Interpretation and Utilization of Expected Progeny Differences

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Expected Progeny Differences (EPD) provide producers with a group of selection tools that specifically address the genetics of the animal. To date, EPD are the best way for producers to predict the relative performance of future progeny for a set of traits. EPD can be a powerful tool for the producer, and with a little knowledge of what each EPD means, they are relatively simple to use.

Statistics Associated with EPD

Calculation of EPD requires a great deal of mathematical equations and computing power. As a by-product of these calculations, many other statistics are computed that are of use to the producer. These are typically shown in the first few pages of sire summaries, prior to the EPD tables. This additional information may at first appear confusing, but with a little explanation, the added information can be of great benefit to the producer.

Breed Averages

Breed average EPD provide a benchmark to compare animals to. Just as the name implies, they are the average EPD for animals included in that run of the genetic evaluation. Many associations will also split the breed averages into those for active proven sires, young sires, dams, non-parents, etc.

Traditionally, breeds had a base year, and the average EPD in the base year was set to zero, so that any difference from zero would correspond to a difference from the average in the base year, not the current year. Recently, however, some breeds have varied from the base year idea, so it is not as easy to determine what an EPD of zero equates to. What is common across all breeds, however, is that zero does not automatically mean breed average. The 2005 breed average EPD for some of the more popular U.S. beef breeds are shown in Tables 1, 2, and 3.

Genetic Trends

Genetic trends show the overall genetic progress for the breed over many years. This is done by plotting the breed average EPD for each year. These trends are typically depicted in graphs similar to the one shown in Figure 1.

Figure 1 depicts a hypothetical genetic trend for weaning weight. It can easily be seen that weaning weight has increased over the past 40 years, most likely due to selection for the trait. It also appears that there has been a stronger emphasis placed on selection beginning in the mid- to late 1980s and continuing through today.

Accuracies

As discussed in the previous chapter, accuracies are a way to determine how reliable an EPD is. Accuracies that are close to 1 indicate that there is more confidence that the EPD value reflects the true genetic worth of an animal for that trait when compared to a lower accuracy.

Table 1. 2005 breed average EPD in the United States for growth traits.[a,b,c]

	Growth							
Breed	**Birth Weight**	**Weaning Weight**	**Milk[d]**	**Yearling Weight**	**Total Maternal[d]**	**Yearling Height**	**Mature Height**	**Mature Weight**
Angus	2.4	37	18	69		0.4	0.5	32
Charolais	1.3	20.3	6.2	35.5	16.4			
Chianina	3.1	30.1	8.5	51.9	23.4			
Gelbvieh	2	41	19	72	39			
Hereford	3.7	37	14	62	33			
Limousin	2.3	36.7	18.2	68				
Maine-Anjou	3.6	41.3	20.1	82.6	40.7			
Red Angus	0.6	31	17	54	32			
Salers	1.1	8.6	7.9	13.1	12.4			
Shorthorn	1.4	16.5	3.1	26.1	11.3			
Simmental	2.5	33.3	5.4	55.9	21.9		0.04	7.1
Tarentaise	1.5	4	1	11	3			

[a] Not all breeds report every trait listed here, and therefore there will be no breed average for some traits in some breeds.
[b] Index values are reported by some breed associations with their EPD values. These are not given here and will be discussed elsewhere in this manual.
[c] Current average of active sires as of September 2005.
[d] Depending on the breed association, Milk may be referred to by a different name, such as Maternal Milk or Maternal; and Total Maternal may be referred to by a different name, such as Maternal Weaning Weight or Milk and Growth.

There is an amount of risk associated with using EPD, and accuracies help to manage that risk. No matter how high the accuracy of an EPD, all parent animals will produce a distribution of progeny performance. Not only do non-genetic effects, such as feed, weather, stress, etc., cause this, but random Mendelian sampling also has an effect. Just by random chance, one calf may get a large proportion of its sire's favorable alleles for a particular trait, and just as randomly, the next calf may get a large proportion of the undesirable alleles. More often, progeny receive some combination of a parent's desirable and undesirable alleles. Because of this, it is impossible for each calf to have the same performance (i.e., it can never be said that every progeny of a bull with a BW EPD of +2 will always weigh 2 lb more at birth than every calf out of a bull with a BW EPD of 0). The EPD predicts the average difference over a large number of progeny.

A bull with a high accuracy will produce a group of calves with just as much variation in performance as a low accuracy sire. What changes with accuracy, however, is how close the EPD is to the actual true genetic potential of the animal. Figure 2 shows calving distributions for two bulls. Bull A (dashed line) is a high

accuracy sire (acc. = 0.95) with a BW EPD of +2.0. Bull B (solid line) is a low accuracy sire (acc. = 0.50) with a BW EPD of -2.0.

