AN388
https://doi.org/10.32473/edis-AN388-2023

Understanding the Basics of EPDs[1]

Fernanda M. Rezende, Caitlin L. Bainum, Joseph H. Walter, and Timothy W. Wilson[2]

When selecting herd sires, producers often give consideration to color, soundness, structure, body condition, temperament, and genetics. Although expected progeny differences (EPDs) provide an excellent genetic description of a bull, many producers have difficulty understanding what EPDs mean and how to use them to drive the genetic advancement of the herd. The purpose of this publication is to provide basic concepts and practical examples to help beef producers and their advisors make informed selection decisions using EPD information.

What does expected progeny difference (EPD) mean?

Expected progeny difference is the genetic description of a bull derived from data from its calves (progeny), its ancestors, and full and half siblings. The EPD represents the average genetic contribution of a specific bull to its progeny (i.e., what is transmitted from an individual to its progeny) and is expressed in the form of deviations from a reference population.

Half of the genetic material is passed on from parent to progeny through gametes (i.e., sperm and egg cells). Hence, only half of the independent effects of all genes affecting one trait are inherited. However, each offspring receives a random sample of its parent's genes, and some samples are better than others. EPDs are a representation of the average value of an individual's gametes for a specific trait. Therefore, EPDs can also be interpreted as the average value of an individual's contribution to its offspring's performance.

EPD values provide an estimate of how a bull's progeny are expected to perform relative to the progeny performance of a group of animals used as a point of reference in the genetic evaluation. This group of animals, formally called genetic base, has the average of their EPDs set as zero for all traits. Thus, all other EDPs are expressed as deviation from this average, explaining positive and negative EPD values that are reported. For instance, if a particular bull has an EPD of +1.6 lb for birth weight, and we are careful to randomly mate him to a cross section of cows, not just those with especially heavy or light birth weight, we can expect the birth weight of its progeny to average 1.6 lb heavier than the average birth weight of the progeny from the genetic base. The genetic base can broadly be explained as a historic group of animals, such as all evaluated animals born at the onset of a 5- or 10-year period, used as a baseline.

Traits reported by a breed association may vary in number, with new traits added periodically. Typically, EPDs for growth traits such as birth weight (BW), weaning weight (WW), yearling weight (YW), and milk are often reported for beef cattle. Depending on breed, additional traits related to carcass and ultrasound data may also have estimated EPDs.

1. This document is AN388, one of a series of the Department of Animal Sciences, UF/IFAS Extension. Original publication date July 2023. Visit the EDIS website at https://edis.ifas.ufl.edu for the currently supported version of this publication.

2. Fernanda M. Rezende, assistant professor, Department of Animal Sciences; Caitlin L. Bainum, livestock agent, UF/IFAS Extension Marion County; Joseph H. Walter, livestock agent, UF/IFAS Extension Brevard County; and Timothy W. Wilson, production agriculture agent, UF/IFAS Extension St. Johns County; UF/IFAS Extension, Gainesville, FL 32611.

EPDs indicate if a bull's progeny are expected to perform above or below compared to the progeny performance of the average bull in that breed. Breed averages can be expressed as the average of the EPDs of current sires (e.g., registered animals with at least one calf record in the herd book), main sires (e.g., sires with at least 35 yearling progeny weights), and non-parents (e.g., registered animals with no current progeny in the genetic evaluation). They are published by various breed associations at least semiannually.

Notably, EPDs are exceptional tools for comparing and ranking candidates for selection, because the difference between the EPDs of two animals is an estimate of the difference expected to be observed in the performance of their progeny.

How reliable is EPD?

The EPD values are always accompanied by an associated measure of reliability named accuracy. The accuracy value, expressed numerically between zero and one, is a function of heritability and is impacted by the number of progeny and ancestral records available. Therefore, a specific bull has a more reliable EPD for birth weight than for calving ease because birth weight has higher heritability. Likewise, an individual with many progeny has more reliable EPD for any given trait than an individual with few or no progeny. As the number of progeny reported to a breed association increases, the accuracy values will move closer to one.

