How to assist your beef clients with bull buying decisions using herd goals and Expected Progeny Differences (EPDs)

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Abstract

Beef cow-calf veterinarians are relied upon more and more to provide advice and consulting to their clients. While issues of health are the mainstay of many conversations, progressive producers are asking their herd health veterinarians about non-health subjects that have a financial impact on their herds. Providing unbiased information on improving the genetics of a herd can make a significant impact on the producer's bottom line.

Key words: genetics, expected progeny differences, genomically enhanced EPDs, crossbreeding, hybrid vigor, heterosis

Résumé

On se fie de plus en plus aux vétérinaires de troupeaux vaches-veaux (bovins allaitants) pour donner des conseils et des consultations à leurs clients. Bien que les questions concernant la santé soient souvent le sujet des conversations, les producteurs d'avant-garde demandent à leurs vétérinaires spécialisé en médecine de troupeau des questions sur des sujets qui ne touchent par la santé mais qui ont un impact économique sur leur troupeau. Fournir des informations impartiales sur l'amélioration de la génétique d'un troupeau peut avoir un impact significatif sur le bénéfice net du producteur.

In November 2019, a survey created by veterinary student Aimee Sink, was sent in an email to the student members of AABP. The survey collected 240 responses through October 2018.

The goal of the survey was to gauge the level of preparedness and interest in several different aspects of genetics and genomics to veterinary students interested in bovine medicine so that the AABP Genetics and Genomics committee can better serve the needs of the student members.

For the question, "Out of the following, what three things would you be most interested in learning more about?" The top responses were:
1. Embryo transfer – 96
2. Reading pedigrees – 87
3. Using hormones in reproductive programs – 82
4. Breed-specific genetic conditions – 80

When asked, "How well prepared do you feel about the following topics?" those with the least amount of confidence were (combined answers "what is this" and "not prepared":
1. Reading/interpreting genomically enhanced EPDs or PTAs – 140 (with 42 saying, "what is this?")
2. Reading bull/cow EPDs or PTAs – 136 (52)
3. Giving advice on sire selection – 134 (8)
4. Reading pedigrees – 129 (6)
5. Using genetic tests to look into the future – 128 (11)

The final question was, "How important do you think the following are in regards to being a bovine practitioner?" (combined answers, "very important and "important"):
1. Using hormones in reproductive programs – 228 (with 185 saying, "very important")
2. Breed-specific genetic conditions – 221 (141)
3. Bull BSEs – 219 (167)
4. Artificial insemination – 216 (158)
5. Recognizing conformational faults – 216 (134)

In this talk, we will cover:
- Questions to ask your producers before consulting on genetics;
- Breed specific genetic defects;
- Expected progeny differences (EPDs) and how to use them in primarily sire selection;
- What are across breed EPD adjustments and how to use these;
- How genomic testing can benefit your beef producers;
- Understanding percentile ranking of EPD traits;
- Does your owner need a maternal or terminal bull?;
- Advantages of hybrid vigor.

Questions to Ask your Producers Before Consulting on Genetics

Before you embark on making genetic recommendations, there are numerous questions you need to ask your producer.
- Is the bull for heifers, cows or both?
  - If the bull is for heifers, calving ease becomes the most important trait.
  - If the bull is for cows, what is the plan for the calves?
    - keep back replacements or not?

- sell feeder calves or finish to slaughter?
  - if sell to slaughter, do you sell live or on a grid?
- What are your short and long-term herd goals?
- In what way(s) is your herd above average?
- From a genetic standpoint, what do you think you need to do even better yet (EBY)?
- Others?

After you obtain answers to these questions, you now have the opportunity to be an asset to your producer in regards to his or her genetic plan.

Breed-specific Genetic Defects

There are numerous genetic defects in the beef cattle population, but the chance of encountering these conditions in a typical practice is rare. Our knowledge of the inheritance of the most common genetic defects is quite solid, and most all defects have a genetic test available. All new AI sires have to be either tested free or be known free based on their pedigree. With some genetic defects, carrier animals have their registration papers revoked so no more of their offspring can be registered.

