



Understanding EPDs and Genomic Testing in Beef Cattle

Expected progeny difference (EPD) accuracy is improved if DNA is available. These calculations are known as a Genomic-enhanced EPD (GE-EPD). This article will walk you through how to use EPDs to improve your beef herd.

Expected progeny differences (EPDs) have been applied to improve the genetics of beef cattle for almost four decades. Expected progeny differences are predictions of the genetic transmitting ability of a parent to its offspring and are used to make selection decisions for traits desired in the herd. For a given trait, EPD values are calculated based on 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).

When DNA information is available, EPD accuracy is improved, and these calculations are referred to as a Genomic-enhanced EPD (GE-EPD). Thus, in addition to pedigree, performance and progeny data, GE-EPDs utilize genomic test for increased reliability of an animal's EPD (Eenennaam and Drake, 2012; Rolf et al., 2014).



Selecting a sire based on desired traits can help you meet the goals for your beef cattle operation.

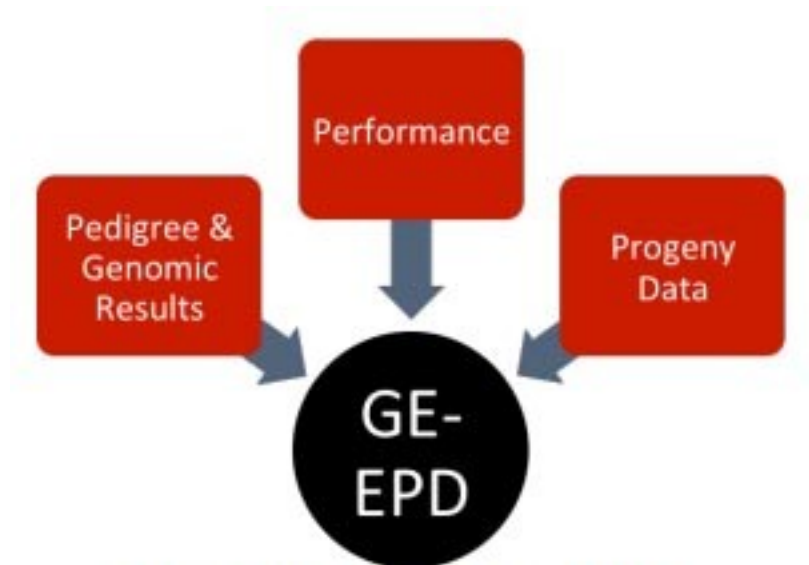


Figure 1. Information contributing to the GE-EPD.

Source: [American Angus Association](#)

Combined with all available sources of information, GE-EPDs are the best estimate of an animal's genetic value as a parent. Genomics permit better accuracies for younger animals and allows a clear picture of genetic traits of interest, especially those that are expensive to measure such as feed efficiency, carcass traits in breeding stock, reproductive traits or maternal traits in bulls.

When a producer buys a young bull that has GE-EPDs, he is buying with the same level of confidence in that animal as one that has already sired between 10 and 36 calves, depending on the trait. In this way, GE-EPDs increase accuracy in those animals much earlier in their lives. With all these benefits, keep in mind that genomically-enhancing the EPDs does not change how the EPD can be used, it just increases its accuracy.

Trait	PE
Calving Ease Direct	26
Birth Weight	23
Weaning Weight	27
Yearling Weight	23
Dry Matter Intake	12
Yearling Height	17
Scrotal Circumference	15
Docility	12
Claw Angle	10
Foot Angle	10
Heifer Pregnancy	17
Calving Ease Maternal	20
Milk	36
Mature Weight	15
Mature Height	9
Carcass Weight	15
Carcass Marbling	11
Carcass Ribeye	17
Carcass Fat	14

Table 1. Progeny Equivalents (PE) – Carcass trait PE equate to actual carcass harvest data, not ultrasound scan equivalents.

Source: American Angus Association (www.angus.org).

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. 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, may equate 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.

The lack of confidence associated with EPDs on young cattle comes from not having progeny or performance data, both of which increase the accuracy of the EPD. In young bulls, for example, most of their genetic value is based on their pedigree. As these animals age and have offspring, we know more and more about their genetic merit. This increased confidence is denoted by an increase in the accuracy value (0–1 scale) associated with each EPD. It does not necessarily mean that the EPD increases if accuracy increases. It just means the EPD becomes closer to the true value, whether it increases or decreases. Remember that EPD stands for expected progeny difference. Genotyping a young animal increases accuracy because SNP genotypes have similar value to evaluating additional progeny.

How to Use EPDs

Before getting started with EPDs, producers should define their specific production goals first and then select based on the EPDs that will best allow them to meet those production goals. For example, producers selling calves at weaning may prioritize EPDs differently than producers wishing to retain heifers or producers wishing to retain ownership through the feedlot. Therefore, producers should use EPDs based on the selection of breeding bulls that meet their personal production goals.

