Breed and Breeder Adaptation to Genome-Enhanced/Enabled Selection Information - Kent Andersen, U.S. Beef Breeds Council

Abstract
In order for genomics information to most effectively impact seedstock selection decisions it should be incorporated into breed association performance programs. This requires new business infrastructure and information technologies that function to integrate the activities of breeders, breed associations, genomics companies and genetic evaluation service providers. Best-use of validated genomics information promises to enhance the accuracy of EPDs (especially important for non-parents) and enable more thorough characterization of genetic differences for additional economically relevant traits (ERTs). In turn, this empowers more informative bio-economic selection indexes and customized decision support. Failure to effectively construct such infrastructure is expected to result in ambiguous, confusing selection information that may impede genetic improvement and threaten most-profitable adoption of genomics technology by seedstock and commercial producers.

Introduction
Historically, the primary function of breed association performance programs has been to process pedigree and performance data and provide Expected Progeny Differences (EPDs). EPDs are typically computed twice per year on a multiple-trait, population basis, as well as daily by breed associations using interim EPD calculation processes applied to incoming data submitted by breeders. Timely inclusion of all available information from a variety of sources into EPDs and associated accuracy values has helped to simplify and empower selection by quantifying genetic merit into one most-informative EPD number for each trait.

Enter Molecular Breeding Values
The emergence of panels of markers and associated Molecular Breeding Values (MBVs) ushers in a new era for beef cattle breeding. Integration of this new information into the existing framework of breed association performance programs and genetic evaluation is anticipated to make adoption by breeders relatively seamless. However, such integration necessitates greater collaboration between breed associations, genomics companies, the National Beef Cattle Evaluation Consortium (NBCEC) and genetic evaluation providers (see figure).

It follows that incorporation of genomics information will require new and enhanced business infrastructure for associations and genomics companies on several fronts, including; legal, staffing, information technology, genetic evaluation, education and marketing. This is a worthwhile undertaking, because integration of evolving genomics information is likely paramount to its most appropriate and profitable use. Beyond seedstock, genomics companies will extend application of molecular-based technologies to commercial cow-calf, feedyard and end-product customers, and that will have ramifications for breed associations and breeders.

Failure to Integrate

Breed association and breeder adaptation to genomics information will be appreciably more difficult if it is not efficiently integrated into existing performance programs. The prospect of a dozen or more traits evaluated separately by both traditional EPDs as well as by MBVs from one or more service providers would create potentially overwhelming ambiguity and confusion in the selection, breeding and marketing of seedstock. If MBVs for important economically relevant traits (ERTs) - not evaluated by EPDs – were not included in economic selection indexes and decision support, their true value to selection would not be realized. Operationally, disparate databases of genetic data would make it more cumbersome for breeders to assemble information for breeding and sales activities.

Adapting to Enhanced Accuracy - MBVs for EPD Traits

For traits evaluated by EPDs, appropriate incorporation of MBV information into the EPD would eliminate ambiguity, enhance accuracy and reduce the possible change, or error, associated with the prediction. If the extent to which accuracies are enhanced by virtue of company specific genomics information is established across traits, it is relatively straightforward for producers to decide if the investment in testing is worth the corresponding reduction in possible change and risk.

As a benchmark, assuming the integration of MBV information into the EPD contributes to an increase in accuracy for non-parents from .20 to .60, the associated possible change is reduced by a magnitude of about one-half for most traits. For example, a weaning weight EPD with accuracy in the .2 range has a possible change of around ±12 pounds, which is reduced to just ±6 pounds with accuracy at the .6 level. Incorporating MBV information into the EPD also eliminates confusion caused by having some genetic predictions expressed as breeding values and others as progeny differences (a progeny difference is one-half of a breeding value).

If non-parent bulls have MBV-enhanced EPDs with accuracies in excess of .5 for most traits, roughly one-half of the risk associated with non-parent sire selection could be eliminated. Sire prospects with superior EPD profiles at this level of accuracy would be of notably higher value because significant possible change has been removed from their predictions. Higher accuracy EPDs for non-parent sires would also help to ensure their best-use, say as heifer bulls or specialized terminal sires, thus adding value to the buyer. Obviously, untested non-parent sire prospects with unenhanced accuracy, as well as those with MBV-enhanced accuracy but significantly inferior genetic merit, would be justifiably discounted.