A good summary on genetic defects is available at: http://extensionpublications.unl.edu/assets/html/g2055/build/g2055.htm This is a University of Nebraska Extension paper and it explains the most common genetic defects, as of the 2011 publication date. The genetic defect developmental duplication (DD) was discovered in 2013 so it is not included in this publication. A table from the publication is below with DD added (Table 1). More information on DD can be found at www.angus.org.

Another helpful reference is a Kansas State PowerPoint by Dr. Dan Mosier, who is now president of Angus Genetics Inc. https://www.asi.k-state.edu/doc/agents/gendefects.pdf. This publication lists sires that are commonly in the pedigree of affected animals.

If a carrier bull is mated to a carrier cow and the defect has a simple recessive mode of inheritance, there is a 25% chance the calf will be free of the disease (AA in Figure 1), 50% chance of being a carrier (Aa), and 25% chance to have the disease (aa).

Two techniques are helpful in greatly reducing or even eliminating the chance of producing a calf with a known genetic defect. First, beef clients should never purchase carrier animals. Before a beef producer purchases a bull, it should be either tested clean or be free of all known genetic defects via pedigree. Via pedigree means, it has no carrier animals in the pedigree or both sire and dam have been tested free. If there are suspect animals in the pedigree, the bull should be tested before purchase.
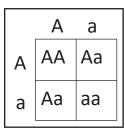
Second, the use of crossbreeding is a proven way to greatly reduce or eliminate genetic defects, as most genetic defects are confined to a single or very few breeds. If the owner of a herd of Angus or Angus cross cows purchased a bull that was a carrier of AM unknowingly 15 years ago, daughters and granddaughters of that bull are most likely in the herd. The purchase of a Gelbvieh or Simmental or other breed bull would eliminate the chance of producing calves that are homozygous for the AM trait. Now, if the producer purchases a Balancer (Gelbvieh-Angus composite) or SimAngus (Simmental-Angus composite) bull, this bull would need to be free of AM as the bull has Angus in his pedigree.

In a commercial herd there is little to no reason to test the cows for genetic defects. Simply purchase bulls that are free. If the herd uses AI and producers their own bulls, then those bulls should be tested to be sure they are clean if known carriers were used in the past.

Conditions like corkscrew claw and scissor claw are more difficult to eliminate from a herd because the mode of inheritance is unknown. Bulls should be thoroughly scrutinized prior to purchase for feet issues. Bulls that develop these conditions should be reported to the breed association. To give assurance of selling animals free of these conditions,

Table 1.

Genetic abnormality	Common term	Primary breeds(s) of incidence	Lethal or Nonlethal	DNA test available
Alpha (a)-Mannosidosis		Red Angus	Lethal	Yes
Arthrogryposis Multiplex (AM)	Curly calf	Angus	Lethal	Yes
Beta (b)-Mannosidosis		Sales	Lethal	Yes
Contractural Arachnodactyly (CA)	Fawn calf syndrome	Angus	Nonlethal	Yes
Developmental duplication (DD)		Angus	Nonlethal*	Yes
Neuropathic Hydrocephalus (NH)		Angus	Lethal	Yes
Hypotrichosis (hairless calf)		Hereford	Nonlethal	No
Idiopathic Epilepsy		Hereford	Nonlethal	Yes
Osteopetrosis	Marble bone	Angus and Red Angus	Lethal	Yes
Protoporphyria		Limousin	Nonlethal	Yes
Pulmonary Hypoplasia and Anasarca (PHA)		Maine-Anjou and Shorthorn	Lethal	Yes

Figure 1. Punnet square to show potential offspring from mating two carriers of condition "a" where "A" is the normal gene.

sellers should guarantee bulls free of these defects. Daughters should not be kept from bulls with these disorders and daughters of affected cows should be fed for slaughter and not retained in the herd.