Here are some traits that can be used by those producers who sell the entire calf crop at weaning or following a backgrounding phase:

- Birth Weight (BW);
- Calving Ease (CE) or Calving Ease Direct (CED);
- Weaning Weight (WW);
- Yearling Weight (YW).

Selecting for these traits adds ease to the beef producers daily workload, by attempting to reduce the number of assisted births, while adding sale value (with weight) to those calves that will be sold as feeders.

For producers who retain replacement heifers, the following EPDs are often used in addition to the previous list:

- Calving Ease Total Maternal (CETM), Calving Ease Maternal (CEM) or Maternal Calving Ease (MCE);
- Milk Production (Milk) or Maternal Milk (MM);
- Total Maternal (TM), Maternal Weaning Weight (MWW) or Maternal Milk and Growth (M&G);
- Mature Weight (MW) or Mature Cow Weight (MCW);
- Maintenance Energy (ME);
- Heifer Pregnancy (HP or HPG);
- Stayability (STAY);
- Mature Height (MH);
- Scrotal Circumference (SC or SCR).

These traits are all related to the predicting the success of replacement heifers at becoming valuable dams in the herd.

Producers who raise their own animals through the feedlot will often focus on the traits below, in addition to the maternal traits previously mentioned:

- Carcass Weight (CW) or Hot Carcass Weight (HCW);
- Fat (Fat) or Back Fat (BF);
- Marbling (MB, MRB or MARB)
- Yield Grade (YG);
- Shear Force (SHR);
- Rib-Eye Area (REA or RE).

In this case, the traits selected are value traits for cattle marketed at the end of life.

Example 1 of Using EPDs for Bull Selection

In this example, a producer is looking for a Charolais bull to use on black Angus-influenced cows that have had at least two calves. In this case, the producer is using the Charolais in what is called a terminal cross, all calves being sold at weaning or after a backgrounding period for slaughter. The producer wishes to maintain calving ease and have the benefit of enhanced weight at the time of sale. Based on the table below, which bull would be more appropriate for the stated purpose based on EPD values?

Bull	CE	BW	WW	YW	MCE	MILK	SCR	CW	REA	FAT	MARB
A	11.6	-4	27	58	3.9	23	1.1	20	0.66	0.041	0.18
B	2.9	3	59	99	2.2	1	2.1	49	0.96	0.041	0.22
Breed Average	3.1	0.7	24.4	43.8	4	7.9	0.6	14.7	0.26	0.002	0.04

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

1 Bulls information retrieved from [Select Sires Beef](#) and [Genex](#).

With the focus on this phase of production, emphasis should be given mainly to 3 traits: CE, BW, and WW. We are assuming that these bulls are most likely young and have low accuracies or are not proven.

Calving ease (CE) relates directly to the bull's pressure on birth weight. Bull B is expected, on average, to have 8.7 percent fewer unassisted births when bred to 2-year-old heifers than Bull A (a disadvantage if breeding to heifers). Bull B has an expected birth weight that would be 7 pounds heavier, on average, than Bull A. Thus, while it is clear that Bull A would be more appropriate for breeding heifers, our producer is interested in breeding multiparous cows. Therefore, because bull B has a BW EPD that is only 2.3 lb. heavier than the breed average, the producer likely will want to put their emphasis on other traits. Examination of the WW EPD indicated that Bull B would be expected to produce calves that are 32 pounds heavier at weaning, on average, than Bull A. This difference is what usually drives sales and profits at weaning. Thus, if the producer decides to sell calves at weaning time, Bull B may be the appropriate choice. In addition, while perhaps not as important if the producer sells at weaning, this producer may also want to look at YW and some carcass traits when selecting their bulls. In this case, the logic is that selling high-quality calves at weaning that will perform well around yearling age and through the feedlot may create a reputation of raising high-value calves that are profitable for feedlot owners. Because this is a terminal cross, no heifers will be retained, and maternal traits can be ignored.

Selection by Index

Now, in addition to individual trait selection using EPDs, animals can also be selected on an "index". An economic index is a tool used to select for several traits at once based on a specific breeding objective. An economic index approach considers genetic and economic values as well as the relationships between traits to select for profit. When genetic improvement is desired for several traits that may differ in variability, heritability, economic importance, and in the correlation among their phenotypes and genotypes, simultaneous multiple-trait index selection has been more effective than independent culling levels or sequential selection (Philipsson et al., 1994; Garrick and Golden, 2009).

These are some examples of the economic indices offered by breed associations. Each breed association has many more selection indices and producers are encouraged to investigate these options.

