Understanding EPDs and Accuracies

Expected Progeny Differences (EPDs)

Expected Progeny Differences (EPDs) are used to compare the genetic merit of animals in various traits. An EPD predicts the difference in performance of future offspring of a parent, as compared to progeny from other parents, when each are bred to mates of equal value.

Remember, the observed performance of an animal is determined by both genetics and environment, and EPDs only predict differences due to genes passed on from parent to offspring.

Another fundamental concept of interpreting EPDs is to recognize that EPDs serve to rank animals. By comparing an animal's EPD for a given trait to the average EPD of all animals, one can determine if the animal is above or below average. Further, by familiarizing yourself with the percentile ranking table, you can determine the degree to which an animal is above or below average for a given trait.

Calving Ease Direct and Maternal EPDs

The Limousin breed has an excellent reputation for calving ease and associated calf vigor and survivability. But even low levels of calving difficulty can mean increased veterinary and labor costs, calf death loss, calf susceptibility to disease, cow mortality, delayed return to estrus and lower conception rates. While birth weight EPDs are useful indicators of potential calving ease, NALF's EPDs for calving ease direct and maternal can help users of Limousin genetics more effectively select for higher levels of calving ease in replacement heifers.

Higher calving ease EPDs are favored and indicate genetics for greater chances of unassisted births in first-calf heifers. The calving ease direct (CED) EPD is important for choosing which sires to breed to first-calf heifers to produce calves that are born easily. The calving ease maternal (CEM) EPD is important for choosing sires that produce replacement heifers that give birth to their first calf easily.

Consider the following two sires for use on first-calf replacement heifers and their CED EPDs:

	CED EPD
Sire A	+5%
Sire B	–5%
Difference	10%

When sires A and B are bred to similar replacement heifers, you'd expect 10 percent (the difference between +5% and –5%) more of sire A's calves to be born unassisted as compared to sire B's calves. Said another way, due to genes for calving ease passed on from the sires to their calves, each of sire A's calves out of first-calf heifers have a 10 percent greater chance of being born unassisted as compared to sire B's calves.

Next, let's briefly look at the following two sires from which replacement heifers are to be retained and what we'd expect based on their CEM EPDs:

	CEM EPD
Sire A	+3%
Sire B	–2%
Difference	5%

When daughters of sires A and B are bred to similar bulls, daughters of sire A have a 5 percent greater chance of calving unassisted with their first calf as compared to daughters of sire B, due to differences in genes the daughters inherited from their sires for easy delivery of their first calves.

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Birth Weight EPDs

Birth weight has been identified as the single most influential factor contributing to calving difficulty. In studies of birth weight data, birth weight EPDs have been shown to be the single most accurate genetic predictor of calf birth weight.

In order to demonstrate how birth weight EPDs work, consider the following two bulls that are being considered for use on first-calf heifers, and the difference between their birth EPDs.

	Birth Wt. EPD
Bull A	-2.5 lbs.
Bull B	+2.5 lbs.
Difference	5.0 lbs.

If bulls A and B were each bred to a similar set of heifers, based on their EPDs we would expect calves from bull A to have birth weights that average 5 lbs. less than calves from bull B. Lower birth weight EPDs indicate lighter progeny birth weights, which generally should translate into less potential for calving difficulty.

Weaning and Yearling Weight EPDs

Feeder cattle are marketed by the pound. Typically, heavier calves return more total dollars than lighter weight calves, assuming you have just as many heavy calves as light calves to offer for sale.

Weaning and yearling weight EPDs are expressed as the added pounds of weaning and yearling weight of offspring expected, due to genes for growth passed on from parents. As an example, consider the weaning and yearling EPDs on the following two bulls:

	Weaning Wt. EPD	**Yearling Wt. EPD**
Bull A	45 lbs.	85 lbs.
Bull B	35 lbs.	65 lbs.
Difference	10 lbs.	20 lbs.

In this example, bull A is expected to pass on genes to his calves which result in weights that average 10 lbs. more at weaning and 20 lbs. more at yearling as compared to the average of calves sired by bull B. Here, the weaning weight difference of calves is solely due to genes for growth the calves inherited from each sire, and is separate from the influence that the dam's milking ability has on calf weaning weight.

