EPDs

Understanding Expected Progeny Differences
for Genetic Improvement in Commercial Beef Herds

Carl Dahlen, NDSU Beef Cattle Specialist
Rick Schmidt, Extension Agent, Oliver County
Lauren Hulsman Hanna, Assistant Professor, Animal Sciences Department
Kris Ringwall, Dickinson Research Extension Center Director

The beef seedstock business is large, and commercial beef producers have many opportunities to purchase bulls that meet the criteria established in their breeding plans. Breed selection and type vary considerably, and this diversity helps keep a strong genetic base in the beef business. Current bull buyer selection tools include visual traits evaluated by the buyer, as well as performance and genetic information.

To help producers better understand modern bull-selection opportunities, we will reference the three largest genetic databases: Angus Genetics Inc., a subsidiary of the American Angus Association; International Genetic Solutions, a subsidiary of the Simmental and Red Angus Associations; and American Hereford Association. Although cattle are available in many breeds, these databases include Angus, Hereford, Gelbvieh, Red Angus and Simmental, and concepts from them can be applied easily to other breeds.

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Defining EPDs

Expected progeny differences (EPDs) have been available for more than 30 years, and the application of EPD technology for the genetic improvement of commercial beef cattle can be a key component of meeting current and future beef production demands. This application requires that beef producers establish clear goals for their operation.

Producers also need a critical evaluation of recent calf crops, calving events and subsequent calf production to identify production areas impacted by the selection of breeding bulls and areas for improvement. In addition, producers need to consider feed resources, environmental conditions (terrain, average moisture, etc.) and labor availability to ensure they are selecting the appropriate genetics for their operation.

Producers selling all calves at weaning may prioritize EPDs differently than producers wishing to retain heifers, who may have different priorities than producers wishing to retain ownership through the feedlot. The following is meant to be a short guide to help producers use EPDs appropriately for the selection of breeding bulls that meet their goals.

Expected progeny differences are predictions of the genetic transmitting ability of a parent to its offspring and are used as selection tools. For a given trait, data submitted by producers to breed associations from an animal's actual performance, performance of progeny, performance of other relatives and genomic data (DNA analysis), if available, are all used to calculate EPD values.

Expected progeny differences are numerical predictions based on actual measurements and genomic information for the various traits on the animal or group of related animals. These predictions are refined to provide the best prediction possible to help guide sire selection and are presented in the same units of the trait being measured.

Weight traits are published in pounds, whereas measurement traits such as height, depth, width or scrotal circumference are published as inches (English) or centimeters (metric). Traits that involve subjective scores or values are reported in the same units as were evaluated.

EPD Accuracy

Accuracy (ACC) reflects the precision of a prediction for a given animal's EPD and provides us with a level of confidence for that animal's genetic merit. As more data becomes available for a particular animal, the ACC of an EPD increases. As accuracy approaches 1, the EPDs are more reliable and will change little with additional progeny. Bulls with greater accuracy values may be called "proven sires."

The EPD prediction of genetic merit for a trait is the best indicator of expected performance of future progeny, which is expressed as deviation from the population's base value. Recognizing that base values may be different among breeds is important; some breeds use an average within a specific year, whereas other breeds use a nonspecific historical point.

To improve the accuracy of EPDs for younger bulls, producers may collect and submit DNA samples, which, depending on the trait, typically equates to about 10 progeny records for a sire with no other progeny records contributing to his EPDs. As more progeny data are obtained for a sire, the relative contribution of genomic data to overall EPD accuracy is reduced.

How to Use EPDs

Regardless of which EPDs producers use in bull selection, the basic process of utilizing all EPDs is the same. If one wants to compare two bulls of the same breed, subtract the EPD values of one bull from the other and look at the difference.

The calculations are a simple mathematical equation: Bull A has a weaning weight EPD of plus 52 and bull B has a weaning weight EPD of plus 36, so the calves from bull A should average 16 pounds heavier at weaning than those calves sired by bull B (52 – 36 = 16).

Other traits are the same. If bull A has a yearling weight EPD of plus 99 and bull B has a yearling weight EPD of plus 79, then bull A's calves should average 20 pounds heavier at yearling age than bull B's yearlings (99 – 79 = 20). If a producer chooses to check these numbers by weighing the calves, the results for a given bull may not be exact, but through time, the genetic trend will express the desired selection and the calves will perform as expected.

Which EPDs to Use

A common question producers ask is: "Which EPD values should I use?" The answer depends on the goals and current production status of the producer's herd.