As can be seen, because Bull A is a high accuracy sire, his true genetic potential is in a much more narrow range of values than the lower accuracy sire. The next time an evaluation is performed, the likelihood of Bull A's EPD falling below 0 or above 4 is very small. Bull B is a lower accuracy sire, however, so the probability of his EPD changing is larger, as can be seen by his distribution curve. As new data are added and future genetic evaluations are performed, Bull B's could realistically be as low as -10 or as high as +8, although the likelihood of reaching these extremes is small.

Accuracies can be used to evaluate risk. Assume for every other trait, Bull A and Bull B are comparable. Bull B looks more appealing because of his BW EPD, but a producer is leery due to his low accuracy value. The chance of Bull B's true EPD for birth weight being larger than Bull A's is small, even though the accuracy differences are large. Therefore, a producer can feel confident choosing Bull B over Bull A.

Possible Change

No EPD is perfect. Each EPD is the best estimate as to the true breeding value of an animal. The more data that are available for calculation of this estimate, the more accurate the prediction will be, but it will never be 100% perfect. That is why accuracies are used in conjunction with EPD. Possible change is associated with accuracy. The higher the accuracy of an EPD on a particular animal, the less chance there is that it will change as more data are added. With lower accuracies, it is more likely that the EPD will change as more data are added. Because of this, breed associations provide tables of possible change. These tables show how much change should be expected in the EPD based on the current accuracy value.

Figure 1. Genetic trend for weaning weight.

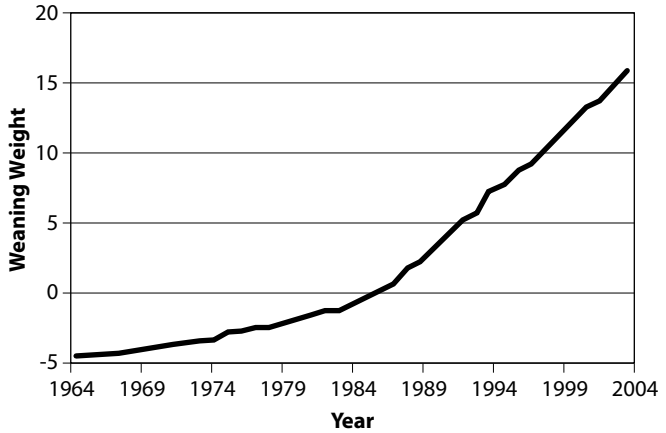


Table 2. 2005 breed average EPD in the United States for carcass traits.[a,b,c]

	Carcass							Ultrasound			
Breed	Carcass Weight	Ribeye Area	Fat Thickness	Marbling	Retail Product[d]	Yield Grade	Tenderness[e]	Percent Intramuscular Fat	Ribeye Area	Fat Thickness	Retail Product[d]
Angus	5	0.13	0	+0.13	+0.09			0.1	0.12	+0.002	0
Charolais	11.2	0.15	-0.003	-0.01							
Chianina	-0.3	0.03	0	-0.11	+0.11						
Gelbvieh	1	0.07	+0.00	-0.03							
Hereford								0	0.07	+0.001	
Limousin	12.8	0.11		-0.02		0.02					
Maine-Anjou	6.8	0.22	0	+0.18	+0.30						
Red Angus		0	0	+0.06							
Salers	12.1	0.01	0	-0.1	0.0						
Shorthorn	-3	0	0.00	-0.03	-0.02		0				
Simmental	-3	0	0	+0.06		0	0.01				
Tarentaise											

[a] Not all breeds report every trait listed here, and therefore there will be no breed average for some traits in some breeds.
[b] Index values are reported by some breed associations with their EPD values. These are not given here and will be discussed elsewhere in this manual.
[c] Current average of active sires as of September 2005.
[d] Depending on the breed association, Retail Product may be referred to by a different name, such as Percent Retail Cuts or Percent Retail Yield.
[e] Tenderness is also referred to as Warner Bratzler Shear Force.

Table 3. 2005 breed average EPD for breeds in the United States.[a,b,c]

	Reproduction					Other		
Breed	Scrotal Circumference	Gestation Length	Calving Ease Direct	Calving Ease Maternal[d]	Heifer Pregnancy	Stayability	Maintenance Energy	Docility
Angus	0.33		4	6				
Charolais	0.49							
Chianina								
Gelbvieh	0.4	-1.3	103	104		4		
Hereford	0.6		-0.2	0.5				
Limousin	0.2		5.2	2.4		15.7		12.5
Maine-Anjou								
Red Angus			4	4	8	10	4	
Salers	0.2					17.7		0.8
Shorthorn								
Simmental			6.8	2.5		7.9		
Tarentaise			0	1				

[a] Not all breeds report every trait listed here, and therefore there will be no breed average for some traits in some breeds.
[b] Index values are reported by some breed associations with their EPD values. These are not given here and will be discussed elsewhere in this manual.
[c] Current average of active sires as of September 2005.
[d] Depending on the breed association, Calving Ease Maternal may be referred to as Calving Ease Daughters.