Expected Progeny Differences (EPDs) and how to use them in Sire Selection

Expected Progeny Difference (EPD) is the prediction of how future progeny of each animal are expected to perform relative to the progeny of other animals listed in the database. EPDs are expressed in units of measure for the trait, plus or minus. A very good review can be found at the University of Nebraska site: http://extensionpublications. unl.edu/assets/html/g1967/build/g1967.htm. The use of EPDs is 7 to 9 times more effective than utilizing actual phenotypes of an animal.[2] For example, if Bull A had a weaning weight of 650 lb (295 kg) and Bull B had weaning weight of 575 lb (260 kg) we might assume that bull A would be the superior choice if the goal was to increase weaning weight. This raw data does not take into account when the bulls were born, the age of the dam, whether the calves were creep fed or not, and many other environmental factors. The heritability of weaning weight is only 0.28[3] according the data found at https://www.angus.org/Nce/Heritabilities.aspx. That means 72% of the variation in calves' weaning weight is due to non-genetic factors. If we had EPDs on these bulls and bull A had a WW EPD of 60 and Bull B had a WW EPD of 70, we are 7 to 9 times more likely to be correct if we select bull B to improve our weaning weights.

One common fallacy is that the EPD of zero is breed average. That is almost never the case now. When EPDs were introduced in 1983, that was the average for many of the traits. Now, it means almost nothing. The "D" in EPDs is the key to how we use EPDs. As in the example above, bull B had a 10 lb (4.5 kg) (70-60=10) advantage (**D**ifference) compared to Bull A on WW EPD.

Another factor that needs to be considered is the *accuracy* of the EPD. Accuracy can be defined as the relationship between the estimated EPD of the animal and the «true» EPD of the animal.[4] This relationship is expressed numerically from 0 to 1. As the accuracy value approaches 1.0, the EPD reported is more likely to represent the true genetic merit of the animal. Young bulls with no progeny will have a lower accuracy than an older bull with many progeny recorded. When mating heifers via AI, it is important to select a bull with greater accuracy as this increases our confidence that the calving ease of this bull is closer to his "true" EPD.

EPDs are dynamic and will change over time. A very young bull that initially appears to be a good candidate to use on heifers may turn out not to be a wise choice as more and more calves are born and recorded. Once a bull's accuracy gets above about 0.80, very little change should occur. I use the analogy of your "grade" after 2 quizzes in a class vs your "grade" after 20 quizzes, 4 tests, and 2 projects. Your grade may change significantly after an exam in the former example, but not much in the latter. This is the same as an animal's EPDs.

If a producer is comparing bulls of 2 different breeds, an EPD adjustment needs to be made so the bulls can be compared on an equal genetic basis. Each breed has their own EPD base and direct comparisons cannot be made without using the adjustments. This is why the Meat Animal Research Center in Nebraska publishes an adjustment table each year. Angus is used as the "base" breed so the Angus adjustment for each EPD that can be compared is 0. For example, a producer is looking at an Angus bull with a YW EPD of 100. She is comparing the Angus bull to a Charolais bull with a YW EPD of 90. At first glance, the Angus appears to have a 10 lb (4.5 kg) advantage, but when we look at the conversion chart for YW, the Charolais has an adjustment factor of 23.2.[5] Therefore, the Charolais, adjusted to the Angus basis (called the Across Breed EPD), is actually 113.2 compared to the Angus at 90.

How Genomic Testing can Benefit your Beef Producers

The industry has made great strides on the utilization of genomic testing in beef cattle. Genomic, or DNA, test results are used to enhance predictability of current selection tools, to achieve more accuracy on EPDs for younger animals, and to characterize genetics for traits that are difficult or expensive to measure, such as feed efficiency, carcass traits in breeding stock or maternal traits in bulls. The area that seems to have the largest impact is the ability to genomically enhance the EPDs of young animals so that the EPD accuracy improves and the animal's EPDs are closer to its true EPDs at a much younger age. A challenge of purchasing a yearling bull for a group of heifers has been the low accuracy of the bull's calving ease direct (CED) EPD. Now with genomically enhanced (GE-EPDs), instead of the bull's EPDs only being calculated based on his pedigree, calving ease score, birth weight and contemporary group data, it is as if the bull has already sired 26 calves where calving ease data was recorded.[6] Do not be confused. This is not a guarantee of calving ease. Just as a bull with high accuracy for calving ease can produce calves that result in a dystocia, so can a bull with GE EPDs that predict calving ease. The fact remains that it is the best tool we currently have to predict calving ease on a virgin bull.