Replacement females and cows with MBV-enhanced EPDs might be expected to have higher accuracy than what a lifetime of natural calves evaluated in competitive contemporary groups might achieve. Theoretically, this should result in a lifetime of better mating decisions if oriented toward defined selection objectives. Soundness and visually evaluated traits aside, higher accuracy, genetically superior females would be

worth more, while those with problems identified via their MBV and those that are only evaluated to traditional levels of accuracy would likely warrant discounts.

Adapting to Enabled ERTs - MBVs for non-EPD Traits

Genomics technology has begun to further enable genetic evaluation of traits not traditionally quantified by EPDs. Typically, these characteristics are difficult and/or expensive and time consuming to measure, but are important ERTs. The following non-EPD traits are known to be in one phase or another of genomics research, validation and commercial testing:

- Feed Utilization
  - Feed Intake
  - Residual Feed Intake
- Animal Health (i.e. Bovine Respiratory Disease, BRD)
  - Disease Resistance
  - Immune Response
- Healthfulness of Beef Products
  - Fatty Acids (saturated and unsaturated content)
  - Minerals
- Palatability
  - Tenderness (shear force)
- Adaptability/Tolerance to Environmental Stress
  - High Altitude Disease
  - Fescue Tolerance
  - Subtropical Heat Adaptability
- Cow Fertility and Productivity (note: EPDs exist for some populations but phenotypes are either difficult, time consuming or not routinely collected outside inventory-based recording schemes)
  - Heifer Pregnancy
  - Cow Longevity (and component traits)
  - Cow Lifetime Productivity

Breed association, breeder and commercial producer adaptation to an evolving suite of MBVs for additional traits represents formidable challenge. First, a clear understanding of the efficacy of each new MBV in specific populations is needed. Second, assuming the MBV possesses significant predictive power, ascertaining its relative economic importance as compared to other traits is necessary for appropriate weighting in selection. Next, threshold levels for some of these new MBVs exist – beyond which economic returns diminish – and this should be factored into multiple trait selection. As a result, incorporation of MBVs for these traits into existing and new economic selection indexes and decision support tools likely offers the best prospect for easiest and most appropriate use of available selection information.

Adapting to Genomics Costs

From a breeder's perspective – depending upon the breed association – the costs associated with cow enrollments, registrations, A.I. service certificates, performance

data entry, ultrasound scanning and ownership transfers adds up to $30 - $50 per head. If animals are also parentage verified and tested for one or more simple-recessive traits such as color, polled and/or genetic defects, breeders incur costs of another $30 - $50 or more per animal. With the prospect of $50 - $100 per head for genomics tests associated with various quantitative traits, at current prices breeders might spend $150 to over $200 per head for recording, data processing, parentage and genomics services.

Most breeders will initially adapt to added genomics costs through some combination of selective recording, scanning and testing. While this is less than ideal from the perspective of complete information for all animals, it is economically justified until the return on investment in specific genomics testing is clearly established.