Figure 2. Probability of the true EPD value for two bulls differing in accuracy.

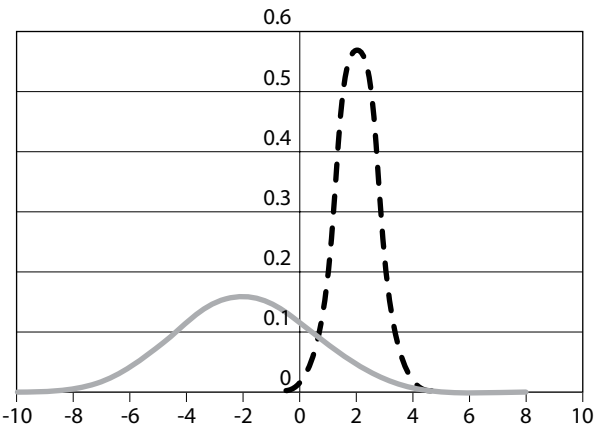


Table 4 shows an example of a typical, but hypothetical, table of possible change.

In this case, if a bull had a birth weight EPD of +2.5 with an associated accuracy value of 0.90, it can be expected that his EPD for birth weight could change by 0.89 lb the next time an evaluation is run. This means that his EPD could be anywhere from 1.61 lb (2.50 – 0.89) to 3.39 lb (2.50 + 0.89) when EPD are calculated again. As accuracy increases, this range will decrease. Additionally, as the magnitude of a trait increases, the range will also increase. For example, the range for birth weight at 90% accuracy is +/- 0.89 lb, but for weaning weight, it is +/- 2.24 lb and for yearling weight, it is +/- 3.05 lb.

Possible change is not a guarantee that an animal's EPD will be within the specified range but is an expectation that it will be within this range approximately two-thirds of the time. Approximately one-third of the time, it can be expected that the change in the EPD will be more extreme than the predicted possible change.

Percentile Ranks

Breed associations also provide percentile ranks for their animals. These charts are a way to see how a specific animal compares with others in the breed. Similar to the way national test scores are reported on children in schools, these percentile ranks indicate what proportion of animals have an EPD that is better than a given value. Breed average EPD are always the 50th percentile.

Because they are based on how many animals perform better than a specific EPD value, those animals with the highest rankings do not always have the largest numerical EPD values. For instance, for birth weight, animals with a lighter birth weight are thought to be more desirable. Therefore, the animals ranked in the top percentages will have negative EPD. However, higher values are thought to be more desirable for other weight traits, such as weaning and yearling weight, which means that the animals listed at the top percentages have the highest EPD for those traits.

Table 5 shows a hypothetical table of percentile ranks. If a bull has a weaning weight EPD of 51.6 lb, it can easily be seen that he is in the top 10% of the breed. Animals with weaning weight EPD of 51.3 lb are in the 90th percentile, meaning 10% of the breed ranks higher. If that same bull had a yearling weight EPD of 111.2, only 2% of the breed would rank higher for yearling weight.

In addition to the percentile tables, the American Hereford Association provides producers with an added tool to compare animals with the rest of the breed. They provide a graph for each animal that shows how that animal compares to the rest of the breed for all traits evaluated. A similar, but abbreviated, graph is shown in Figure 3.

On the left-hand side of the graph are listed the traits that are being evaluated, and the right-hand side shows which direction is the favorable direction for each EPD (i.e., lighter birth weights are better, while heavier weaning weights are better). Each bar shows where the animal in question places among the rest of the breed. Bars that reach to the left indicate below average, and bars that reach to the right indicate above average. The longer the bar, the farther from breed average, whether that be better or worse.

Table 4. Possible change.

Accuracy	Birth Weight	Weaning Weight	Yearling Weight	Milk
0.05	4.24	17.02	24.76	14.3
0.1	4.04	16.15	23.48	13.6
0.15	3.85	15.28	22.21	12.9
0.2	3.65	14.41	20.93	12.1
0.25	3.46	13.54	19.66	11.4
0.3	3.26	12.68	18.38	10.7
0.35	3.07	11.81	17.09	9.95
0.4	2.87	10.94	15.82	9.23
0.45	2.66	10.07	14.54	8.5
0.5	2.47	9.20	13.27	7.78
0.55	2.27	8.33	11.99	7.04
0.6	2.08	7.46	10.72	6.32
0.65	1.88	6.59	9.44	5.59
0.7	1.69	5.72	8.17	4.87
0.75	1.49	4.85	6.89	4.13
0.8	1.30	3.98	5.60	3.41
0.85	1.09	3.11	4.33	2.68
0.9	0.89	2.24	3.05	1.96
0.95	0.70	1.37	1.78	1.22

Table 5. Percentile ranks.