For example, producers who sell the entire calf crop at weaning or following a backgrounding phase could use a fairly simple approach to EPDs. The EPDs to emphasize in this scenario represent the direct impact a bull can have on progeny up to the point of weaning or yearling sale. The following are example EPDs from various breed associations that a producer could use in sire selection:

- **BW** = birth weight – This is the expected difference in birth weight of a bull's progeny expressed as pounds of calf. The greater the number, the heavier the calf will be at birth.
- **CE or CED** = calving ease or calving ease direct – This is the expected difference in percentage of unassisted births from a bull when mated to 2-year-old heifers, with a higher value indicating greater calving ease in first-calf heifers.
- **WW** = weaning weight – This is the expected difference in adjusted weaning weights of a bull's progeny in pounds. The greater the number, the heavier the calves would be at weaning.
- **YW** = yearling weight – This is the expected difference in adjusted yearling weights of a bull's progeny in pounds. The greater the number, the heavier the calves would be as yearlings.

When producers retain replacement heifers, the following EPDs could be used and added to the previous list. The previous EPDs are still important in this scenario, but the following EPDs provide additional insight into milk production, mature cow characteristics and fertility of future offspring:

- **CETM, CEM or MCE** = calving ease total maternal, calving ease maternal or maternal calving ease – This is the expected difference in the percentage of unassisted births of that bull's daughters, with a higher value indicating greater calving ease in first-calf daughters.
- **Milk or MM** = milk or maternal milk – This is the expected difference in the amount of preweaning body weight gained by calves that can be attributed to the milking ability of a bull's daughters. It's expressed in pounds of calf. The greater the number, the more pounds per calf that are added due to milk production of that bull's daughter.
- **TM, MWW, M&G** = total maternal, maternal weaning weight or maternal milk and growth – Each of these terms measures a sire's ability to transmit milk production and growth rate to weaning through his daughters. It is the expected difference in the weaning weight of the sire's daughters' calves, in pounds, calculated as the milk EPD plus half of the WW EPD of that bull.
- **MW, MCW** = mature weight or mature cow weight – These are a predictor of the difference in mature weight of daughters of a sire, expressed in pounds. The greater the number, the heavier you can expect the progeny to be at maturity.

- **ME** = maintenance energy - This indicates differences in mature cow maintenance energy requirements. It is expressed in megacalories per month, with greater numbers indicating that more feed inputs would be required to maintain body condition in progeny.
- **HP, HPG** = heifer pregnancy – This is the expected difference in the probability of female progeny for a bull conceiving as 2-year-olds. Greater numbers are desired if the goal is to have daughters from a bull with a greater probability of being pregnant and calving as 2-year-old heifers.
- **STAY** = stayability – This represents differences in the percent of the probability of a bull's daughters staying productive past the age of 6. The greater the number, the longer you could expect female progeny of a bull to remain in the herd.
- **MH** = mature height – This is a predictor of the difference in mature height of a sire's daughters, expressed in inches. The greater the number, the taller/larger framed the progeny will get.
- **SC or SCR** = scrotal circumference – This is the expected difference in adjusted yearling scrotal circumferences of a bull's progeny, in centimeters.

For producers who retain ownership through the feedlot, several additional EPDs will help with selection. In addition, producers selling calves at weaning or yearling age may benefit indirectly from selecting for carcass traits by creating a reputation of raising high-value calves that are profitable for feedlot owners. Those carcass traits are:

- **CW, HCW** = carcass weight or hot carcass weight – This is the expected difference in adjusted carcass weights of a sire's progeny, expressed in pounds. The greater the number, the more pounds of carcass weight.