Milking Ability EPDs

Milk EPDs are more difficult to explain. Read carefully...a sire's milk EPD is expressed as the additional pounds of weaning weight of calves (grandprogeny of sire) from daughters, due to genes for milk passed on from the sire to his daughters. Similarly, a dam's milk EPD indicates added pounds of weaning weight of calves (grandprogeny of dam), from her daughters, due to genes for milk the daughters inherited from the dam.

An example helps make milk EPDs easier to understand. Consider the following two bulls:

	Milk EPD
Bull A	20 lbs.
Bull B	10 lbs.
Difference	10 lbs.

Again, EPDs are used to make comparisons. The difference in milk EPD of bulls A and B is 10 lbs. Daughters of bull A are expected to wean calves that are 10 lbs. heavier than the calves from daughters of bull B, due to genes for milking ability the daughters inherited from sires A and B.

Determining the **optimum** range in milk EPDs which is most appropriate for any given situation and the amount of emphasis that should be given to this trait depends upon a number of different factors, including environment and management practices.

Scrotal Circumference EPDs

Older age at puberty has been linked to lower conception rates and later calving dates in females, a reduction in the quality and quantity of semen produced by bulls, and poor performance in several other measures of reproduction and fertility. Thus, it is important for Limousin breeders to correct potential deficiencies in this trait, especially if replacement females are retained for breeding from the bulls in question.

Scrotal circumference has been found to be a good indicator of age at puberty, and is a highly heritable trait which responds favorably to selection. EPDs for scrotal circumference are expressed in centimeters (cm), with higher values indicating genes for larger yearling scrotal circumferences of sons and earlier puberty of daughters. Consider the scrotal EPDs for the following two bulls:

	Scrotal Circumference EPD
Bull A	–.5 cm
Bull B	+.5 cm
Difference	1.0 cm

If bulls A and B were each bred to a similar set of cows, we would expect bull calves from sire B to have yearling scrotal circumferences which average 1.0 cm larger than bull calves from sire A at 12 months of age. Since yearling scrotal circumference in bulls and age at first cycling (puberty) in heifers are highly correlated traits, daughters of bull B would also be expected to have inherited genes for earlier puberty than daughters of bull A. It is important to consider scrotal circumference EPDs when selecting bulls from which daughters are going to be retained for replacements.

Also note that scrotal circumference EPDs are not substitutes for breeding soundness examinations (BSEs) conducted by veterinarians. Breeders are advised to use scrotal EPDs to determine genetic differences in puberty and utilize results from BSEs (includes evaluation of semen, actual scrotal circumference measurements and physical examinations) to help identify infertile or subfertile bulls. Use of the BSE should be a routine practice prior to merchandising and prior to the start of each breeding season. Please contact the NALF office for additional information on BSEs.

Stayability EPDs

Stayability EPDs are calculated from calving and pedigree information, and predict genetic differences in the likelihood that daughters will remain in production until six years of age or beyond, given that daughters had at least one calf reported prior to six years of age. Since the primary reason Limousin cows are culled is because of reproductive failure, EPDs for stayability are mainly thought to indicate genetic differences in sustained reproduction. To a lesser extent, stayability EPDs may also represent genetic differences in a multitude of additional factors which contribute to reasons why daughters of certain sires are "preferred" by Limousin breeders, and as a result have calves reported before and after six years of age.

The following example using two sires illustrates how to interpret stayability EPDs.

	Stayability EPD
Bull A	+ 25%
Bull B	+ 15%
Difference	10%

If sires A and B above were bred to comparable groups of cows, 10% more of sire A's daughters are expected to remain in production until the age of six years as compared to sire B's daughters (+25% – 15% = 10%). Said another way, each daughter of sire A is expected to have a 10% greater likelihood of staying in production to six years as compared to daughters of sire B. Stayability EPDs for cows are defined in exactly the same manner, with differences in EPDs indicating differences in the probability that daughters of the cows will remain in production to six years of age.

Docility EPDs

EPDs for docility predict genetic differences in the probability that offspring are scored as 1 (docile) or 2 (restless) as opposed to 3, 4, 5 or 6 (nervous to very aggressive). Higher EPD values for docility represent genetics for calmer behavior.