Top Percent	Birth Weight	Weaning Weight	Yearling Weight	Milk
1%	-4.4	69.3	120.2	33.6
2%	-3.6	63.8	111.2	31.2
3%	-3.0	60.9	105.5	29.3
4%	-2.6	58.5	101.4	27.8
5%	-2.2	56.7	98.3	27
6%	-2.0	55.7	96.0	26
7%	-1.7	54.3	93.8	25.1
8%	-1.5	53.3	91.7	24.5
9%	-1.3	52.2	89.9	23.9
10%	-1.2	51.3	88.5	23.1
15%	-0.6	47.6	81.5	20.9
20%	0.0	44.9	76.7	18.8
25%	0.3	42.3	72.2	17.3
30%	0.7	40.2	68.0	15.8
35%	1.0	38.1	64.7	14.4
40%	1.3	36.3	61.5	13.2
45%	1.6	34.4	58.4	12
50%	1.8	32.3	55.4	11
55%	2.1	30.3	52.4	9.9
60%	2.4	28.5	49.1	8.7
65%	2.7	26.6	45.6	7.5
70%	3.0	24.5	42.2	6.2
75%	3.4	22.2	38.3	5
80%	3.8	19.5	33.9	3.3
85%	4.2	16.4	28.5	1.5
90%	4.8	12.2	21.2	0
95%	5.8	5.4	10.4	-3.9
100%	15.8	-30.2	-50.7	-31.5

Figure 3 shows that the animal depicted is above average for weaning and yearling weight and below average for birth weight and milk. Approximately 90% of the animals in the breed have birth weight EPD that are better (lighter) than the animal depicted in this graph. Furthermore, only about 19% have better (heavier) weaning weights, about 70% have higher milk EPD values (production scenario determines if this is better or worse), and about 17% have better (heavier) yearling weight EPD.

Heritabilities and Genetic Correlations

Heritabilities are a measure of how much genetic influence there is on a particular trait. Heritability is a value between 0 and 1, and the higher the number, the more genetic influence there is on that trait. This value is critical in calculations of EPD.

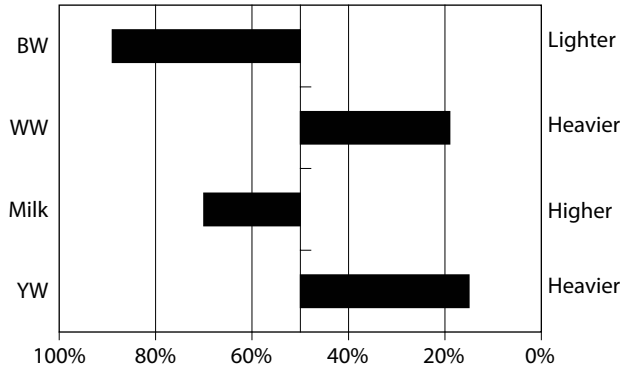
Genetic correlations are important in multiple-trait analyses. These values can range from -1.0 to +1.0. When two traits are correlated, having information on one trait will aid in the calculation of EPD for the other trait. For instance, yearling weight and yearling height are often calculated together in multiple-trait analyses. Even if an animal has no yearling height measurement, knowledge of its yearling weight will provide information for the yearling height EPD. The more extreme the correlation (the closer it is to -1 or +1), the more information one trait will provide for the other trait.

Types of EPD

Theoretically, an EPD can be developed for any quantitative trait (a trait where the phenotype can be measured on a numerical scale). Because of this, there are numerous EPD that are currently being calculated for different breeds of beef cattle and more in development. The EPD described here are those that are currently reported in the United States. Other traits, such as 400- and 600-day weights, are common in other countries but will not be discussed here.

In most cases, these EPD are reported in the same units as they are typically measured (i.e., birth weight is reported in pounds of birth weight), but in a few cases the units are less obvious. The units for each type of EPD are described in the paragraphs that follow.

Figure 3. Percentile ranking of a hypothetical bull.



Both bulls and heifers/cows can have calculated EPD, but EPD are most often associated with bulls. This is mainly because:

- bulls have more progeny than cows and therefore usually have higher accuracy values;
- there is more opportunity for selection among males than among females, so EPD are of more use in bulls; and
- bulls contribute more, genetically, to the herd because, as females are retained, the sires of these females are contributing half of their genetics to the cows.

