. However, the last 20 years of the 20th century saw a marked increase in across-breed matings among dairy herds. Quite often this has entailed the use of a Jersey bull on other-breed females. The most common reasons given for using Jersey bulls are for calving ease and to increase the component levels in the bulk tank.

Mention crossbreeding and the conversation quickly turns to hybrid vigor, or heterosis, of the first cross. Then you hear the proverbial line, "Well, the first cross is great, but I don't know what do with the second cross because we lose everything we gained." But more recently you may have heard, "When I cross back with a Jersey bull, I don't seem to lose as much, or any, of the hybrid vigor in production and reproductive traits."

Are these comments really true, or are they just individual perceptions with no real relevance to today's dairy industry?

In actuality, both statements have some sound scientific support. Let's review some of the basic tenets of dairy cattle breeding, as well as the reasons which explain why dairy producers get the type of results they do when crossbreeding.

To truly understand the effects of crossbreeding, there are three basic genetic concepts we need to understand: (a) heterosis, (b) additive versus non-additive gene action, and (c) heritability.

Hybrid vigor or *heterosis* is the phenomenon in which progeny of crosses between inbred lines or purebred populations are better than the expected average of the two populations or lines for a particular trait. Thus heterosis is the complement of inbreeding depression and usually appears in traits that show depression of performance under inbreeding. Reproductive traits in dairy cattle are usually very sensitive to inbreeding depression and thus cross breeding or out-crossing can show large heterotic effects. An example of heterosis would be a group of first generation Jersey-Holstein crosses producing

900 lbs. protein and the average of their parents showed they should produce 850 pounds. The extra 50 pounds could be attributed to heterosis and would be expressed as a percentage, in this case roughly 7%.

Studies have shown heterosis figures ranging from 2% to 10% on production traits (milk, fat and protein). However, even at 10% the heterosis is probably not sizeable enough to be "effective" or worthwhile enough to justify crossing on that basis alone. To be effective, you would want the resulting cross to outperform both of the parental lines completely, not just be better than the average. But any Jersey breeder will tell you the bottom line is not based solely on gross production; it consists of many factors. Thus scientists have started taking a look at heterosis from a herd lifetime profitability standpoint. Here crossbred Jersey and pure Jersey both excel.

For simplicity's sake, let's first divide all *gene action* into two categories: additive and non-additive. Heterosis is usually small or absent in traits that are influenced by additive genetic effects, which leads us to our next definition. In its most basic form, additive gene action is simply the summation of many genes "adding up" together to bring about a total result. Heterosis is then one of several genetic effects that are part of non-additive genetic effects.

But getting back to additive effects, let's say for example that a cow in your herd produces 1,000 lbs. fat. The genetic portion of her that gives her the capacity to make that much fat is most likely a result of the combining of many genes that add up to that 1,000-lb. potential. Think of individual genes, each of which contributes the ability to synthesize one, five and 10 pounds of fat, respectively. For a cow to have the genetic potential of 1,000 lbs. fat, she needs to have the sum total of many of these individual genes added together. The magnitude of additive gene effects then becomes important in how heritable a trait is.

Heritability in a broad sense is simply what proportion of differences in a trait (like milk production) are due to genetic difference rather than environmental differences. In a more narrow sense like the values we use for breeding dairy cattle,

heritability is the proportion of differences from additive genetic effects versus overall phenotypic variations, or how a trait actually looks. Thus logic tells us that a non-additive effects like heterosis will express themselves in traits that are lowly heritable.

You might be wondering what exactly this has to do with the living and breathing Jersey-Holstein crossbreds all over the country. Let's go back to the original two statements about crossbreeding that we started with. The concern about losing the "hybrid vigor" after the first cross and the observation that continuing to cross back with Jersey bulls slows the loss of hybrid vigor are both legitimate. Here's why. Theoretically, hybrid vigor or heterosis is cut in half each successive generation after the first cross. So the loss of heterosis in traits is real and should be expected if we cross back with one of the original purebred lines.

So do Jersey bulls then have some magical power that allows them to overcome this genetic principle? Absolutely not! However, what they probably do have are thousands of genes (additive gene action) that when introduced to other breeds allow the next few generations of resulting crosses to excel in traits like fat and protein yields and percentages, fertility and productive life—all traits that Jerseys are renowned for. Keep in mind the use of proven A.I. bulls can make this effect even greater because they are more intensely selected for than your average barn yard bull.

In reality, what you may have thought was hybrid vigor in that first cross might have mostly been the contribution of the Jersey breed on an additive gene basis. Science has shown that crossbreeding dairy cattle for the sake of utilizing heterosis is very difficult unless the intent is to synthesize a new breed.

So if a producer is already pleased with first-generation Jersey crosses, the answer to the age-old question of what to do after the first cross becomes easy: Keep using Jerseys!

With the help of some good old fashioned additive genetics and strong selection, in most milk markets today, the more Jersey you have in your cows the more profitable your operation should be.