Genetic Relationships

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Part 1: Growth and Maternal Traits

Beef cattle production systems are characterized by a number of genetically-controlled traits that are economically important. Reproductive efficiency, maternal ability, growth performance, and end product merit are four broad categories into which these traits can be assigned. In today's industry, the ability to make simultaneous genetic progress in these areas is important – as each of them has economic relevance. With the shift of our industry away from a commodity and toward a consumer-driven business, resulting pricing structures have placed increasing economic incentives (and disincentives) on carcass merit. At the same time reproductive efficiency continues to be the single most economically important aspect of the cow-calf enterprise, along with growth and maternal performance. However, financial incentives that reward specific end product specifications have shifted the balance of these traits relative to their economic importance, which in turn was five times as economically important as carcass merit. Under a value-based marketing system, the ratio of 10:5:1 for reproduction, growth and carcass may be closer to 2:1:1. This ratio will certainly vary from one operation to the next, depending on the marketing and production system. However, it is clear that our selection focus has changed and will continue to change as economic signals in our industry change. Considering the number of specific traits that are economically relevant (reproductive efficiency, calving ease, calf survival, weaning weight, post-weaning growth, feed efficiency, mature size, red meat yield, and palatability – just to name a few), the question becomes: How can multiple trait selection be practiced without a setback in performance in one or more areas?

Due to the overwhelming number of traits that we measure and have accurate estimates of genetic differences between animals for (EPDs), it is nearly impossible to find an animal that excels in all traits of interest. Therefore, we are resigned to the fact that we need to focus on a few traits in order to do an effective job in a task such as bull selection. Since there are genetic relationships that exist between a large number of traits, effectively we are changing nearly all traits even though our selection emphasis may only be on a handful of traits (birth weight, weaning weight, and milk for example). These genetic relationships between traits are important to understand, as they assist us not only in understanding why bulls with specific EPDs for two or more traits may be difficult to find, but also how selection for a particular trait results in change in other traits.

Correlations are statistical measures of the relationship between two variables. Correlations range from -1 to +1. A positive correlation means that the two variables both move in the same direction (ie. as one trait moves higher so does the other). A negative correlation indicates the two traits move in opposite directions. Correlations that are closer to -1 and +1 are considered stronger than correlations that are close to 0.

Specifically, genetic correlations exist because some of the same genes affect both traits. As an example, weaning weight and yearling weight have a high positive genetic correlation. Therefore, selection for cattle that weigh more at weaning also results in cattle that tend to weigh more at a year of age (since some of the same genes that influence weaning weight also influence yearling weight). Another way to define genetic correlations is they can be thought of as the correlations between EPDs for two traits. In the previous example, bulls with high WW EPDs also tend to have high YW EPDs (and vice-versa). In this case, the genetic correlation is favorable as more growth is generally desired. However, the sign of a genetic correlation does not necessarily indicate if the relationship between the traits is positive or antagonistic. An example of this is birth weight and weaning weight. The positive correlation between these traits indicates that cattle with heavier weaning weights tend to have higher birth weights (or cattle with lower birth weights tend to have lighter weaning weights). In this case, the genetic correlation is antagonistic since we generally would select for cattle with lower birth weights and increased weaning weight.

The following table lists genetic correlations for growth and maternal traits. (Editor's note: correlations used in the RAAA NCE can be found on page 3 of the 2002 Sire Summary.) As mentioned previously, measures of growth are generally positively related. Selection for increased weight at a particular age (birth, weaning, or yearling) normally is associated with heavier weights at all ages. Birth weight EPD is the most commonly used tool for managing calving difficulty in heifers. The reason for this is that there is a strong negative correlation between birth weight and calving ease- indicating that lighter birth weights are associated with more calving ease. In contrast, the genetic relationships between milk and growth (weaning and yearling weight) are negative and antagonistic/unfavorable. These relationships suggest that increasing growth would come at the expense of improvement in milk production. However, these relationships are less strong that those previously discussed.

	BW	WW	YW
Weaning Wt.	+.50		
Yearling Wt.	+.55	+.81	
Milk	-.14	-.16	
Calving Ease	-.74	-.21	-.29

Adapted from Koots et. al., 1994

So how do we deal with these relationships? The most important factor is that multiple trait selection be practiced. With these relationship described, it is easy to comprehend how selection for a trait such as low birth weight can cause serious problems. If low birth weight were the only criteria used in bull selection, growth and milk would quickly decline. The second factor to overcome these challenges is to effectively use tools that accurately describe genetics of individuals. EPDs are the tool which do this in a very effective manner. With EPDs it is possible to identify bulls that have a desirable combination of several traits. As an example, bulls with acceptable birth weight genetics and above average growth and milk genetics can readily be identified and selected with

EPDs. By doing so, bulls can be selected with the right combination of genes that influence the traits of interest in a favorable fashion.

Overcoming the challenges of these genetic relationships is relatively simple for birth, growth, and milk traits. However, the genetic relationships between these traits, carcass traits, and reproductive efficiency becomes more challenging. In the next article, we will examine relationships between growth and mature size, carcass traits, as well as carcass traits and reproduction.