The accuracy values can be viewed as a percentage. For example, a value of 0.39 could be seen as 39% accurate while a value of 0.98 could be viewed as 98% accurate. A low accuracy value indicates that a sire may be young, or that few calves have been reported to the breed association. As the EPD value is adjusted to more accurately define the genetic capabilities ("true" progeny difference) of the bull, the accuracy values increase. In other words, as additional calves are registered each year, EPD values for a bull are adjusted and the accuracy value increases, which reflects in lower expected change or potential deviation between the EPD and the "true" progeny difference.

Selection must be based on EPD values, and accuracy should be used as a guide to decide how intensively an individual animal should be used in the case of change (up or down) in its EPD value. If accuracy is low (e.g., young bull with few or no progeny), the producer assumes more risk that the animal's EPD is not a perfectly accurate prediction of genetic merit. Nevertheless, good reasons for using young bulls include their higher EPD values and lower cost of the bull or semen from the bull when compared to proven bulls. When selecting young bulls, producers can mitigate the risk by using a larger number of sires and setting a more stringent threshold (e.g., purchasing bulls or semen from bulls in the top 10% of available young bulls). This approach ensures higher accuracy of the EPDs of the group of young bulls than the accuracy of any one of these young bulls' EPDs. In addition, if one young bull is worse than the others, that young bull will sire a smaller fraction of calves. Fine-tuning the selection based on morphological and functional attributes of individuals selected by EPDs is still possible.

How do I use expected progeny difference?

Individual EPD values are negligible, but they are a powerful selection tool when used to compare an individual to its breed average EPDs and to rank candidates for selection. For example, if the EPDs listed in Table 1 for bull A were for an Angus bull, how would it compare to its breed average (Table 2) for birth weight (BW)? How would calves from bulls A, B, and C be expected to perform for birth weight?

Bull A has a BW EPD of +0.6 with 98% accuracy. When comparing the BW EPD of +0.6 to the breed average of +1.2, bull A would be expected to produce calves with lower birth weights than the average bull in the Angus breed (0.6 - 1.2 = -0.6, or 0.6 lb lower than the breed average). Compared to its counterparts B and C, bull A would be expected to produce the heaviest calves at birth. Indeed, bull A is expected to produce calves 1.4 lb and 3.4 lb heavier at birth than bull B [0.6 - (-0.8) = 1.4 lb heavier than bull B] and bull C [0.6 - (-2.8) = 3.4 lb heavier than bull C], respectively.

It is also important to consider the accuracy value, especially when selecting a sire that will breed heifers, since little or no information may be available on the female genetic contribution to the progeny. Bull A has the highest accuracy value for BW, 0.98 or 98%, so it can be anticipated that this bull's progeny will have birth weight differences close to the expected value.

If bull A was a Charolais rather than Angus, the results would differ from those in the first example. Using the same +0.6 BW EPD, which is higher than the Charolais breed average of -0.4, would result in calves from bull A weighing 1 lb more than the mean birth weight of calves from an average bull in the Charolais breed [0.6 - (-0.4) = 1 lb heavier than the breed average].

Genomic-Enhanced EPDs

Proven bulls have more reliable EPDs than young genomic-tested bulls due to a higher number of available progeny records. However, the latter tend to have greater EPD values due to genetic progress over generations. Genomic-enhanced EDPs have become available to the beef industry and provide for unproven bulls the same amount of accuracy as if they had on average 20 progeny records, depending on the trait of interest. This is possible through the incorporation of genomic or DNA test information in the traditional genetic evaluation that uses pedigree and performance records. When evaluating young bulls with low accuracy values and no available genomic EPDs, an alternative is to include EPD information from their sire, dam, and grandsire in the decision-making process with an understanding that ancestral EPDs are not as accurate of a selection tool as genomic EPDs. If available, genomic EPDs provide a more accurate estimate of a young bull's genetic potential as a sire than ancestral EPDs and should be used for animal selection. It is also advised to use a group of young bulls, as the accuracy of the group EPD is greater than the accuracy of each individual bull's EPD. The accuracy of a group of young genomic-tested bulls is given by $Acc = 1 - (1 - average\ acc_i)/n$, where acc_i is the average accuracy of individual bulls and n is the number of bulls in the group. For example, if the average accuracy of individual young bulls is 50%, the accuracy of EPD for a group of 3 bulls is about 83% [1 - (1 - 0.5)/3 = 0.83].