Because of this, in the paragraphs that follow, EPD will be described in terms of bulls, but keep in mind that the same EPD are available on cows and could be used for female selection.

It is important to keep in mind the specific production scenario that animals are being selected for and only use those EPD that are important to that scenario. If a trait is not important to the specific production scenario or the production scenario of the customer, that EPD should not be considered in selection decisions.

For the most part, traits can be grouped into three main groups: growth, reproduction, and carcass traits.

Growth Traits

The earliest developed EPD for beef cattle were for birth weight, weaning weight, yearling weight, and milk. These are still the standard EPD that are calculated for all breeds that conduct genetic evaluations. Even those breeds that have genetic evaluations and that report no other EPD still report birth weight, weaning weight, yearling weight, and milk.

Birth Weight: The birth weight EPD indicates the weight of a bull's calf at birth and is used as an indicator of the probability of dystocia when that calf is born. Because birth weight EPD is expressed in pounds of birth weight, higher birth weight EPD values indicate larger calves that could result in more calving difficulty. It is normally recommended to use low birth weight EPD sires, especially when breeding heifers.

Weaning Weight: The weaning weight EPD is measured in pounds of weaning weight and predicts the weight of a bull's calf at weaning. Because producers selling calves at weaning are usually paid solely by pounds of calf, a higher value is more desirable.

This EPD may be of little value for producers retaining ownership of calves beyond weaning, except for its correlated response to general growth, i.e., yearling weight and mature weight.

For producers selling calves at weaning by the pound, this is one of the most important EPD to consider when making selection decisions.

Milk: The milk EPD is actually a by-product of the weaning weight EPD. The milk EPD is the maternal portion of weaning weight that is thought to be mainly due to the milk production of the dam. Because of this, the milk EPD is measured in pounds of weaning weight of a bull's grandprogeny due to the milk production of the bull's daughters.

In areas where feed resources are abundant, selection for increased milk EPD should not be a problem, but in areas where resources are limited and females are retained, care should be taken not to use bulls with high milk EPD. This is because a high milking female will require more feed energy for lactation and have less energy available to put on the condition necessary to rebreed.

This EPD is of no use in terminal mating systems in which heifer replacements are not retained because this predicts the weaning weight of the grandprogeny.

Depending on the breed association reporting the values, sometimes the milk EPD is referred to as the maternal milk, milking ability, maternal, or maternal traits EPD.

Yearling Weight: The yearling weight EPD is measured in pounds of yearling weight and predicts the weight of a bull's progeny at one year of age. Typically, a larger value is better.

This EPD is of use if calves are going to be retained beyond weaning. For production scenarios where calves are sold at weaning or at some point before yearling, this EPD has little value as a prediction of yearling weight; however, its correlation with weaning weight and mature weight (if heifers are retained) can make it valuable.

More recently, other growth-related EPD have been developed by some breed associations. These are not reported by all associations.

Total Maternal: Like milk, total maternal EPD are expressed in terms of weaning weight of a bull's daughter's calves. The EPD is calculated by taking half of the weaning weight EPD and adding the entire milk EPD. This accounts for the half of the weaning weight genetics that the grandprogeny will receive from its dam (the other half will come from the calf's sire) and all of the milk production of that calf's dam. Because this is an indicator of weaning weight (of grandprogeny), a higher value is better, similar to the weaning weight EPD.

Because this EPD is used to predict the performance of the bull's grandprogeny, this EPD is of no use if heifer calves are not being retained as replacements.

Depending on the breed association, this EPD is also referred to as the maternal weaning weight, maternal milk and growth, or milk and growth EPD.

Yearling Height: Yearling height EPD were developed as a frame size selection tool. This EPD is reported in inches of hip height at one year of age. Although intermediate values are usually more desirable, this EPD could also be used to increase the size so that a herd with mainly small-framed cattle can become more moderate.

This EPD is useful for both terminal production systems and those systems where heifers are kept as replacements. Taller calves can be expected to take a longer amount of time on feed in order to reach the Choice grade. For replacements, yearling height is highly correlated with mature height, and this EPD could be used as an indicator for mature size.

Mature Height: Similar to yearling height, the mature height EPD was also developed as a frame size selection tool. In theory, selection for shorter cows will result in cows that require less feed inputs for maintenance. Therefore, this EPD, which is reported in terms of inches of hip height at maturity, could be used as an indicator of the amount of energy required to maintain heifer calves once they reach maturity.

As a prediction of mature height, this EPD is of no use in a terminal situation where replacements are not retained. It is, however, useful as an indicator of yearling height due to the high genetic correlation between the two traits.