An example using the following two sires helps make docility EPDs easier to understand and use:

	Docility EPD
Sire A	+ 20%
Sire B	+ 5%
Difference	15%

If sire A has a docility EPD of +20% and sire B is +5%, we would expect 15% more of sire A's offspring (20% - 5% = 15%) to be scored as either 1 (docile) or 2 (restless) as compared to the percent of offspring of sire B scored as 1 or 2. By definition, each offspring of sire A is expected to have a 15% greater likelihood of possessing docility scores of 1 or 2 as compared to offspring of sire B. Thus, docility EPDs can be used to minimize the proportion of animals produced and perhaps culled which possess genetics for potentially unacceptable behavior.

Carcass Weight EPDs

Carcass weight EPDs are tools to help genetically design carcasses with weights which fall within an acceptable industry weight range.

As a means of demonstrating how carcass weight EPDs work, consider the following two bulls:

	Carcass Wt. EPD
Bull A	+ 10 lbs.
Bull B	+ 40 lbs.
Difference	30 lbs.

If bulls A and B were each bred to comparable groups of cows, the average carcass weights of the resulting offspring of each sire would differ by 30 lbs. due to genes for carcass weight from the sires. More specifically, on average, offspring of bull B would produce carcasses which are 30 lbs. heavier than carcasses from bull A, at an age constant end point.

Knowing which of the above two bulls is most appropriate is a difficult question. On one hand, bull B is expected to produce more total carcass weight. However, if bull B produces some carcasses which are too heavy, overweight discounts may work to bull B's disadvantage.

Optimum carcass weight EPDs for sires will vary according to characteristics of the cows to which the sires are mated and the calf growing/finishing management regime. Gaining a feel for optimum carcass weight EPDs will require some trial and error until thresholds are more clearly defined. In the meantime, avoiding extremes on both ends of the carcass weight EPD spectrum may be a logical alternative. It follows that selecting sires of moderate size will help avoid production of carcass weights which are outside of an acceptable weight range.

Ribeye Area EPDs

Ribeye area EPDs offer an objective measurement of genetic differences in muscularity. EPDs for ribeye area are expressed in units of square inches, with larger values indicating larger ribeye areas and increased expected overall carcass muscularity. As an example of how to interpret ribeye area EPDs, consider the following two sires:

	Ribeye Area EPD
Sire A	–.40 sq. in.
Sire B	+.60 sq. in.
Difference	1.00 sq. in.

By definition, if sires A and B are mated to similar groups of cows, the average ribeye area of calves from sire B are expected to be 1.00 square inch larger than the average of calves from sire A at an age constant end point, due to genes passed on for ribeye area.

Similar to carcass weight, bigger is not necessarily better. The challenge to cattle producers appears to be one of producing muscular, high red meat yield type finished cattle without overstepping thresholds on carcass and ribeye size.

Yield Grade EPDs

USDA yield grades estimate beef carcass cutability, which is defined as the combined yield of closely trimmed, boneless retail cuts from the round, loin, rib and chuck. Yield grades range from 1 to 5, with lower values being more favorable and indicating greater yield of lean, saleable beef from the carcass. Just as lower yield grade EPDs are favored and indicate greater cutability, lower yield grade EPDs are favored and indicate genetic differences for yield grade and cutability of offspring. Generally, animals with the most favorable combination of EPDs for large ribeye area, low fat thickness and light carcass weight also have the most desirable and lowest EPDs for yield grade.

To get a feel for interpreting EPDs for yield grade, consider sires A and B listed below:

	Yield Grade EPD
Sire A	– .25
Sire B	+ .25
Difference	.50

When bred to similar cows, offspring of sire A are expected to average one-half (.50 units) of a yield grade better than offspring of sire B. This is expected to equate to a little over one percent (1.15%) greater yield of closely trimmed, boneless retail product from carcasses of sire A's offspring compared to sire B's. Assuming 800 pound carcass weights, carcasses from progeny of sire A are expected to yield an average of slightly over 9 pounds (1.15% x 800 lbs. = 9.2 lbs.) more retail product than carcasses from progeny of sire B.

Marbling Score EPDs

Marbling scores are subjective evaluations of intramuscular fat in the ribeye. The marbling score EPD is expressed in units of numeric marbling score, with higher values indicating genes for greater deposition of intramuscular fat, or higher expected marbling score and higher USDA quality grade at a constant age.

Consider the marbling score EPDs of sires A and B for an illustration of how to interpret these values:

	Marbling Score EPD
Sire A	–.25
Sire B	+.25
Difference	.50

If bred to comparable groups of cows and processed at a constant age, the average marbling score of carcasses from offspring of sire B is expected to be .50 score units higher than the average of carcasses of offspring produced by sire A, due to genes passed on from the sires for marbling score.

