Considerations in Genetic Selection & What About DNA?

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A successful beef enterprise is contingent upon the integrated management of genetics, nutrition, health, marketing, and finances. From a genetic perspective, the industry has worked hard to identify and develop prediction tools (EPDs) for a large number of economically important traits. These EPD tools have been very effective in changing the genetic merit of beef breeds, and as a result, many breeds now offer in excess of 20 traits for which EPDs are available. It is well recognized that effective sire selection involves identification of bulls which balance a multiple number of these traits. Equally important is the identification and prioritization of the EPDs given the specific goals and breeding objectives within a herd. So which EPDs are most relevant for the genetic improvement of my herd, and among the traits of interest how does one properly weight the importance of these individual traits for the selection scheme?

Recognition of these challenges has led to the development of multi-trait selection indexes. These indexes allow for selection for several traits simultaneously. For each trait (EPD) contained in the index, both genetic and economic values are considered, and the end result is a comprehensive genetic prediction value that represents overall economic merit of the animal which is for a specific goal. The strategy of these multi-trait EPD indexes is to provide simplicity and convenience to selection decisions by allowing for selection based on one index EPD value rather than several individual component EPDs. Multi-trait index EPDs differ from individual trait EPDs in that they are expressed in economic terms, meaning they predict differences in progeny performance in dollars rather than in pounds or other performance indicators. This is accomplished by assigning economic weightings to the component EPDs of the index, and by using a set of assumptions which impact estimated revenue and costs for impacted traits.

A number of selection indexes have been developed by beef breed associations. The following will examine a few of these indexes and provide a short description of each.

Angus $B (Beef Value)- $B is a multi-trait genetic selection index for both feedlot performance and carcass merit. Specifically, $B represents the expected average dollar-per-head difference in progeny post-weaning performance and carcass value compared to progeny of other sires. In calculating $B, expected carcass weight and its value are calculated, along with production cost differences. $B is composed of two other multi-trait index EPDs- $F and $G. $B is not simply the sum of $F and $G, as adjustments are made to avoid double-counting weight between feedlot and carcass segments.

Angus $F (Feedlot Value)- The $F value is the expected average difference in progeny post-weaning feedlot performance compared to progeny of other sires. $F is expressed in dollars per head and incorporates weaning weight and yearling weight EPDs. Typical feedlot gain value, feed consumption and cost differences are accounted for in the final

calculations, along with a standard set of industry values for days on feed, ration costs and cash cattle price.

Angus $G (Grid Value)- $G value is the expected average difference in progeny performance for carcass grid merit compared to progeny of other sires. The $G index combines quality and yield grade factors, and is calculated for animals with carcass EPDs, ultrasound EPDs, or both. A three-year rolling average is used to establish typical industry economic values for quality grade and yield grade (premiums for Prime, CAB and Choice carcasses, as well as YG 1 and 2; discounts for Select and Standard quality grades, and discounts for YG 4 and YG 5). $G is also expressed in dollars per head.

Charolais Terminal Sire Index- Ranks sires based on their genetic merit for post-weaning performance and carcass merit. The Charolais Terminal Sire Profitability Index utilizes an interactive on-line tool generate dollar indexes per specific inputs provided by the user. Inputs include weaning weight, projected ADG for backgrounding/grower/finishing phases, live prices, and carcass premiums/discounts. In this manner, the TSI can be calculated to fit the needs of each individual operation.

Gelbvieh Grid Merit EPD- The Grid Merit EPD measures the dollar value associated with marketing progeny on a value-based carcass merit grid. Specifically, the Grid Merit EPD predicts the carcass value associated with selling carcasses on a grid based on quality grade, yield grade and fitting weight specifications.

Gelbvieh Feedlot Merit EPD- The Feedlot Merit EPD measures the dollar value associated with the expected gain and feedlot efficiency of progeny when fed in a typical feedlot arrangement.

Hereford Certified Hereford Beef Index- A terminal sire index, where Hereford bulls are mated to British-cross cows and all offspring are sold as fed cattle on a CHB grid.

Simmental Terminal Index- Evaluates sires for use on mature Angus cows with all offspring put on feed and sold grade and yield.

Angus Weaned Calf Value Index- Predicts the expected average difference in progeny preweaning value in dollars per head. Provides way to compare sire impact on cow-calf herd based on his maternal and growth contributions. incorporates EPDs for birth weight, weaning weight, milk, mature weight, yearling weight and mature height.

Hereford Baldy Maternal Index- Index designed for commercial cow-calf producers who use Hereford bulls in rotational crossbreeding programs on Angus-based cows and heifers. Retained ownership of calves through the feedlot phase of production is assumed, with fed cattle marketed on a Certified Hereford Beef pricing grid.

Simmental All-Purpose Index- Evaluates sires for use on the entire cow herd (bred to both Angus first-calf heifers and mature cows) with the portion of their daughters

required to maintain herd size retained and the remaining heifers and steers put on feed and sold grade and yield.

Interpretation of index values in bull selection is very similar to using EPDs. For example, a $10 difference in Angus $B value between two bulls would indicate an average of $10 difference in progeny profitability when the calves are fed post-weaning and marketed on a carcass value grid. The relative difference between animals is of most interest.