Depending on the breed, this EPD is sometimes referred to as the daughter height EPD.

Mature Weight: The mature weight EPD is another indicator for maintenance energy requirements. In theory, when a cow weighs more, she should be expected to require more feed energy in order to maintain herself. Mature weight is reported in terms of the pounds of mature weight of a bull's daughters and is usually selected for reduced size.

If replacement females are not retained, this EPD is not necessary in a selection program.

Depending on the breed, this EPD is sometimes referred to as the daughter weight EPD.

Reproductive Traits

In addition to growth traits, breed associations have also placed an emphasis on developing EPD for reproductive traits. These traits vary from association to association and are listed below.

Scrotal Circumference: Scrotal circumference is another indicator trait. The EPD for this trait is used as an indicator for the age at puberty, and consequently, heifer pregnancy of a bull's granddaughters. In theory, the larger a bull's scrotal circumference, the earlier his daughters will reach puberty. Therefore, the EPD can be used to select for the scrotal circumference of a bull's sons with implications on the daughters of those sons. The scrotal circumference EPD is expressed in centimeters with a larger number being more desirable.

This EPD is of use only in situations in which heifers are retained as replacements.

Gestation Length: Similar to birth weight, the gestation length EPD is another indicator of the probability of dystocia. This EPD is reported in terms of days in utero of a bull's calves. The longer a calf is in utero, the more that calf will weigh at birth and the higher probability of dystocia. This EPD is also used to provide cows with a longer postpartum interval before having to be rebred for the next year's calf. Therefore, the gestation length EPD with smaller values are more desirable.

Calving Ease Direct: The calving ease EPD, both direct and maternal, are the economically relevant traits (ERT) that indicator traits, such as birth weight and gestation length, are attempting to predict. calving ease direct EPD are a measure of the ease at which a bull's calves will be born. This has to do mainly with size and shape of his calves. Calving ease direct EPD are calculated using information from calvings of two-year-old females only (no older calvings are included) and the birth weight information of the bull's progeny (Speidel et al., 2003). In most cases, this EPD is reported as a percentage so that a higher value indicates a higher probability of unassisted calving but is sometimes also reported in ratio form (i.e., 104 versus 4%).

Calving Ease Maternal: Similar to the calving ease direct EPD, the calving ease maternal EPD is also an ERT for unassisted calving. Contrary to calving ease direct EPD, however, the calving ease maternal EPD predicts the probability of a bull's daughters calving without assistance. This EPD is also expressed in terms of percentages with a higher value indicating that the bull's daughters are more likely to deliver a calf unassisted.

Like other EPD that are related to a bull's grandprogeny, this EPD is of no use unless heifers are retained as replacements.

Depending on the breed association, this EPD is sometimes referred to as the calving ease daughters EPD.

Heifer Pregnancy: Heifer pregnancy is an ERT that indicator traits, such as scrotal circumference, predict. Heifer pregnancy EPD report the probability that a bull's daughters will conceive to calve at two years of age. This EPD is also reported in percentages where a higher value indicates progeny with a higher probability of conceiving to calve at two years of age.

Carcass Traits

Carcass traits are another group of traits that have begun to be included in genetic evaluations. These EPD are calculated on an age endpoint as if all cattle were slaughtered at a specific age. Some breed associations report carcass EPD only, some report ultrasound EPD only, and some report both. Even if an association reports only one type of EPD (i.e., carcass), both ultrasound and carcass information may go into the calculation of those EPD because of the genetic correlation between the traits.

For producers who are selling calves based strictly on weight with no premiums for carcass traits and not selling seedstock to customers concerned with carcass traits, both carcass and ultrasound EPD are of limited benefit in selection schemes.

Carcass EPD: Carcass EPD predict the genetic differences of animals on the rail.

Carcass Weight: Carcass weight EPD report the expected carcass weight, in pounds, of a bull's progeny when it is slaughtered at a constant age so that producers can select cattle that will produce calves within a certain weight range in order to avoid discounts. There is no ultrasound equivalent to this EPD.

Ribeye Area: Ribeye area EPD are reported in square inches and indicate the area of the longissimus muscle between the 12th and 13th ribs (Boggs et al., 1998) of a bull's offspring when slaughtered at a constant age. Although bigger is usually better, some grids may discount for ribeyes that are too large. The ultrasound equivalent to this EPD is the ultrasound ribeye area EPD.

Fat Thickness: This EPD is measured in inches as the prediction of the 12th rib fat thickness of a bull's progeny when slaughtered at a constant age.

A lower value is better to an extent. However, for breeds that are naturally lean, selecting against fat may result in progeny that are too lean, and consequently carcass quality is reduced.

