Positioning for the Future of Beef Production: Bringing It All Together

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Introduction

The Beef Improvement Federation (BIF) is an organization established fifty year ago by forward thinking industry leaders to provide a platform for discussion of topics related to genetic improvement. Those topics include appropriate methods of data collection, methods of analyzing those data in genetic evaluations, selection and mating strategies and the development and implementation of new technologies. An integral part of the success of sustaining beef production has been the commitment and efforts of beef producers to improve the genetic capability of cattle following many guidelines established by BIF. It is appropriate to reflect on the accomplishments of the past 50 years, but we can also use this opportunity to question how to do even better going forward in meeting challenges of the future. In celebration of the 50th anniversary of BIF, this symposium focuses on "Positioning for the Future of Beef Production."

Contributions by Mark McCully and Michael Genho address quality of beef products and efficiency in producing beef, respectively. These are examples of traits important to the industry. I emphasize these being examples as the portfolio of economically relevant traits (ERTs) in beef production is much more diverse and complex. Sara Place discusses sustainability and the need to address three components defining sustainability; economic viability, environmental footprint and social concerns. Dorian Garrick examines traits currently not considered in the scheme of beef selection.

Over the past 50 years the beef industry has witnessed tremendous growth in the amount and type of data collected. Over that same period the industry experienced numerous advances in technology for managing cattle, capturing data and in computing genetic evaluations. Most recently, DNA technology adoption has reach a level at which that technology is making a significant contribution to genetic evaluations for traits in the EPD portfolio. It is against this backdrop that we look to future opportunities for selection.

Selection is a process used to make genetic improvement towards a desired goal. The process includes creating a well-defined breeding objective and gathering data on traits included in that breeding objective either directly on the trait and/or through genetic indicators for those traits. These data are used in the assessment of genetic merit of individuals. Selection among candidates to be parents is done by ranking animals on specific traits or indices and keeping the requisite number of animals needed to meet the size requirement of the population. In thinking of selection in this light, there really are no alternatives to the process. Rather our focus should be on alternatives to the components within the process to better reflect the industry needs (the goal and breeding objective) or enhance the response to selection (e.g., more or better data, better assessment strategies). The objective of this paper is to further examine some concepts, challenges and opportunities presented in the symposium presentations and discuss them in terms of impact on strategies for the future selection of beef cattle.

The Goal of the Breeding Program

Garrick states:

"There is a logical approach to developing a breeding program that includes thorough biological and economic considerations of the traits to consider. The first step is the formulation of the goal of the breeding program. That would normally reflect some measure of increasing satisfaction...."

What should the goal of the breeding program for the beef industry be moving forward into the next half century? I am not aware of a well-articulated and universally accepted statement of the goal for beef production that provided the motivation for our historical selection program. However, even if one did exist it certainly needs to be refreshed given current economic trends in the industry, environmental concerns on production footprint and consumer demands. Perhaps the first step moving forward into the future is to establish a modernized statement of the goal for beef production and *BIF is the perfect venue to have this discussion.*

The Breeding Objective

The breeding objective provides a basis for the overall value of an individual's potential contribution to the goal. The seedstock segment of the beef industry is the engine that drives genetic progress throughout the industry. The ambassadors of the seedstock genetic enterprise are the yearling bulls produced by the selection program. Ideally the selection program would address the needs of the commercial, feedlot, processing and marketing segments of the industry as well as expectations of consumers. If

we make an honest assessment of the current selection program, we will likely find that there are areas of weaknesses in doing so. So, if we step away from the current situation in the industry and take the utopian approach of defining a breeding objective that meets all challenges of a segmented industry and consumer demand, we can identify those weaknesses. Once identified, we can then design strategies to overcome them. In addressing this concept Garrick points out several shortcomings in the current selection strategy:

"Namely, there is inadequate consideration of reproduction, inadequate consideration of eating quality, inadequate consideration of the human healthfulness of the beef, inadequate consideration of disease resistance, inadequate consideration of feed intake and feed efficiency, inadequate consideration of lifetime performance, inadequate consideration of welfare traits such as horns, and inadequate consideration of environmental attributes such as water use, greenhouse gas emissions, or levels of effluent particularly Nitrogen outputs. All of these characteristics exhibit phenotypic variation, and all are heritable, so could be included in breeding programs."

One motivation for this exercise is simply to ensure the economic viability of beef production. There are still ERTs for profitable beef production that we do not adequately address such as health. A second motivation is to systematically address other components of sustainability. Sustainability encompasses not just economic viability but also environmental issues and consumer concerns. Sara Place cautions us that:

"Sustainability has been an issue at the forefront of the beef industry for most of the past decade. Given current marketing trends and the real pressures on our food and earth system as the global population grows by 2 billion additional people in the next two decades, sustainability will not be going away as an issue."