Generally, higher marbling score EPDs are favored over lower values. Choice grade carcasses are typically more valuable than carcasses which grade Select or lower, if other carcass characteristics are equal. This is because of the anticipated benefits to juiciness and flavor which higher marbling scores are expected to help ensure. When deciding how much emphasis to place on this trait, it should be remembered that a number of additional factors such as age, days on feed, post-mortum treatments and cooking can have substantial influence on palatability. Also, tenderness has been shown to be the most important component of overall palatability, and it has been demonstrated that there is not a meaningful relationship between level of marbling and tenderness in Limousin cattle.

Mainstream Terminal Index

The mainstream terminal index ($MTI) is a multiple-trait selection index, expressed in dollars per head, designed to assist beef producers by adding simplicity to genetic selection decisions. It measures differences in expected profit per carcass produced on a mainstream grid (yield grade 1 or 2, Select to low-Choice quality grade, and no over- or underweights or dark cutters).

The $MTI is based on the assumption that Angus-Hereford cows in a two-breed rotation are mated to Limousin-influenced terminal sires with the resulting calves sold into the commodity beef market with premiums and discounts based on both quality and yield. It is determined by economic values and genetics associated with post-weaning growth, yield grade and quality grade and gives an estimate of how future progeny of each sire are expected to perform, on average, compared to progeny of other sires in the Limousin herdbook if the sires were randomly mated to similar herds of black baldy cows and if the calves were exposed to the same environment.

For example, a bull with a +$55 for $MTI would be expected to return $15 more per carcass produced than a bull with a +$40 for $MTI ($55 - $40 = $15) due to combined genetic merit for post-weaning growth and mainstream carcass merit passed on to offspring. If each bull produced 25 carcasses per year over the next four years, the +$55 bull would be expected to produce an extra $2,500 return over the +$40 bull:

($55 – $40) x 25 carcasses per year
x 4 years of service = $2,500

When using $MTI, it is wise to simultaneously select for economically important traits that are not included in the index. The index was developed for use in a terminal sire situation in which Limousin and Lim-Flex bulls are bred to mature British-cross cows and all calves are placed in the feedlot and sold on a mainstream grid. Maternal traits, such as calving ease, are not included in the index. If you intend to use high $MTI bulls on first-calf heifers, you will also want to use EPDs for calving ease direct to minimize calving difficulty. Likewise, in order to keep pace with the Limousin breed’s tremendous improvement in temperament, selection for superior docility EPDs is also advised.

It is also important to understand the assumptions behind $MTI and consider genetic differences among animals in the component traits that contribute to $MTI. For example, a $45 bull whose $MTI value comes from superiority in marbling is a more appropriate choice than a $45 bull whose value is from high growth and low yield when the cows to which they are to be mated are of low genetic merit for marbling.

Because $MTI is composed of EPDs for several traits, it does not have an associated value for accuracy. However, animals with high accuracy values for

Table 1. Limousin Possible Change Values (+ or –) for EPDs of Various Traits

BIF Accuracy	CE Direct (%)	Birth Wt. (lbs.)	Weaning Wt. (lbs.)	Yearling Wt. (lbs.)	Milk (lbs.)	CE Maternal (%)	Scrotal (cm)	Stayability (%)	Docility (%)	Carcass Weight (lbs.)	Ribeye Area (in²)	Marbling Score (units)
0	8.6	3.0	16.2	24.7	14.8	8.9	.70	8.6	15.8	36	.46	.24
.1	7.8	2.8	15.0	22.0	13.7	8.0	.62	7.7	14.3	32	.41	.22
.2	6.9	2.5	13.4	19.4	12.2	7.1	.56	6.9	12.7	29	.37	.20
.3	6.1	2.2	11.7	16.8	10.8	6.2	.49	6.0	11.1	25	.32	.17
.4	5.2	1.9	10.0	14.2	9.2	5.3	.42	5.2	9.5	22	.28	.14
.5	4.3	1.6	8.1	11.5	7.4	4.5	.35	4.3	7.9	18	.23	.12
.6	3.5	1.3	6.4	9.0	5.8	3.6	.28	3.4	6.3	14	.18	.10
.7	2.6	1.0	4.8	6.4	4.3	2.7	.21	2.6	4.8	11	.14	.07
.8	1.7	0.7	3.2	3.9	2.9	1.8	.15	1.7	3.2	7	.09	.05
.9	0.9	0.4	1.5	2.1	1.4	0.9	.08	0.9	1.6	4	.05	.02

each of the component traits (weaning weight, yearling weight, yield grade and marbling score) have more reliable $MTI that are less subject to change than animals with low accuracies for each of the component traits.