So how can these index EPDs assist us in bull selection? The index values can be very useful, particularly for traits associated with carcass merit. The immediate importance of carcass merit for an individual herd will largely be dependent on an operation's marketing scheme (retained ownership vs. selling feeder cattle), current genetics, management, and other factors. However, a common challenge for all producers is placing proper selection emphasis on the individual carcass trait EPDs that are available (marbling, REA, fat thickness, growth/weight). The advantage of index EPDs is that they combine the effects of these several carcass EPDs and put them into one understandable, easy to interpret value. By using industry averages for premiums/discounts and costs of production, the individual EPDs that comprise the index are weighted accordingly.

There are some challenges to using these indexes that have been discussed here. These post-weaning/carcass indexes consider are terminal sire indexes, and are intended as predictors of slaughter progeny performance. They should not be used as the sole selection tool for producing replacement females, as they do not consider maternal genetics. Carcass traits carry significantly less importance economically compared to reproduction and growth for cow-calf producers. However, genetic merit for carcass merit is becoming increasingly important for all producers- even those currently not retaining ownership. Consequently, carcass traits need attention in today's selection programs so that producers may position themselves for the future. With these multi-trait index EPDs, that process has been simplified.

The maternal indexes work in a similar fashion and allow for some balance between EPDs which enhance performance/production and the increased costs commonly associated with enhanced performance. For example, the indexes assume a higher cost associated with increased milk production which results in heavier calf weaning weights and more revenue. By expressing the index in economic terms or profit, both the income and expense components of the system are accounted for.

What About DNA?

The livestock sector, including beef cattle, has benefited greatly in recent years through the rapid advances in scientific discovery in humans. Mapping of the human genome has led to the mapping of the bovine genome (and other species). This genetic map provides the pathway for things to come related to genetic selection in beef cattle. The use of DNA technology is rapidly expanding in the cattle arena, and as a result our toolbox is getting bigger. A specific example is our ability to manage genetic defects through DNA tests which provide the specific genotype of an animal in question. DNA

genotyping tests have very rapidly been discovered and applied commercially for the industry to deal with arthrogryposis multiplex (AM), neuropathic hydrocephaly (NH), and fawn calf syndrome (CA) which are examples of recently discovered genetic defects controlled by single genes. Our ability to manage coat color through DNA genotyping (identification of black and red alleles) has been available for several years, as has parentage verification.

Historically, genetic evaluations in beef cattle have been developed using pedigree information complimented by performance records. In simple terms, EPDs originate from the average of an animal's sire and dam EPDs, which are then adjusted for the animal's own performance and the performance of its progeny. As more performance data is accumulated on an animal's progeny, and its relatives, the accuracy of the EPD is enhanced. EPDs are reflective of the cumulative effect of the many genes influencing economically important traits (growth, maternal, carcass traits).

DNA selection offers the potential to identify individual genes or groups of genes which have an effect on a trait of interest. Research to date using DNA markers (markers have close association with region of genome affecting a trait) has shown that for most growth and carcass traits, each individual marker explains a relatively small proportion of the genetic variation in the trait. Consequently, it is possible for an animal to have a very strong EPD a given trait yet have a "poor" DNA test for the same trait. The reason for this is that EPDs reflect the cumulative genetic merit for all genes that affect a trait, whereas a single DNA marker only provides a snapshot of one (or a few) genes that affect that same trait. Such scenarios create challenges with incorporating DNA genotypes into selection decisions, particularly for traits which also have EPD information. Ideally, the two sources of information could be integrated- and DNA information could enhance EPDs. This is the precise direction the industry is headed with DNA.

Very recently, DNA technology has advanced to the point that it is now possible to determine the DNA profile of an animal utilizing many markers simultaneously (50+). These DNA tests are likely to be more informative since they scan a larger number of genes impacting a trait. Just over a year ago, the American Angus Association released the first EPDs enhanced by DNA information. Angus breeders are currently submitting samples to commercial genotyping companies (such as Pfizer and Igenity) which in turn report DNA results to breeders and the breed associations. These DNA genotypes are incorporated into the evaluation process and compliment performance records in the computation of EPDs. DNA profiles are recorded for several traits, some of which EPDs are currently available (carcass, growth, maternal traits) and some which do not exist in EPD form (feed efficiency). The primary impact of this new approach is enhanced accuracy of EPDs for young animals (those without progeny records).

Moving forward, DNA technology and the utilization of genomic information in genetic evaluation provides great potential to offer selection tools for traits which are difficult and/or expensive to measure (and therefore there is limited performance data), such as feed efficiency. The utilization of genomic information will not eliminate the

need to collect and record performance data since phenotypes are needed to associate differences in DNA with corresponding influence on the trait.

In summary, DNA technology is advancing rapidly and offers significant potential to enhance genetic evaluations in beef cattle. By incorporating DNA information into existing genetic evaluation systems to provide enhanced EPDs, the industry will be able to capitalize on this technology in a fashion which is already familiar to producers.