In preparing for the future, two significant challenges in implementing a better industry breeding program are to create incentives to broaden the scope of traits included in the breeding objective and to establish the infrastructure to capture data to support that objective. Sustainability is an excellent starting point in the planning for an alternative breeding objective for the future and *BIF is the perfect venue to have this discussion.*

I discussed a breeding objective as if there should be one for entire industry. The beef industry is not one large integrated operation but rather is comprised of a multitude of independent businesses. There will naturally be variation in the emphasis of traits under selection. It is also recognized that, given most seedstock are sold to commercial operations within a limited radius of the seedstock operation, certain traits will be more important in some geographical regions then others. Fescue tolerance, heat or cold stress tolerance, and high-altitude tolerance are some examples of traits that would need to be emphasized differently in their respected regions. This does not distract from having a comprehensive breeding objective with a more complete portfolio of traits but rather place emphasis on the economic values of those traits when being selected within individual programs. Decision support tools can be useful in addressing regional or local economic values.

Phenotypic Data

Much of the selection that has occurred over the past 50 years has been driven by traits for which data collection was relatively easy. This does not diminish the importance of those traits but does constrain the selection program. Dorian Garrick refers to this as being "Data Driven Selection":

"Bull breeders and bull buyers tend to focus more on attributes that they can easily visualize or measure, such as growth rate or calving ease..."

A more sustainable breeding objective as discussed above, requires reaching for "higher hanging fruit" which by its very nature will be more difficult and perhaps more expensive to collect. We must keep in mind that conceiving of what new traits to include in a breeding objective is easy. Building the infrastructure to collect, store and process data once those traits are identified is more difficult. Understanding that there can be significant differences in the investment needed for including new traits means prioritizing traits based on some long-term cost/benefit analysis as investment funding within the industry is limited. *This is another area for fruitful discussion within BIF.*

One certainty going forward is that the capability to gather phenotypic data will continue to evolve as it has in the past. Over the past 50 years we have seen the development of technology such as ultrasound for measuring carcass characteristics on live animals, technology for obtaining individual feed and water intake and technology for instrument grading. There is a growing emphasis in research in precision management which has a focus on improving capability for data collection on individuals within a group through enhanced instrumentation. Much of the effort is focused on developing technology to capture data in existing production systems.

We also know that there are valuable databases in segments of the industry that do not contribute to the national breeding program. An excellent example is the massive amounts of health data collected in feedlots. That data may not currently be able to be connected to databases for genetic evaluations due to animal ID issues or knowledge of parentage but at least the infrastructure for data collection exists. Strategies to circumvent issues in connecting that data can be establish given the right

incentives and *BIF is the perfect venue to have discussions on how to do so.*

Another issue for discussion is whether the trait, as measured and evaluated, is consistent with industry needs. As a positive example, McCully discusses the improvement in carcass quality grades that has occurred over the years because of a consistent market signal:

"The rise in quality grades across the industry has been very intentional, and the factors behind this improvement have been well-documented (Dykstra, 2016). Improvements in cattle genetics and management, supportive feeding economics and grading technology enhancements have all contributed to the trend, but ultimately the industry has responded to the market signals calling for more high-quality beef."

Genho, however, discusses efficiency of gain in the Elanco's Benchmark Feedyard Performance database which shows that actual average feed conversion for lots has increased in heifers and only slightly decreased in steers. This result is attributed in large part to the industry trend in increasing days on feed. Genho argues for an alternative efficiency measure:

"A better approach to evaluating efficiency would be to control for endpoint using a metric such as Empty Body Fat (EBF)."

The premise for this argument is to define a trait that more closely aligns with a measure of success which in this case is lot average feed conversion. This idea raises the larger issue as to whether we are doing an appropriate job in evolving our methods of data collection to accommodate trends in the industry. Are we adequately monitoring our data collection protocols such that we are sensitive to any trend in the industry that might negatively impact the value of phenotypes currently being collected? *BIF is the perfect venue to have this discussion.*

One final area of discussion relative to phenotypic data is to examine if are we fully capitalizing on existing data in our programs to evaluate traits. In some cases, the existing data might be useful in providing an EPD for an ERT for which data does not exist. An example is the use of information on mature size and milk yield EPDs to estimate Cow Maintenance Energy requirements. Advantages in using functions of existing information to create EPDs on any new trait is 1) leveraging existing information increasing its value, 2) doing so provides information on historic animals and 3) starting with the use of existing data could provide an impetus to develop programs to capture actual measures of the new trait if the value proposition for doing so exists. *BIF is the perfect venue to have this discussion.*