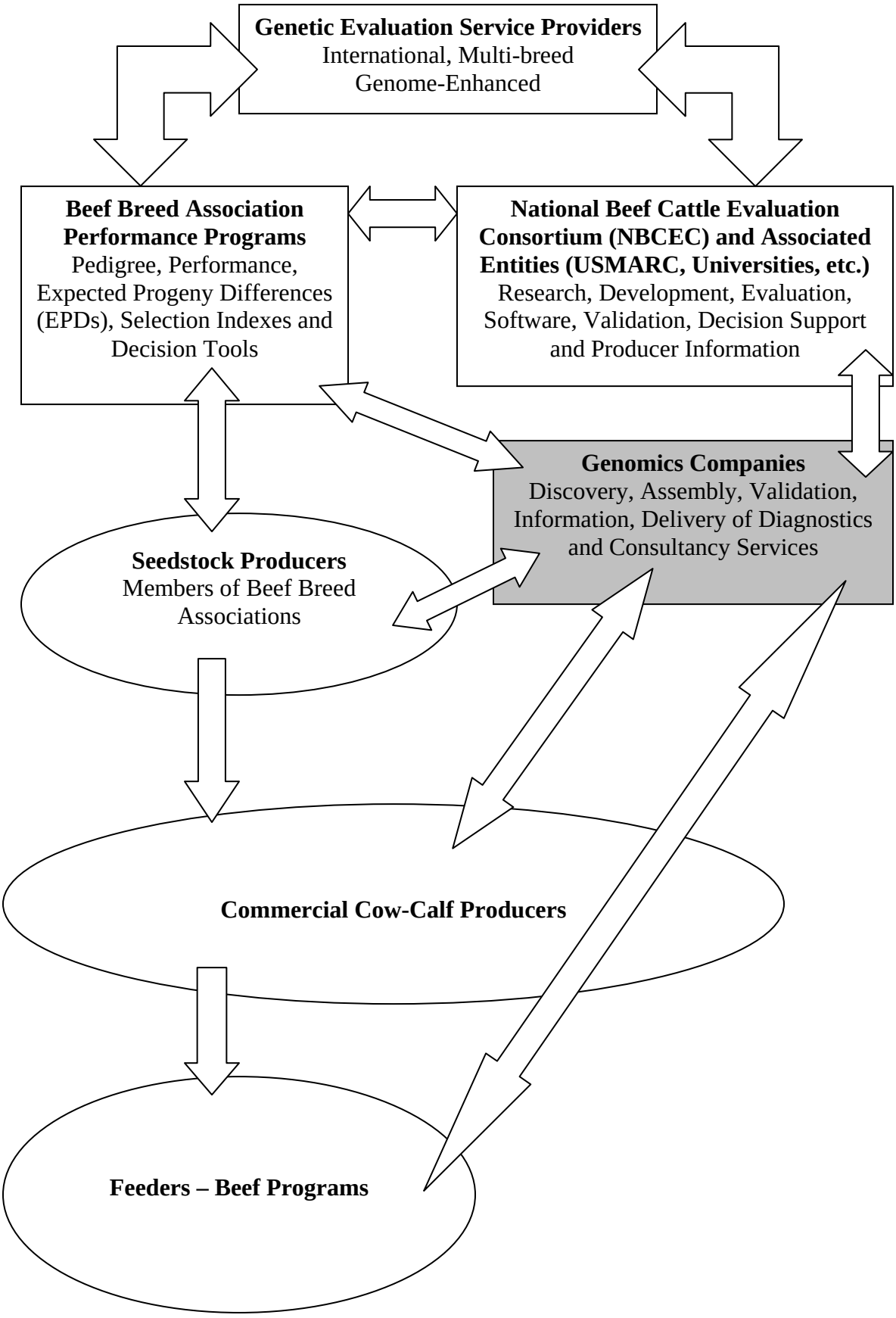
Assuming a favorable value proposition, the added accuracy and thoroughness with which animals might be evaluated should favorably impact breeder profitability. Over time, more sophisticated selection tools should drive notably greater genetic improvement. This should equate to reduced costs for breeders (i.e. feed, labor, bull and heifer development, customer credit, etc.) – and added revenue from a higher proportion of animals that can be readily marketed at premium seedstock prices.

Associations could play an important role in adding to this value proposition. Beyond integration of genomics information into genetic evaluation and serving as a clearinghouse for information, associations could become more actively engaged in helping breeders formulate selection objectives and mating plans that produce seedstock which better serve the evolving needs of customers. Association commercial marketing programs could help commercial bull buyers more fully exploit the economic benefits of seedstock that are more accurately and comprehensively evaluated.

Breed association adaptation to genome-enhanced and enabled selection information will equate to increased costs associated with programming, personnel, member information, as well as research and service development. Cost recovery will be necessary through a combination of strategies, including relationship agreements with genomics companies, creative development of new revenue generating information services for members and customers, as well as potential price adjustments to existing services.

Summary

The beef seedstock business is entering a new era of animal evaluation. Breakthroughs in genomics technology and the emergence of MBVs for a variety of traits offer the potential to enhance the accuracy of existing EPDs and enable selection for important traits not previously evaluated. Depending upon the extent to which breed associations, genomics companies and genetic evaluation providers effectively collaborate, breeder adaptation to genomics technology could be relatively seamless or confusing and cumbersome. Most appropriate and profitable adoption likely hinges on establishment of symbiotic relationships focused on delivering tangible value to seedstock producers and their customers.


Genetic Evaluation Service Providers
International, Multi-breed
Genome-Enhanced
Beef Breed Association Performance Programs
Pedigree, Performance, Expected Progeny Differences (EPDs), Selection Indexes and Decision Tools
National Beef Cattle Evaluation Consortium (NBCEC) and Associated Entities (USMARC, Universities, etc.)
Research, Development, Evaluation, Software, Validation, Decision Support and Producer Information
Genomics Companies
Discovery, Assembly, Validation, Information, Delivery of Diagnostics and Consultancy Services
Seedstock Producers
Members of Beef Breed Associations
Commercial Cow-Calf Producers
Feeders – Beef Programs