- **Fat, BF** = fat or back fat – This is the expected difference in adjusted fat thickness at the 12th rib of a sire's progeny, expressed in inches. Lower numbers indicate leaner carcasses. Greater number indicates a greater fleshing ability of progeny, compared with a lower number.
- **MB, MRB, MARB** = marbling – This is the expected difference in adjusted marbling score of a sire's progeny, expressed in percent. A greater number indicates a greater potential quality grade.
- **YG** = yield grade – It is expressed as the expected difference in the deviation of yield grade units for a bull's progeny. A lower number would move progeny, on average, toward lower numerical yield grades than the population average. Yield Grade 1 equates to more red meat yield, and Yield Grade 5 equates to less red meat yield.
- **SHR** = shear force – This is the expected difference in pounds of force required to shear a steak from a bull's progeny. Lower values indicate less force to cut through a steak, and, therefore, more tender meat.
- **REA or RE** = rib-eye area – This is the expected difference in adjusted rib-eye area of a sire's progeny, measured in square inches. Selecting for larger REA EPD will emphasize heavier muscled progeny.
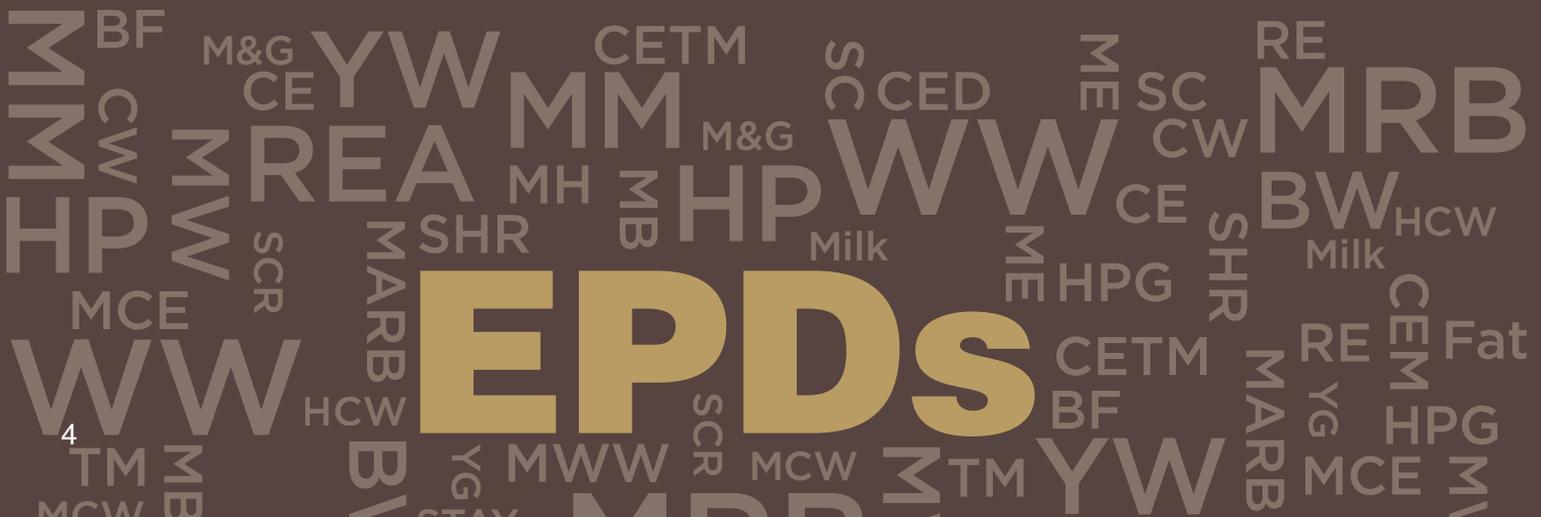
Selection Indices

Some breed associations also offer selection indices designed to match common production goals. Typically, a selection index is formed for a set of traits that have production importance in the industry. Once an index is identified as needed, extensive research investigates individual traits that should be included, collection of those performance records and analysis to determine economic weights for each of the traits involved.

These economic weights create an equation in which EPDs or raw performance records of those traits are used to create a specific selection index. In the cattle industry, these generally are reported as dollar values to indicate the amount of profit or savings the producer could expect when utilizing that index.

Comparing two bulls using a selection index or selection indices is very similar to using EPD comparisons, but it allows a producer to evaluate a single number that combines several traits to meet a focused goal.

Note that indices are listed with specific goals in mind and often are meant for specific breed or type of crossing; some are for producers selling calves at weaning or retaining ownership through the feedlot phase, and others are holistic in nature for producers with long-term herd goals that manage cattle from conception to harvest. To demonstrate the variety of indices available, here are several examples from selected breeds:

American Angus Association

Weaned Calf Value (**$W**), an index value expressed in dollars per head, is the expected average difference in future progeny performance for preweaning merit. $W includes revenue and cost adjustments associated with differences in birth weight, weaning direct growth, maternal milk and mature cow size.

Beef Value (**$B**), an index value expressed in dollars per head, is the expected average difference in future progeny performance for postweaning and carcass value, compared with progeny of other sires.

American Red Angus Association

HerdBuilder Index (HB) is an index using Red Angus bulls mated to cows and heifers, with replacement heifers retained from within the herd and all remaining progeny sold on a quality-based carcass grid. By using the HerdBuilder Index, producers can increase the sustainability of the cowherd and, ultimately, their operation.

GridMaster Index (**GM**) is an index built using the Red Angus bulls mated to cows and all progeny sold on a quality-based carcass grid. The GridMaster Index is for producers whose primary goal is to maximize profitability of feeders in the feedyard and on the rail.

