New Trait Development and Economic Relevance in National Cattle Evaluation

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Introduction

Ever since the historic cattle drives north from Mexico and Texas, the beef industry has weathered many challenges from changes in market location, swings in the weather, to extreme fluctuations in beef prices. The past several years in both the U.S. and Canada have been particularly stormy. Over these years we have witnessed across-border trade restrictions, rapidly rising fuel and fertilizer prices, along with feed prices reaching record highs. During May, 2008, gasoline prices in the U.S. recorded 27 record highs in 28 days. A recently released study predicted costs of production for corn, barley, and soybeans will rise 26%, 25%, and 32%, respectively, from a 2007 baseline by 2020 (Doane Advisory Services, 2008). That study assumed a barrel of oil would rise from $67 to $94 in 2020! United National Secretary-General Ban Ki-moon has stated that world food production must rise by 50% in 2030 to meet increasing demand, so there may be hope for increased prices, yet cow numbers in North America continue to decline (Alberta Agriculture and Rural Development, 2008). As cattle producers we must be willing to adopt economically viable technologies that will help us become more profitable. From a genetic improvement perspective, those technologies must improve our accuracy of selecting young animals and address the economically relevant traits in a cost-effective manner.

Our current national cattle evaluations (NCE) often do not address all of the economically relevant traits (ERT). As an industry, we must identify the deficiencies in our current NCE and focus efforts on the additional ERT for which EPD development should be a priority. A framework for identifying these traits has been suggested with research and development efforts initiated for a number of new traits. Once released, as with any trait, genetic improvement in these can result in long term, sustainable returns.

The Process

The concept of economically relevant traits was introduced at the BIF meetings in Wichita, KS in 2000 (Golden et al., 2000) as a method for producers to focus selection pressure on traits, that if genetically improved, correspondingly influenced profitability. In brief, the ERT identification process requires breeders to outline the current production levels of their herds, to determine the method by which those cattle will be marketed in the future (i.e. sell calves at weaning, retain ownership, etc.) and to identify what performance characteristics will determine the value of those animals when sold. For seedstock breeders that process should be centered on the characteristics of their customers' operations—the focus should be on meeting the needs of their customers. For commercial cattlemen that examination should be based on their own operation's characteristics.

That characterization is then used to identify the traits that will be economically relevant in those specific production systems where the ERT are traits for which a unit genetic change directly influences either the costs of production or the revenues

from production on that ranch. Once the ERT are identified, the breeder can then focuses selection decisions only on EPDs for those traits, eliminating many EPD from consideration, thereby reducing the amount of information needed to make selection decisions that result in more profitable offspring. For instance, this process provides a mechanism to help breeders realize that there is no need to select on both birth weight EPD and calving ease EPD. To illustrate, consider two sires with the same BW EPD that are mated to genetically similar heifers. After the calving season some summary statistics are calculated and both bulls' calves averaged 85 pounds at birth. However, there was a 10% higher assist rate on one of the bull's offspring. The calving ease EPD would identify this sire as more difficult calving while the birth weight EPD would not. Put another way, birth weight does not describe all of the factors involved in whether a calf is born unassisted. Shape of the calf might be one of the factors involved in that higher assistance rate. Economically, we know that calves born assisted have reduced survival rates, increased probability of health problems later in life, and incur greater labor costs. The female requiring assistance also has a longer post-partum interval, likely delaying her conception during breeding season. In this example, calving ease is the economically relevant trait, and birth weight is an indicator.

While not immediately obvious, there is a reason that it is important for breeders to focus selection pressure on only those traits that are economically relevant. As many are aware, the greater the number of traits that are selected for, the more slowly genetic progress occurs in any one of those traits—now that is not an endorsement of single trait selection! This merely illustrates the importance of focusing selection on the limited set of ERT.

In this process, identifying current herd production levels, traits influencing costs of production or sources of revenue is relatively easy, forecasting traits of importance in the future is more challenging. Genetic improvement is a long term endeavor however, where selection decisions and matings made in 2008 in a seedstock herd will likely continue to influence the profitability of commercial customers' herds well past 2024—especially if replacement females are retained from matings in the commercial herd.

New Trait Development

In the process of new trait development, we must address not only traits for which the current NCEs are deficient but also look forward 20 years, identifying ERTs for the future. For some of these traits, traditional methods of collecting and reporting individual animal phenotypic information on the scale with which we collect birth, weaning, and yearling weights will likely not be possible. For many of these new traits, we will likely have to rely on the development of genomic information and on public/private research populations to facilitate phenomics research. While a new term to many, phenomics is the study of optimum animal phenotypes that can be used to elucidate information from genomics research and gene discovery that will ultimately be used in genetic improvement programs. In essence, development of EPDs for many new traits will require detailed collection of performance information from research populations that is often expensive and/or difficult to collect; whereas genomic/marker information could be collected more widely from the industry especially for traits such as tenderness or feed intake. Those issues aside, let's work through some examples where there is a need for development of EPDs for new traits.

