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Understanding and Using Expected Progeny Differences (EPDs)

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Introduction

Sire summaries are published by breed associations to provide current genetic evaluations on progeny-proven sires. While the sire summary formats may vary among breeds, they all are designed to use the best linear unbiased prediction procedures to produce expected progeny differences (EPDs) for all cattle that have legitimate performance records. An EPD is always the best estimate of an animal's genetic worth given the data available for analysis, so EPDs provide a genetic description of an animal for the traits included in the analysis.

Expected Progeny Difference

One-half of the estimated breeding value is the expected progeny difference (EPD). Breeding value is the value of an individual as a genetic parent. Breeding value is the part of an individual's genotypic value that is due to additive gene effects that can be transmitted from parent to offspring. Because parents transfer a random sample of their genes to their offspring, it is impossible to control or predict whether a particular offspring will inherit a superior, average or below average sample of genes from each parent. Thus, an offspring's breeding value for a trait will be, on average, the average of its parents' breeding values for the trait. It is important to understand that the average of the parental breeding values does not determine the breeding value or performance of every offspring from a mating – just the average offspring. Estimated breeding values give an estimate of the average transmitting ability of the parent. Expected progeny differences are useful in comparing or ranking individuals within a breed for traits of interest. They also are a prediction of future progeny performance for a specific trait of one individual compared to another individual. Thus, it is the differences in EPDs that are informative. The animal with the highest or lowest EPD is not necessarily the most desirable animal. The most desirable animal often represents a balance of EPDs for various traits. The EPD values can only be used to compare animals within a breed.

Generating EPDs

Sire evaluation until the 1980s was utilizing only progeny (offspring) information. As a result, only older bulls were included in sire summaries, and EPDs could not be calculated for younger breeding stock. New animal breeding technology, as well as a new generation of computers, brought about the use of an animal model. An animal model provides techniques whereby the animal itself as well as

all available information on relatives is included in the estimate of genetic merit. As a result, as soon as an animal reaches breeding age, EPDs are available.

Use of an animal model has some very nice features. EPDs are calculated for all animals, male and female. Preferential mating of certain individuals does not bias the results. Therefore, a popular bull can be used only on genetically superior cows and his EPD will not be inflated. This is accomplished by adjusting for the EPDs of the cows to which he is mated. Also, appropriate adjustments are made for genetic trend, genetic level of contemporary group and early culling on the basis of poor performance. For example, this adjustment allows young bulls to be directly compared to older bulls with many progeny records.

Contemporary Groups

Proper contemporary grouping is the cornerstone of accurate genetic evaluation. A contemporary group is simply a group of cattle of the same sex raised in the same environment and measured under the same conditions. When comparing the actual performance of cattle, it is important to compare cattle from the same contemporary group. To produce accurate EPDs, it is important for producers to correctly form and identify contemporary groups in their within-herd performance programs to ensure accurate across-herd comparisons.

Accuracy

Accuracy is a measure of confidence in an EPD. Classical accuracy is the correlation between an animal's unknown actual breeding value and a calculated breeding value. A published accuracy is a function of classical accuracy that reflects the amount of information used in calculating its associated EPD. Both classical and published accuracy values range between 0 and 1 and may be interpreted in the same way. A high accuracy (> 0.7) means that an EPD is not expected to change much as further information is gathered. A low accuracy (< 0.4) means that the EPD may change a great deal as additional progeny information is gathered. Accuracy is influenced by not only the amount of progeny data but also the distribution of those progeny across herds. Non-parent animals have lower accuracy values because no progeny information contributes to their EPDs. Published accuracies are helpful to breeders in management of selection risk. Sires whose published accuracy values are high should breed as indicated. Accuracy information allows breeders to take as much or as little risk as they like.