American Simmental Association

All-Purpose Index (**API**) is an index that evaluates sires for use on the entire cow herd (bred to 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 on grade and yield.

Terminal Index (**TI**) is an index that evaluates sires for use on mature Angus cows, with all offspring put on feed and sold on grade and yield.

American Hereford Association

Baldy Maternal Index (**BMI$**) is an index to maximize profit for commercial cow-calf producers who use Hereford bulls in rotational crossbreeding programs on Angus-based cows. Retained ownership of calves through the feedlot phase of production is maintained and the cattle are to be marketed on a certified Hereford beef (CHB) pricing grid.

Certified Hereford Beef Index (**CHB$**) is a terminal sire index in which Hereford bulls are used on British-cross cows and all offspring are sold as fed cattle on a CHB pricing grid. This index places no emphasis on milk or fertility because all cattle will be terminal. This index promotes growth and carcass.

American Gelbvieh Association

$Cow (**$Cow**) is an index of value expressed in dollars for a replacement female relative to other animals in the herd. $Cow includes stayability, reproductive efficiency, milk, calving ease, moderate mature weight, calf gain feedlot feed efficiency and carcass value.

Feeder Profit Index (**FPI**) is an economic selection index designed to aid producers in selecting sires whose progeny will perform in the feedlot and are sold on grade and yield. Well-ranking sires for FPI have higher marbling and carcass weight than their contemporaries.

Across-breed EPD Comparisons

Realizing that each breed may have a different base value for each EPD and the appropriate way to use absolute EPD values is within breed, the US MARC (Meat Animal Research Center) publishes Across Breed EPD (AB-EPD) tables once yearly. The tables provide adjustment factors for each breed to create a common EPD scale for bulls of different breeds. To view the current adjustments, visit http://beefimprovement.org/ and review conference proceedings to see the current year's across-breed EPD tables and further instructions for comparing bulls of different breeds.

Many more aspects of utilizing EPDs are available on the various websites for breed associations. This discussion was not intended to encompass all breeds, all traits or the many other tools available through the breed associations.

Knowing breed averages, percentile rankings and other data associated with the breed can help producers understand how individual bulls rank in comparison with average bulls in the breed. Gaining knowledge about EPDs and other associated data is critical to expand a producer's understanding of the genetic potential of bull offerings and to make an informed bull buyer's bid.

The performance of cattle results from a combination of genetics and the environment. Poor environmental conditions or management decisions quickly can reverse any gains made through selection of high-quality genetics.

EPDs are a tools that you can use to select bulls to fit your operation. Start with a clear vision of what your goals are for a calf crop and the future of your cow herd, then find bulls with the visual appearance and EPDs to match your production goals.

Examples of using EPDs for bull selection:

Table 1. Charolais bulls for use on mature crossbred females.

Bull	CE	BW	WW	YW	MCE	Milk	TM	SC	HCW	REA	Fat	Marb
A	10.5	-5.4	13	27	4.1	19	26	0.6	4	.19	-.009	.04
B	9.0	-2.3	36	62	5.9	6	24	1.4	47	.53	.034	.11
Breed average	3.1	0.7	24.4	43.8	4.0	7.9	20.1	0.6	14.7	0.26	0.002	0.04

Example 1. A producer is looking for a Charolais bull to breed to mature black baldy cows that all have had at least two calves. This is a terminal cross, with all calves being sold at weaning or after a backgrounding period. The producer wishes to maintain calving ease and have the benefit of enhanced weight at the time of sale.

Which bull would you choose based on EPD values?

Considering that these bulls are most likely young and have low accuracies, we would select **Bull B**. To address the specific goals of the producer:

1) Maintain calving ease

In terms of direct calving ease (CE), which relates directly to the bull's pressure on birth weight, Bull B is expected, on average, to have 1.5 percent fewer unassisted births when bred to 2-year-old heifers than Bull A (a disadvantage if breeding to heifers). Bull B also has an expected birth weight that would be heavier, on average, than Bull A.

However, here are two things to consider: Recall that mature baldy females will be used, and we anticipate much less calving difficulty, compared with heifers. In addition, both of the bulls are better than the breed average (BA) for both traits. Therefore, the great majority of emphasis in selecting between these two bulls would be put on WW EPD alone.

2) Enhance sale weight of calves

Bull B would be expected to produce calves that are 23 pounds heavier at weaning, on average, compared with Bull A. Because weight often drives sales and profits, this is a large difference and important to consider. Furthermore, because this is a terminal cross, no heifers will be retained, so maternal calving ease can be ignored.