Across-Breed EPD Comparisons

In many operations, producers opt for a crossbreeding program to take advantage of heterosis: performance advantages of the resulting crossbred calf crop compared to the average of the parental breeds. This can present a challenge when utilizing within-breed estimated EPDs for genetic merit comparison of bulls from different breeds because breed associations often use different national evaluation programs and differences exist in the genetic base across breeds. In crossbred operations, producers must be capable of comparing sires across breeds by adding appropriate adjustment factors to the EPD produced in the genetic evaluations for each breed. Across-breed EPD (AB-EPD) adjustment factors were developed to help producers select a sire for their goals with crossbred cattle.

AB-EPD factors are published yearly for 18 different breeds by the U.S. Meat Animal Research Center (MARC) in Clay Center, NE, and made available on the BIF website (www.beefimprovement.org). If the three bulls listed above (Table 1) are Angus, Brahman, and Charolais, respectively, the across-breed adjustment factors (Table 3) can be used to convert noncomparable within-breed EPDs to comparable across-breed EPDs (Table 4).

Remember that EPDs are not perfect when comparing bulls even within a breed; therefore, AB-EPDs are less accurate when comparing animals of different breeds. Many breed associations have adopted an alternative: the implementation of multibreed genetic evaluations, which combines records from purebred and crossbred animals and accounts for direct and maternal heterosis and breed effects. Multibreed genetic evaluations yield more accurate EPD predictions by virtue of data volume and permit direct comparison of EPDs from animals of different breed and breed composition. When EPDs from multibreed evaluations are available, they are the most effective to commercial producers who are comparing and purchasing bulls of more than one breed to use in the crossbreeding system.

Take-Home Message

In summary, EPDs are an excellent means to evaluate the expected genetic potential of a sire. Thus, EPDs are exceptional tools for comparing and ranking candidates for selection. Producers who use EPDs must consider that they are designed to predict expected progeny differences in performance and not actual bull performance. The adjustment factors may serve as a valuable tool for producers to more appropriately compare within-breed EPDs of bulls from different breeds for a crossbreeding program. Multibreed EPDs are the most effective and accurate alternative for comparing the genetic merit of bulls from different breeds or breed combinations.

Table 1. Estimates of EPD and accuracy values.

Animal	BW acc	WW acc	YW acc	Milk acc
Bull A	+0.6 0.98	+60 0.97	+109 0.96	+27 0.95
Bull B	-0.8 0.83	-1 0.85	+1 0.73	+10 0.78
Bull C	-2.8 0.68	+56 0.63	+118 0.58	+38 0.31

BW: Birth weight.
WW: Weaning weight.
YW: Yearling weight.
acc: Accuracy.

Table 2. Breed average EPDs for Angus and Charolais.

Breed	BW	WW	YW	Milk
Angus	+1.2	+59	+105	+26
Charolais	-0.4	+57	+104	+23

BW: Birth weight.
WW: Weaning weight.
YW: Yearling weight.

Table 3. MARC adjustment factors to estimate across-breed EPDs.

Breed	BW	WW	YW	Milk
Angus	0.0	0.0	0.0	0.0
Brahman	9.0	60.2	24.0	12.4
Charolais	6.4	5.5	-23.9	-1.8

Table 4. Example of using across-breed adjustment factors to convert noncomparable within-breed EPDs to comparable across-breed EPDs.

Animal	Breed		BW	WW	YW	Milk
Bull A	Angus	AB adj. factors[1]	0.0	0.0	0.0	0.0
		EPD[2]	+0.6	+60	+109	+27
		AB-EPD[3]	+0.6	+60	+109	+27
Bull B	Brahman	AB adj. factors[1]	9.0	60.2	24.0	12.4
		EPD[2]	-0.8	-1	+1	+10
		AB-EPD[3]	+8.2	+59.2	+25.0	+22.4
Bull C	Charolais	AB adj. factors[1]	6.4	5.5	-23.9	-1.8
		EPD[2]	-2.8	+56	+118	+38
		AB-EPD[3]	+3.6	+61.5	+94.1	+36.2

[1] AB adj. factors are the MARC across-breed adjustment factors from Table 3.
[2] EPDs are the EPD values from within-breed genetic evaluation.
[3] AB-EPDs are the across-breed EPDs after adjustment factors are applied to within-breed EPDs.