Understanding Percentile Ranking of EPD Traits

EPDs have evolved from only comparing 2 or more animals based on the expected *difference* of their progeny to evaluating where a bull ranks within the breed based on certain EPDs. This is especially popular for marketing purposes. Touting that a bull is in the top 1% of the entire breed for some trait seems to excite potential buyers. The question that we will not take time to discuss here is "Does the buyer *need* a bull in the top 1% of a certain trait?"

Many producers do find using this data to be useful when selecting an AI sire to use on a group of heifers. As stated earlier, calving ease is the most important trait to consider for the majority of producers that are breeding heifers. It is common to hear experts recommend using a high accuracy bull in the "top 10% of the breed for CED". Every breed has an EPD percentile chart and you as an advisor need to be familiar with what is above and below average or a certain threshold when helping a producer select a sire. You don't need to memorize these, as they are easy to find on each breed's website. If you work with a particular breed frequently, you will become familiar with some of the traits. For example, if you suggest SimAngus bulls for many of your commercial herds, you may know that a YW EPD of 110 is well above average for the breed (actually top 25% currently).

Many seedstock producers will have traits where they are placing much selection pressure and others where they place very little pressure. If a seedstock herd is selling bulls to commercial producers that retain females for replacements and retain ownership of cattle into the feedlot, he or she may select AI sires that rank in the top 25% for calving ease and docility, bottom 50% for frame score and mature weight, top 40% YW, and top 10% marbling. The list of bulls that is generated is then further scrutinized for other traits like scrotal circumference, milk, and stayability. It would be rare to impossible find a bull in the top say 25% of the breed for every trait a producer felt was economically important. Some concessions need to be made in your selection criteria.

If a search of AI sires with the above criteria results in 70 bulls selected, adding selection pressure to some other traits will help reduce the list to a manageable level. If on the other hand, the search yields zero bulls, reducing the selection pressure on 1 or more traits is where to begin.

If the bull selected is to be used on heifers, CED EPD should have the most selection pressure. Do not look at birthweight (BW) EPD as it is a proxy for calving ease direct. CED measures actual calving ease scores from heifers. The 2 traits are correlated, but CED already takes into account BW EPD, so simply look at CED and not BW EPD. Do not be concerned with actual birth weight except on rare instances. Actual BW is influenced by non-genetic factors. CED is a direct measurement of calving ease on heifers. It is disappointing to read surveys and see that actual birthweight of bulls is 1 of the traits where producers place the highest selection pressure. I hope that you can train your clients to mostly ignore this number.

Does your Owner need a Maternal or Terminal Bull?

Most commercial herds retain their own heifers for replacements, and whether that is ideal or not is up for debate. Nevertheless, most herds *intend* to buy a maternal bull; one where they will keep replacement females. Traits that are deemed important would likely include docility, fertility, longevity, structural integrity, moderate frame/mature size, calving ease, moderate milk, hybrid vigor, acceptable growth, and marbling. The problem is that from a marketing standpoint it is easier to tout "top 1% YW EPD" if the goal is to get top dollar for the bull. Expressing that a bull is very good to good in a number of areas and average in others does not excite buyers. If we compare a dairy cow to a beef cow, the dairy cow needs to give a lot of milk that is high in components. We bring her feed to her every day, we accept a 25% first-service conception rate and if she has a calving interval of 14 months and only lasts 3 lactations, we accept that. Longevity is not part of the equation. Our beef cow needs to get pregnant in the first 30 to 42 days (ideal) of her first breeding season, calve unassisted, get bred back 3 months after calving, wean off an acceptable calf at 6 months of age, graze forage for 7 to 9 months of the year, keep body condition in a variety of environmental conditions, and do this every year for hopefully 10 to 15 years. Beef producers cannot single-trait select or even select for just a few traits. We need balance in our EPD selection criteria in the beef world. Too many producers are buying terminal bulls (high growth, large frame, high marbling, large ribeye) when they really need a maternal bull.