Table 2. Simmental bulls for use on crossbred Simmental-influenced herd.

Bull	CE	BW	WW	YW	MCE	Milk	MWW	Stay	CWT	REA	BF	Marb
A	18.1	-3.7	56.5	70.8	13.9	35.3	63.4	26.8	5.5	0.8	-0.036	0.08
B	1.1	7	97.4	147.4	6.5	14.7	63.3	15.9	66.9	0.81	-0.047	-0.15
Breed average	8.7	1.9	62.8	91.7	9.4	21.5	52.8	20.5	26.9	0.77	-0.057	0.13

Example 2. A producer is looking for a Simmental bull to breed to his crossbred, Simmental-influenced herd. Cows and heifers are managed as one group during the breeding season. The producer is looking to expand his herd through heifer retention and hopes the bull selected will produce females that calve easily and have the longevity to grow old in the herd.

Which bull would you choose based on EPD values?

In this scenario, emphasis would be put on maternal calving ease, birth weight and, due to management, direct calving ease for heifer retention. First, if the producer wants to produce females that calve easily, then the bulls' maternal calving ease should be compared. **Bull A** is the preferred bull in this scenario because he is expected, on average, to have 7.4 percent more unassisted births in his daughters as 2-year-old heifers, compared with Bull B's daughters.

Considering that bulls in this scenario also will be used on cows and heifers, the direct calving ease EPD also should be considered. Bull A still is preferred in comparison with Bull B because the expectation, on average, is that Bull A will have 17 percent more unassisted births in 2-year-old heifers, compared with Bull B, and, likewise, have calves that are 10.7 pounds lighter at birth, only adding to calving ease ability.

Example 2 (continued on next page)

Example 2 (continued from page 7)

The choice of Bull A is supported further by the stability EPD because the expectation is that, on average, an additional 10.9 percent of this bull's daughters will stay in the herd past age 6, compared with Bull B's daughters, greatly benefiting the producer's longevity goals.

One note: Because steers would be produced and most likely sold, Bull A does not have as heavy calves as Bull B at weaning, but his daughters' calves (total maternal) will be close or equivalent to Bull B's daughters' calves due to the expected milking ability and associated growth (milk EPD).

Because of this, selection for maternal attributes should not be detrimental to growing ability for those calves that will be sold out of the operation. However, this producer should be aware that heavy-milking cows will require higher feed input.

Table 3. Angus bulls for use on straight-bred Angus females.

Bull	CED	BW	WW	YW	CEM	Milk	HP	CW	REA	Fat	MARB	$B
A	1	3.2	71	117	12	24	19	85	0.79	0.051	0.25	112.90
B	-11	4.2	62	111	1	32	17	58	0.99	0.085	0.45	112.93
Breed average	5	1.5	50	89	8	24	10.4	31	0.49	0.015	0.51	104.67

Example 3. A producer is looking for an Angus bull to breed her straight-bred Angus herd. The producer retains ownership through a finishing phase in which cattle are placed on high-concentrate diets. The goal is to develop calves that provide the greatest carcass value.

Which bull would you choose based on EPD values?

To address the producer's goal as stated, we can look solely at the dollar beef value index ($B) because it provides an indication of expected profit based on growth and carcass characteristics. The $B value, however, shows that the two bulls are extremely similar (only $0.03 difference).

With similar $B values, the price likely would drive the decision between the two bulls. If closely priced, this scenario highlights a time when goals need to be more clearly defined to pick the bull that is appropriate for the operation. Specific contributions to greater carcass value (CW, MARB, etc.) need to be identified, prioritized and sought out in potential breeding bulls.

Bull A is expected, on average, to have lighter birthweight calves, compared with Bull B, but those calves are expected to outperform Bull B's calves at weaning and yearling weight (for example, consider their WW and YW EPDs). If the base cow herd is strong in marbling and rib-eye area traits, then perhaps the lighter birthweight and additional growth offered by Bull A make him the better candidate.

On the other hand, Bull B has slightly more desirable EPDs for rib-eye area and marbling than Bull A. If the base cow herd is strong in calving and growth characteristics, then Bull B likely would be the better candidate.

Producers also should consider specific questions regarding whether heifers will be retained in the herd and the relative value the producer wants to put on slightly divergent maternal traits offered by the respective bulls. At the end of the day, possibly the most important factor in buying bulls is appropriately understanding the operation and the operation's goals.

For more information on this and other topics, see **www.ag.ndsu.edu**