From the American Angus Association (AAA, 2020):

- 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.
- Combined Value (\$C), expressed in dollars per head, is an index that includes all traits that make up both Maternal Weaned Calf Value (\$M) and Beef Value (\$B) with the objective that commercial producers will replace 20% of their breeding females per year with replacement heifers retained within their own herd.

From the American Hereford Association (AHA, 2020):

- 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.
- 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.

From the American Simmental Association (2020):

- 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.

Example 2 of Using EPDs for Bull Selection

A producer is looking for an Angus bull to breed a straight-bred Angus herd. The producer plans to retain ownership of the females to use in the breeding herd and sell the calves at weaning. Thus, maternal traits of the females will be important.

Bull	CED	BW	WW	YW	CW	Marb	RE	Fat	\$M	\$W	\$F	\$G	\$B
A	16	-0.6	68	129	62	1.8	1.11	-0.028	62	79	124	120	244
B	16	-2.5	64	118	32	0.42	0.53	0.046	51	78	69	38	106
Breed Average													
2	3	1	26	45	22	0.42	0.32	0.008	52	54	82	44	126

Table 2. Angus bulls 1 for use on straight-bred Angus females.

1 Bulls information retrieved from [Select Sires Beef](#). 2 Breed average retrieved from [The American Angus Association](#).

To address the producer's goal as stated, we can look at the Maternal Weaned Calf Value (\$M) because it provides an indication of expected maternal ability and profit based on sale of weaned calves. Bull A will produce calves that will profit, on average, \$11 more than Bull B using the \$M. Bull A will be the better buy for this scenario where female retention and weaned calf value are both important.

Across-breed EPD Comparisons

Within a breed, EPDs can be directly compared. Bulls of different breeds can also be compared, but adjustment factors to the EPDs are needed because an EPD from one breed evaluation is not directly comparable to an EPD from another breed evaluation. Since 1993, the U.S. Meat Animal Research Center (USMARC) has produced a table of these adjustment factors so that the merit of individuals can be compared across breeds.

Example 3 of Using EPDs for Bull Selection

In this example, suppose a producer needs to make a decision between a Simmental bull and a Limousin bull to breed his crossbred cow herd. The important traits for him are BW, WW, YW, and Milk.

Bull	CE	BW	WW	YW	Milk	DOC	YG	CW	REA	Marb
Simmental 1	17.1	-3.9	68	95.7	26.3	7.4	-0.22	28.2	0.58	0.35
Limousin 1	14	1.7	61	90	21	8	-0.73	16	1.23	8

Table 3. DEPs from different breeds to use on a commercial crossbred herd.

1 Bulls information retrieved from [Select Sires Beef](#).

With the above information, the producer also needs to access the table below:

Breed	Birth Wt. (lb)	Weaning WT. (lb)	Yearling Wt. (lb)	Maternal Milk (lb)	Marbling Score a	Ribeye Area (in 2)	Fat Thickness (in)	Carcass Wt. (lb)
Angus	0.0	0.0	0.0	0.0	0.00	0.00	0.000	0.0
Hereford	1.4	-16.5	-44.4	-12.5	-0.30	0.02	-0.073	-71.1
Red Angus	2.6	-19.4	-31.4	1.5	-0.03	0.25	-0.040	-13.2
Shorthorn	4.5	-34.4	-46.6	-0.1	-0.07	0.47	-0.032	5.6
South Devon	2.6	-29.9	-55.4	3.1	-0.53	0.64	-0.213	-68.8
Beefmaster	4.0	23.4	1.1	7.7				
Brahman	10.3	53.3	14.4	16.7		0.03	-0.166	-35.9
Brangus	3.1	14.9	5.3	12.9				
Santa Gertrudis	5.2	40.4	39.8	16.8	-0.44	0.12	-0.085	-12.3
Braunvieh	2.2	-21.1	-46.6	4.1	-0.61	1.00	-0.100	-53.4
Charolais	6.6	32.7	23.2	8.1	-0.29	0.79	-0.201	5.1
Chiangus	2.8	-21.1	-36.2	2.5	-0.47	0.59	-0.142	-19.3
Gelbvieh	2.9	-15.5	-27.1	8.2	-0.37	0.66	-0.066	1.5
Limousin	2.5	-16.9	-53.9	-2.4	-0.03	0.59	-0.024	-5.1
Maine-Anjou	2.4	-30.3	-55.2	-7.0	-0.43	0.95	-0.179	-35.1
Salers	0.9	-11.2	-48.0	5.6	0.07	1.08	-0.177	-47.6
Simmental	2.8	-11.6	-19.2	1.8	-0.12	0.45	-0.049	-7.5
Tarentaise	2.7	20.2	-12.1	15.7				

Table 4. Adjustment Factors to Estimate across-breed EPDs.

a Marbling score units: 4.00 = s1°0; 5.00 = Sm00 Source: [US Meat Animal Research Center](#) (2020) through [Beef Improvement Federation](#).