Depending on the breed association reporting the estimates, the fat thickness EPD is also sometimes referred to as the backfat EPD or just simply the fat EPD.

Marbling: The marbling EPD indicates the marbling of the ribeye of a bull's progeny when slaughtered at a constant age. Table 6, adapted from the Beef Improvement Federation's Guidelines (BIF, 2002), shows how breed associations code marbling scores for analysis.

For most breeds, marbling EPD values range from -0.50 to +0.50, which directly corresponds to the scale in Table 6. This means that the difference in marbling expected between the progeny of a bull with a +0.50 and a bull with a -0.50 would be a full grade (i.e., Low Choice to Average Choice or Select to Low Choice).

The ultrasound equivalent to this EPD is the percent intramuscular fat EPD.

Retail Product: This EPD is a prediction of the salable meat that the carcass of the progeny of an animal will yield. It is roughly equivalent to the yield grade EPD because it takes into consideration the same component traits: fat thickness, hot carcass weight, ribeye area, and percentage kidney, pelvic, and heart fat but weighs each component slightly different than for yield grade.

The retail product EPD is expressed in percentage units with a higher value indicating that a greater proportion of the carcass is in the form of salable meat. The ultrasound equivalent to this EPD is the ultrasound retail product EPD.

Depending on the breed association, this EPD is also called retail yield percent, percent retail, percent retail product, percent retail cuts, or retail beef yield percentage.

Yield Grade: Similar to the retail product EPD, the yield grade EPD are a measure of lean meat yield of the carcass. All of the same component traits are included in yield grade as in retail product, but each is weighted differently than for retail product.

Although retail product is expressed in percent, yield grade is expressed in grade units. The lower the grade, the leaner the carcass, in contrast to retail product where higher values indicate a higher percentage of retail cuts. An animal receiving a calculated yield grade of 1.0 – 1.9 is a Yield Grade 1, an animal receiving a calculated yield grade of 2.0 – 2.9 is a Yield Grade 2, etc. The highest yield grade is 5, so any animal receiving a calculated yield grade of 5.0 or more is classified as a Yield Grade 5.

There is currently no ultrasound equivalent to the yield grade EPD.

Tenderness: The tenderness EPD is measured in pounds of Warner Bratzler Shear Force so that a higher value indicates that more pounds of shear force are required to cut through the meat. Therefore, a lower value indicates more tender meat and is more desirable.

There is no ultrasound equivalent to the tenderness EPD.

Ultrasound EPD: Ultrasound EPD predict differences at ultrasound, which is an indicator of the carcass traits when it is on the rail.

Percent Intramuscular Fat: The ultrasound equivalent of the marbling EPD is the percent intramuscular fat EPD. Like the carcass marbling EPD, a higher value indicates more marbling and is generally more desirable.

Table 7, adapted from the BIF Guidelines (BIF, 2002), shows how marbling score and intramuscular fat percentage are related to one another.

Table 6. Codes for various marbling levels.

Quality Grade	Marbling Amount	Marbling Score
High prime	Abundant	10.0-10.9
Average prime	Moderately abundant	9.0-9.9
Low prime	Slightly abundant	8.0-8.9
High choice	Moderate	7.0-7.9
Average choice	Modest	6.0-6.9
Low choice	Small	5.0-5.9
Select	Slight	4.0-4.9
High standard	Traces	3.0-3.9
Low standard	Practically devoid	2.0-2.9

Adapted from BIF, 2002.

Table 7. Marbling scores and the equivalent percent intramuscular fat.

Marbling Score	Intramuscular Fat %
Slightly Abundant	10.13
Moderate	7.25
Modest	6.72
Small	5.04
Slight	3.83
Traces	2.76

Unlike the carcass marbling EPD, this EPD is measured in percentages.

Ribeye Area: The ultrasound ribeye area EPD is the ultrasound equivalent to the carcass ribeye area EPD. The ultrasound version is measured the same, in square inches, and it is also generally more desirable to have a higher value.

Fat Thickness: The ultrasound fat thickness EPD is comparable to the carcass fat thickness EPD and has the same limitations. In most cases, it is more desirable to select for less fat at the 12th rib, but selection to extremes can result in decreased carcass quality. Like the carcass equivalent, this EPD is measured in inches.

Retail Product: Similar to its carcass version, the ultrasound retail product EPD combines several component traits to determine the amount of salable meat in the carcass. A higher value indicates a higher proportion of the carcass is in the form of salable meat. This is measured in percent, like its carcass equivalent, but uses the ultrasound component traits.

Other Traits

A few traits do not fit into the general categories of growth, reproduction, or carcass. These, mostly having to do with characteristics expressed by cows, are described below.