Possible Change

It is important to realize that an EPD is a prediction of an individual's genetic transmitting ability for a given trait. As with any prediction, there is a margin of error, or possible change, associated with an EPD. When the accuracy is low, the margin of error is high. As more information (i.e., progeny data) becomes available, the margin of error becomes smaller. For example: If a bull has a birth weight EPD of +3.0 pounds, accuracy of 0.95 and possible change that is ± 1.0 pounds, we are 67 percent certain that his actual EPD is between 2.0 and 4.0 (+3 ± 1.0).

Pedigree Estimated EPDs

Many sale catalogs will contain EPDs for the bulls. Some bulls will appear in catalogs with limited or no EPD information. Sometimes, the weights on yearling bulls may not be reported by their breeder or they may not be usable because they did not meet certain criteria set up by the Beef Improvement Federation. When no data are available for a bull, he can still have EPDs, but they are computed based solely on his parents' EPDs. Each calf receives a random sample half of the sire's genes and random sample half of the dam's genes. The two halves combine to form the complete genetic makeup of the calf. By understanding this halving nature of inheritance, the EPDs on parents and grandparents in the pedigree of a young bull may be used to compute Pedigree EPDs.

Interim EPDs

Most beef cattle breed associations have genetic evaluation systems as a part of their performance recording programs. These National Cattle Evaluations (NCE) programs provide EPDs for sires, dams and non-parents on an annual or biannual basis. For calves recorded during the time period between NCE analyses, interim EPDs are calculated using the calves' pedigree index and within-herd performance. The interim EPDs provide breeders the

means of making early selection decisions on calves prior to the next breed NCE analysis.

Breed Average EPD and Base Year

Many producers believe that the breed average EPD for a given trait is zero. In most cases, however, breed average is not zero. A zero EPD represents the average genetic merit of animals in the database at the time when there was sufficient information to calculate EPDs (base year). Some breed associations now set the base year to a particular year. If the breed has made any genetic change for a trait, the average EPD for the trait will no longer be zero. Breed associations publish average EPDs in the sire summaries made available to the public. EPDs may increase or decrease over time compared to the base year.

Growth Trait EPDs

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 EPD of sires has been shown to be the single most accurate genetic predictor of calf birth weight. To demonstrate how birth weight EPDs work, consider the following two bulls in Example 1.

Example 1. Birth weight EPD

	Sire A	Sire B
EPD in pounds	+4	-1

The expected difference in the progeny of Sire A and Sire B for birth weight is 5 pounds. Sire A has an EPD of +4 and Sire B has an EPD of -1. On the average, it would be expected that the calves from Sire A would be 5 pounds heavier at birth than calves from Sire B. This is assuming that all calves are managed uniformly and are from cows of similar genetic merit and age.

Weaning and Yearling Weight EPDs

Most beef cattle producers are interested in marketing pounds of beef. Therefore, weaning weight and yearling weight are very important traits for most commercial producers.

Example 2. Weaning Weight EPD

	Sire A	Sire B
EPD in pounds	+20	+40

The expected difference in the progeny of Sire A and Sire B for weaning weight is 20 pounds. Sire A has an EPD of +20 and Sire B has an EPD of +40. On average, it would be expected that the calves by Sire B would be 20 pounds heavier at weaning than calves of Sire A.

Example 3. Yearling Weight EPD

	Sire A	Sire B
EPD in pounds	+40	+80

The expected difference in the progeny of Sire A and Sire B for yearling weight is 40 pounds. Sire A has an EPD of +40 and Sire B has an EPD of +80. On the average, it would be expected that calves by Sire B would be 40 pounds heavier at one year of age than calves of Sire A.

Maternal Trait EPDs

Maternal Effects

Maternal effects are an important consideration when evaluating beef cattle performance. Maternal performance is expressed in terms of milk production. Maternal performance, however, takes into account more than just milk production. Traits such as calving instincts and behavior are also included. Therefore, maternal effects are defined as any environmental influence that the dam contributes to the phenotype of her offspring. The genetics of the dam allow her to create this environment for her calf. Maternal effects are important during the nursing period with diminishing effects through postweaning.