Cow-calf producers are the largest segment of the North American beef industry. Many producers sell weaned calves and cull cows, and they retain

female replacements from within the herd. For these producers, the economically relevant traits are likely

- Calving ease
- Sale weight—in this case weaning weight and weight of cull cows (mature weight)
- Milk production
- Cow maintenance feed requirements
- Cow length of productive life (or stayability)
- Heifer pregnancy rate
- Bull fertility (ability to produce pregnancies)
- Cow and calf health

EPD have been developed and are currently available for the first six of these traits. The final two traits will require additional development, but clearly influence costs and revenues of production and are therefore ERT. Bull fertility, or the number of females a bull can successfully service in a restricted breeding season, determines the number bulls required in the herd, and the impact each bull has on herd performance through their progeny. With the new DNA technologies, we will likely be able to address this trait much more thoroughly. Additionally, cow and calf health are clearly related to profitability through their impacts on herd morbidity, mortality, and reduced performance. Both of these traits should therefore be a focus of genetic improvement research yielding selection tools deliverable to the industry.

The above list for the cow/calf segment introduces the issue of accuracy. Even though EPD are available for several of these, the time required to achieve acceptable levels of accuracy for cow maintenance feed requirements, length of productive life, and heifer pregnancy is considerably longer than for calving ease, sale weight, and milk production. Because accuracy of selection is one of the 4 factors that determine how quickly genetic progress can be made (the others are intensity of selection, generation interval, and genetic variability), genomic information could be especially useful as a means to improve accuracy of selection of young animals. Dr. Crews will cover this topic much more thoroughly in the next paper.

The feedlot phase of production is an area where there are a number of ERTs for which no EPD exist. Given current production and marketing of fat cattle, our list of ERTs includes:

- Sale weight (live weight or carcass weight depending upon how marketed)
- Quality grade
- Yield grade
- Days on feed
- Animal health (including mortality)
- Feed intake requirements.

The current NCE have EPD that are related to sale weight, quality grade, and yield grade—the "income traits", but are lacking in the areas of days on feed, animal health, and feed intake requirements—the "cost traits", yet all of these are economically relevant in the feedlot segment. Days on feed influences profitability through yardage costs and feed intake requirements are directly related to feed costs. Animal health influences the costs of production through lost performance, mortalities, and cost of treatment. In 2005 the value of cattle lost to respiratory disease alone was over $690 million in the U.S. These are all ERT for which selection tools should be developed to help improve profitability of this sector of the industry.

Past the harvest phase of production there are other potential ERT to position the beef industry for the future. These likely include traits related to eating quality, nutrient content and/or density of beef. Development of these new traits might lead to new value added products similar to the development and marketing of "low cholesterol" eggs.

The traits discussed in this paper are not to be considered an all-inclusive list. There are

other economically relevant traits for specific environmental circumstances which have not been considered in this paper. Included in these "regionalized environmental" ERT are likely traits such as resistance to High Altitude Disease (Brisket Disease) in the Rocky Mountain West and heat and parasite resistance in other production environments.

In addition to the distinction between true ERT and indicators, a distinction should be made between component and composite traits. For example, yield grade or retail product percentage are composite carcass merit traits which are made up of component traits such as fat depth, ribeye area, and carcass weight. In the past decade, considerable new trait development has been directed at optimal approaches to evaluating composite traits as indexes of their components. These approaches generally reduce the computing requirements for adding composite traits to NCE (e.g., Crews et al., 2008). Another application includes the wide array of multiple trait indexes that are composite traits made up of linear combinations of components. Maternal productivity (Mwansa et al., 2002), for example, can be defined as a linear combination of EPD for stayability, cow maintenance requirements, and weaning weight. These examples simply illustrate that new trait development isn't restricted to identification and modeling of new or novel phenotypes, but also to new approaches for combining genetic evaluations and expressing them in economically relevant terms.

Our purpose in this paper was to develop the perspective that new traits should be developed through a process that includes identification of economically relevant traits. This process will require close working-relationships between producers and scientists to produce selection tools that help our industry improve profitability.

Summary and Conclusion

There is considerable need throughout the beef production system for the development of new economically relevant traits and associated selection tools. We have discussed a framework by which traits should be identified and subsequently offered a prospective list of ERTs upon which to focus.

Development and delivery of these tools will likely require better data tracking systems, facilities for intense phenotype collections (e.g. feed intake) and/or increased use of genomic tools in the NCE systems. Many of these "new" ERT will be good candidates for utilization of marker tools to produce the evaluations and/or improve the accuracy of current genetic evaluations. All of these technologies will likely be needed to deliver selection tools for these new traits.

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