Stayability: Stayability is an indicator of longevity of a bull's daughters in the cow herd. This EPD is reported in percent and predicts the probability that a bull's daughters will remain in the herd through six years of age. The higher the EPD value, the higher the probability that the bull's daughters will remain in the herd through six years of age.

Because this EPD is used to predict the longevity of a bull's daughters, it is of no use if replacements are not going to be retained.

Maintenance Energy: The maintenance energy EPD is a predictor of the energy needed for a cow to maintain herself. Daughters of bulls with lower maintenance energy EPD values will require less feed resources than will daughters of bulls with higher values. Therefore, it is beneficial to select bulls with lower maintenance energy EPD values. Maintenance energy EPD are measured in terms of megacalories per month.

This EPD is of no use if heifer calves are not retained as replacements.

Docility: Docility EPD are a measure of the behavior of a bull's calves as they leave the chute. Animals are evaluated by producers on a scale of 1 to 6, with 1 meaning docile and 6 indicating extremely aggressive behavior. Docility EPD are reported as percentages so that animals with a higher docility EPD value will have a higher probability of producing calm animals (Speidel et al., 2003).

Pulmonary Arterial Pressure: Pulmonary arterial pressure EPD also provide another indicator for longevity in the cow herd. Animals with higher pulmonary arterial pressure are more susceptible to brisket (or high mountain) disease. Pulmonary arterial pressure EPD are measured in millimeters of mercury with a lower value being more desirable.

Similar to stayability, because this EPD is an indicator of longevity, it is of no use in strictly terminal situations where heifer calves are not retained. This EPD is also not necessary for cattle that are not going to be in high elevations.

The pulmonary arterial pressure EPD is not routinely calculated by any breed association but is calculated, by request, for some individual producers.

Summary

Table 8 shows the traits that are reported by many of the breed associations in the United States.

Expected Progeny Differences provide producers with useful tools for their selection decisions. Although they are very useful, there is a lot of information to sort through based on the breed and production scenario in question. Care should be taken to narrow down the information to only those values that are pertinent to the production situation that cattle are being selected for.

Literature Cited

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Speidel, S.E., R.M. Enns, D.J. Garrick, C.S. Welsh, and B.L. Golden. 2003. Colorado State University Center for Genetic Evaluation of Livestock: Current approaches to performing large-scale beef cattle genetic evaluations. Proc. West. Sec. Amer. Soc. Anim. Sci. 54:152-158.

Table 8. Current EPD available from breeds in the United States.

	Growth								Reproduction					Carcass							Ultrasound				Other		
Breed	**Birth Weight**	**Weaning Weight**	**Milk**	**Yearling Weight**	**Total Maternal**	**Yearling Height**	**Mature Height**	**Mature Weight**	**Scrotal Circumference**	**Gestation Length**	**Calving Ease Direct**	**Calving Ease Maternal**	**Heifer Pregnancy**	**Carcass Weight**	**Ribeye Area**	**Fat Thickness**	**Marbling**	**Retail Product**	**Yield Grade**	**Tenderness**	**Percent Intramuscular Fat**	**Ribeye Area**	**Fat Thickness**	**Retail Product**	**Stayability**	**Maintenance Energy**	**Docility**
Angus	x	x	x	x		x	x	x	x		x	x		x	x	x	x	x			x	x	x	x			
Blonde d'Aquitaine	x	x	x	x	x				x																		
Beefmaster	x	x	x	x	x				x																		
Brahman	x	x	x	x																							
Brangus	x	x	x	x	x				x												x	x	x				
Braford	x	x	x	x	x																						
Braunvieh	x	x	x	x	x						x	x															
Charolais	x	x	x	x	x				x					x	x	x	x										
Chianina	x	x	x	x	x									x	x	x	x	x									
Gelbvieh	x	x	x	x	x				x	x	x	x		x	x	x	x								x		
Hereford	x	x	x	x	x				x		x	x									x	x	x				
Limousin	x	x	x	x					x		x	x		x	x		x		x						x		x
Maine-Anjou	x	x	x	x	x									x	x	x	x	x									
Red Angus	x	x	x	x	x						x	x	x		x	x	x								x	x	
Red Brangus	x	x	x	x	x																						
Romagnola	x	x	x	x	x																						
Salers	x	x	x	x	x				x					x	x	x	x	x							x		x
Santa Gertrudis	x	x	x	x	x																						
Senepol	x	x	x	x	x				x																		
Shorthorn	x	x	x	x	x									x	x	x	x	x		x							
Simmental	x	x	x	x	x		x	x			x	x		x	x	x	x		x	x					x		
Tarentaise	x	x	x	x	x						x	x															