With both tables of information, a table for across breed comparisons can be made, similar to Table 5.

Bull		BW (lb)	WW (lb)	YW (lb)	Milk (lb)
Simmental	EPD 1	-3.9	68	95.7	26.3
	AB Adj. Factors 2	2.8	-11.6	19.2	1.8
	AB-EPD 3	-1.1	56.4	76.5	28.1
Limousin	EPD 1	1.7	61	90	21
	AB Adj. Factors 2	2.5	-16.9	-53.9	-2.4
	AB-EPD 3	4.2	44.1	36.1	18.6

Table 5. Example of using across-breed adjustment factors to convert noncomparable within-breed EPDs to comparable across-breed EPDs.

1 EPDs are the within-breed EPD values from the breed's genetic evaluation for the bull of interest. 2 AB adj. factors are the across-breed adjustment factors from Table 1. 3 Across-breed EPDs after adjustment factors are applied to within-breed EPDs.

The across-breed (AB) adjustment factors for BW are 2.8 lb for Simmental sires and 2.5 lb for Limousin sires. The AB-EPD for that trait is -3.9 lb + 2.8 lb = -1.1 lb for the Simmental bull and 1.7 lb + 2.5 lb = 4.2 lb for the Limousin bull. The expected birth weight difference of offspring when both are mated to cows of another breed (e.g., Angus) would be -1.1 lb - 4.2 lb = -5.3 lb. At weaning, the

Simmental bull will produce heavier calves. This weight difference becomes more evident at yearling age, when the expected yearling weight of the Simmental bull offspring will surpass the Limousin bull offspring by almost 40 lb. On top of that, its daughters will produce, on average, 9.6 lb more milk than the daughters of the Limousin bull. Therefore, the Simmental bull will be easier on heifers (lower birth weight), provide faster growth pre- and post-weaning, and have daughters that produce more milk.

Benefits of Genomic Testing Females

Selecting females for replacement is one of the most challenging aspects of commercial cow-calf production. Also, heifer development is an expensive proposition. Therefore, producers may decide whether a given heifer can be productive and profitable before she has had an opportunity to express productivity associated with profitability, including fertility, calving ease, milking ability, growth and mature size. By using a good breeding strategy and being specific about selection principles, producers can raise the right replacement heifers for the herd to optimize profitability. Genomic testing enables seedstock and commercial beef producers to make more informed decisions, and with more confidence, and to capitalize on animals with superior genetic merit.

Genotyping females can help producers know where their heifers are genetically, so that they will be able to make bull selection with more confidence (Pryce and Hayes, 2012). Focusing on profitability indexes that include health traits, performance, carcass quality, and maternal traits, the commercial herd as well as the pure breed herd will steepen the genetic progress curve and the herd will be more profitable, creating better genetics long term. Genomic testing is that frontier that allows us to get the most value with the least amount of inputs through smart selection pressures.

It is important to keep in mind that success in the cattle business is a function of both genetics and phenotype. The best genetics may still occasionally produce offspring with poor feet and legs that will not hold up well in pasture or feedlot systems. Understanding how and where the herd is excelling and where changes need to be made can help producers make improvements. Keep in mind that single trait selection, selecting, for example, solely on milk production, is usually a disaster. Cattle genetics must be selected to fit the environment and production practices of the operation or the operation they will be marketed to. Know what your market wants and learn how to provide the type of cattle that fit that market by applying appropriate selection principles.

Summary

For seedstock producers, genomic testing is a no-brainer and the way of the future. The adoption of this technology by seedstock producers has already begun to determine their success in the market. For commercial cattlemen, as genomic testing costs continue to drop, genotyping females should become increasingly popular to capture extra value.

Herds with a superior genetic profile have a fundamental advantage over other herds and, in many cases, will outperform their contemporaries over their lifetime. When young animals are part of a genetic improvement program, the use of GE-EPDs on the bull side and genomic testing on the heifer side are critical. Using good selection techniques will allow producers to select and develop the right replacement heifers and consistently mate them to complementary sires to optimize profitability.

Implications

Remember, EPDs need to be used in conjunction with operation goals and resources. Limited available feed may limit how aggressively you select for traits that require a great deal of inputs, and knowing what creates value for your marketplace will result in focusing on traits that are relevant. Your genetic parameters may be different from someone else based on your environment, so focus on your needs. Remember, cattle must still be sound structured and reproductive to last, grow, and reduce your workload. A balanced approach is crucial for a sustainable enterprise, and that includes making sure that your genetics still match your system with desired physical features that will last in your system and meet buyer demand.

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Penn State College of Agricultural Sciences research and extension programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

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Code: ART-6389

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