If your herd owner is not keeping back replacement heifers, he or she should buy a terminal bull. In the past, we might have thought of using a Charolais or Simmental bull. When we think of these breeds, we think muscle and growth. When we examine the most modern genetic choices and apply the across-breed EPD adjustments, there are actually many Angus bulls that excel as terminal sires. These bulls would have high carcass weight, yearling weight, and marbling EPDs. They tend to be large-framed and have high mature weight EPDs (correlated positively with carcass weight). Carcass weight is a large driver in the equation, as is marbling. The Angus breed has an index that is a terminal index, $Beef ($B).

Compared to any of the Continental breeds, the Angus will be far superior on marbling. If there is a hefty premium for prime and/or the choice/select spread is significant, the carcass premiums will be much higher for the Angus-sired cattle. Not every Angus would be a good choice as a terminal bull. Look at $B and if a bull is near the top of the breed in that trait, he is an excellent choice as a terminal bull.

When I work with large herds that feed their own calves to slaughter, I often recommend breeding about 40% of the mature cowherd to terminal bulls. A well-managed herd has only a 10 to 18% replacement rate, so they will only need to keep back about 15 to 25 heifers in a 100-cow herd. If 60% of the herd is bred maternal, that gives the owner about 25

to 30 heifer calves born from the maternal sires and ~20 from the terminal sire. Those heifers and their steer mates should all be more valuable as feedlot animals, as compared to the maternal-sired animals that will end up in the feedlot.

Advantages of Hybrid Vigor

The benefits of crossbreeding in beef cattle have been documented for many years. In a 1949 circular from the USDA, Knapp et al reviewed the earliest work.[7]

> *"Black and coworkers (1934) and Rhoad and Black (1943) have reported greater weight-for-age for crosses between the Brahman and breeds of English origin in the Gulf Coast area than for the English breeds. Wentworth (1912) reported a crossbreeding experiment at the Iowa Agricultural Experiment Station in which he concluded that "blue-gray" cattle (crosses between Shorthorn and Aberdeen-Angus or Galloway) have demonstrated their equality or even superiority, as market animals to parent breeds. Deakin and Muir (1935) found that crosses of yak and bison with domestic cattle showed remarkable vigor as expressed by stamina, size and longevity. In swine, Winters and associated (1935) found that the three-breed crosses excelled either the two-breed cross or the purebred breeds in the production of market pigs."*

This is not new news, doctors! In the swine and poultry world, virtually all animals are hybrids. Why are we still debating something that we have known to be true for over 100 years? Have some breeds done a tremendous job of marketing? Are producers 'loyal' to certain breeds? During a webinar on cattle genetics, the participants were asked if a producer used 2 distinct "lines" of the same breed would the resulting offspring display any hybrid vigor. Over 50% of the attendees said "Yes", when the answer is "No"!

Here is the science on the advantages of the crossbred calf:[8]

Trait	Observed improvement	% Heterosis
Calving rate	3.2	4.4
Survival to weaning	1.4	1.9
Birth weight	1.7	2.4
Weaning weight	16.3	3.9
Average daily gain	0.08	2.6
Yearling weight	29.1	3.8
Longevity	1.36	16.2

Crossbreeding advantages of the crossbred cow:[8]

Cow lifetime production	Observed improvement	% Heterosis
Number of calves	0.97	17.0
Cumulative weaning weight	600	25.3

In a study published in 1994, the authors showed that maternal heterosis increased net profit nearly $70/cow/year compared to straightbred cows.[1] In 2018, Dr. Bob Weaber at Kansas State put that figure at $150/cow/year. Therefore, in a 50-cow herd, having 100% crossbred cows could net the owner $7500/year more profit at virtually no extra cost. If your herd owner has slipped into a nearly purebred herd, helping him or her find a complimentary breed for their goals and then retaining those crossbred cows could have a very positive financial impact.

If you are going to be an advisor to your beef cow-calf clients on genetics, you will need to understand the herd owner's goals, be able to examine which traits are important to them and how to use EPDs to make the best mating decision. Adding hybrid vigor is paramount to improving cow longevity and herd profit.

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