DNA Genotypic Data

The most significant change in the selection program for beef in the last decade has come from DNA technology. The current level of adoption has provided for an impactful infusion of new information into genetic improvement programs. As previously stated, the seedstock industry is where most of the investment in the genetic enterprise for the beef industry occurs. Bulls produced in the seedstock sector and transferred to the commercial industry traditionally had low accuracy EPDs, several based only on pedigree information. Incorporation of DNA marker information into the genetic evaluation programs has greatly enhanced the accuracy of evaluating these bulls.

DNA technology also provides for a way to obtain genetic evaluations on animals for the "novel" traits. Several large USDA grants addressing novel traits have been issued. USDA has also invested in the extensive GPE project at USMARC which now supports genomic investigation. All the requirements of discovery populations and ongoing assessment of marker value, issues of using results across breeds or in crossbred populations have been ongoing topics of conversation. These are challenges that will ultimately be resolved, and the technology will provide for inclusion of new traits into the breeding objective. Are we prepared to appropriately align the economic value of these traits in our multiple trait indices? *BIF is the perfect venue to have discussions on the economic weights for these new traits.*

One area of potential great significance in using marker information is the identification of deleterious alleles such as embryonic lethal variants. Garrick points out:

"Marker panels such as the commonly-used 50k chips, allow chromosome fragments known as haplotypes to be identified and their inheritance to be traced. Deleterious recessive mutations are often underrepresented in breeding populations in their homozygous form, or may be completely absent if they cause embryonic lethality. Identification of these haplotypes, or the causal mutations themselves, allows matings between carriers to be avoided, and this can markedly affect trait performance, in fertility and in any other affected traits."

Opportunities provided by this technology bring promise to addressing the desire for a more comprehensive breeding objective.

Determining How to Measure Success

Data collected on animals are utilized to evaluate genetic merit on the individual and relatives. Change occurring from selection is derived from yearly averages of EPDs over some span of time. The historic breed trends show selection has changed numerous traits. However, the question remains as the whether these changes represent

progress towards reaching industry objectives. Are there alternatives to defining success? An example is the issue of greenhouse gas emissions in the cattle industry. Concern over the contribution of cattle to the greenhouse gas issue has led researchers to investigate methane production and the microbiome of individual animals. There is the opportunity to define metrics that might be useful for genetic assessment and subsequent selection towards reduced emission if they are heritable. If these metrics are included in the breeding objective, then over time we can evaluate success in response to selection by the change in the average emission per animal per year as we do when looking at trends in weight or any other trait.

However, an alternative measure of success and perhaps one that resonates more closely to public concern is to estimate the yearly production of greenhouse gases by beef cattle based on animal numbers and total beef produced. Sara Place commented:

"Cattle herd size relative to beef produced is a critical component that determines the total resource use of beef production within the United States and globally. Per capita beef consumption is sometimes used as a proxy for estimating impacts from beef production, and recent reductions in per capita consumption within the United States have been highlighted as a reason for reduced greenhouse gas emissions. However, this is incorrect. Emissions from U.S. beef production have declined because the U.S. cattle herd has declined, and more beef has been produced per live animal (considering all supporting herd cows, bulls, replacement heifers, and cattle bound for finishing)."

In doing so, the emphasis changes from how well we are progressing with selection for the new metrics used to evaluate emissions to how well the entire selection portfolio is impacting success. For example, new strategies for selecting or mating cattle for improved fertility utilizing knowledge of variants causing early embryonic death will result in a change in the ratio of gas emission per pound of beef produced either by increasing the number of calves harvested or decreasing the size of the national cow herd.

There are other scenarios where we can alter our approach to measuring success that appropriately examine the impact of the breeding program. such as production per acre rather than individual animal performance. *BIF is the perfect venue to have this discussion.*

Summary

It is suggested that as we look to the future as an industry, we establish a statement of our goal for beef production. Based on this goal we should establish a breeding objective that ensures economic viability but also focuses on the needs of the industry to respond to today's social climate. The portfolio of traits will surely contain those for which we currently have genetic evaluations. We need to make sure our current approach to collecting existing data and the evaluations produced from those data are consistent with the needs of the industry. The portfolio will also include new traits for which we will need to develop strategies of collection and use. We will need to understand the cost/benefit ratio of developing new datasets and prioritize our approach to inclusion as investment resources are limited. There will be the need to incentivize this entire process. *BIF is the perfect venue to have these discussions.*

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