Accuracy

Accuracy is a measure of the reliability associated with an EPD. For Limousin cattle, accuracy is designated by either a “P”, “P+” or a numeric value which ranges from 0 to 1. Accuracy indicates the type and amount of performance information which was used to calculate the EPD.

More specifically, EPDs with “P” accuracy generally have the lowest level of reliability because only pedigree (“P”) information has been included in the calculations. Since an animal inherits a sample half of its genes from each parent, EPDs with “P” accuracy are calculated by adding 1/2 of the sire’s EPD for a given trait to 1/2 of the dam’s EPD. Breeders should also consider an animal’s adjusted weights and ratios if the EPD only has “P” accuracy.

Accuracy defined as “P+” indicates that both pedigree (“P”) data and an animal’s own performance and contemporary group information have been incorporated into the animal’s EPD. However, the animal’s performance and contemporary group information do not contribute back to its parents’ values until the next genetic evaluation. Also in the next evaluation, an animal’s “P+” accuracy will be updated to a numeric value.

Animals with numeric accuracy have had their own performance and group information and that of their progeny processed through genetic evaluations at the University of Georgia and Colorado State University. Higher accuracy values, those closer to one, indicate greater reliability because more information has been incorporated. The concept of accuracy is more useful if you realize that more data means higher accuracy, and higher accuracy means less error associated with the EPD. Less error means that the EPD is less subject to “possible change” as more data accumulates.

Keep This In Mind

Possible change corresponds to accuracy and is a measure of potential error associated with EPDs. It is expressed as the plus (+) or minus (–) value an EPD may deviate from the animal’s true genetic value (Table 1).

For a given accuracy, the true progeny differences of 2/3 of all animals evaluated are expected to fall within the plus (+) or (–) possible change value. Approximately 1/3 of the animals evaluated may have true values outside the range indicated by the possible change. For any range of possible change, the true progeny difference is much more likely to be toward the center of the range than the outside.

As more information accumulates, accuracy increases while error or possible change diminishes. For a given trait, possible change values apply to any EPD with that accuracy. Hence, positive EPDs are just as likely to include error as negative EPDs. Table 1 provides possible change values associated with various levels of accuracy.

For example, consider the possible change of plus or minus (±) 1.4 lbs. for a milk EPD with a .90 accuracy. A bull with a milk EPD of +20 (.90 accuracy) has about a 1 in 6 chance of having a "true" milk progeny difference that is 18.6 (+20 – 1.4 = 18.6) or less and a similar chance of being greater than +21.4 (+20 + 1.4 = 21.4). Using this example, two out of three bulls with milk EPDs of +20 and .90 accuracy are expected to have "true" progeny differences between +18.6 and +21.4 (20 ± 1.4).

Example:
Trait = Milking Ability
Milking Ability EPD = +20

Accuracy = .90
Possible Change = ±1.4

Calculations: +20 – 1.4 = +18.6
+20 + 1.4 = +21.4

* 2/3 of all animals with the above EPD and accuracy expected to have "true" progeny differences between +18.6 and +21.4

1/6 may have "true" progeny differences less than +18.6

1/6 may have "true" progeny differences greater than +21.4

Other Risk Management Information

Along with accuracy values for each trait, additional information which helps evaluate the reliability of the EPDs is also provided. The number of contemporary groups from which birth weight records were collected is printed below the birth weight EPD accuracy. This information can be used as an indicator of the extent to which a bull has been sampled in different herds. For milk and scrotal EPDs, the number of progeny weaning weight records from daughters and number of sons with scrotal records, respectively, are also provided to help further measure the reliability of these EPDs.

Remember, EPDs can be directly compared regardless of accuracy because the number of records is accounted for in the calculations. Use EPDs to determine which bulls to sample and accuracies to determine how extensively each bull is to be used, relative to the amount of risk you are willing to accept.