Milk EPD

Weaning weight is determined by the genetics for growth in the calf and genetics for milking ability in the cow. There are separate EPD values for these components. The weaning weight EPD reflects preweaning growth of the calf, and the milk EPD reflects the milking ability of the sire's daughter expressed in pounds of calf weaned. The milk EPD that results from the separation of weaning weight into growth and milk segments is, like any other EPD, fairly simple to use.

Example 4. Milk EPD

	Sire A	Sire B
EPD in pounds	+20	+10

Sire A has an EPD of +20 and Sire B has an EPD of +10. Calves from daughters sired by Bull A would be expected to be 10 pounds heavier at weaning than calves from daughters sired by Bull B due to the difference in milk production of Sires A and B daughters. The 10 pounds are expressed in pounds of weaning weight, not pounds of milk.

Combined Maternal EPD

Combined maternal EPD is a measure of a sire's ability to transmit milk production (milk EPD) and growth rate (weaning weight EPD) through his daughters. It predicts the weaning weight of a sire's daughters' calves.

Example 5. Combined Maternal EPD

	Weaning Weight EPD	Milk EPD	Combined EPD
Bull A	+36	+12	+30
Bull B	+32	+16	+32

The combined EPD for Bull A (+30) is computed by taking one-half the weaning weight EPD plus the milk EPD. The +30 pounds affect both the milking ability transmitted to daughters and the direct weaning growth transmitted through daughters to their calves. In a similar method, the combined EPD for Bull B is one-half times the weaning weight EPD (+32) plus the milk EPD (+16), or +32 pounds. An average difference of two pounds would be expected as the difference in weaning weight of calves out of daughters of the bulls based upon the genetic merit for growth (WW EPD) and milk (Milk EPD). Other expressions for the combined maternal EPD include combined value (CV), total maternal (TM) and milk + growth (M+G). Calculations to derive these values are all the same. The combined EPD is the best estimate to compare bulls for maternal traits.

Carcass Trait EPDs

Carcass traits are becoming more important in the beef industry as consumers demand a more consistent quality product. Also, as value-based marketing continues to develop, carcass traits will become more important. EPDs for carcass traits predict genetic carcass differences just like growth and maternal EPDs.

Carcass Weight EPDs

Carcass weight is a good predictor of total retail product. Carcass weight is not a good predictor of percent retail product. Selecting sires with higher carcass weight EPDs will result in progeny carcasses that produce more total retail at constant fat and age end points. The industry target weight range for carcasses is 650 to 850 pounds.

As a means of demonstrating how carcass weight EPDs work, please refer to Example 6.

Example 6. Carcass Weight EPD

	Sire A	Sire B
EPD in pounds	+5	+35

The expected difference in the progeny of Sire A and Sire B for carcass weight is 30 pounds. Sire A has an EPD of +5 and Sire B has an EPD of +35. On the average, offspring of Sire B would produce carcasses which are 30 pounds heavier than carcasses from Sire A, at an age-constant end point.

Optimum carcass weight EPDs for sires will vary according to characteristics of the cows to which the sires are mated and the overall management program. Some trial and error may be required to decide what optimum carcass weight EPDs will work most effectively with a particular cow herd. Avoiding extremes on both ends of the carcass weight EPD spectrum may be a logical alternative. Selecting sires of moderate size generally will help avoid production of carcass weights which are out of acceptable ranges in most cases.

Fat Thickness EPDs

The National Beef Quality Audits identified excess external fat and excess seam fat as two of the largest contributors to lost economic opportunity in the cattle feeding industry. For the purpose of learning how to interpret EPDs for fat thickness, look at the two bulls listed below.

Example 7. Fat Thickness EPD

	Sire A	Sire B
EPD in inches	.00	+.10

The expected difference in the progeny of Sire A and Sire B for fat thickness is 0.10 inches. Sire A has an EPD of 0.00 and Sire B has an EPD of +0.10. Offspring of Sire A are expected to produce carcasses which have 0.10 inches less outside fat measured at the 12th/13th rib as compared to carcasses from offspring of Sire B.

Selecting for extreme levels of either low or high external fat could be dangerous. Intermediate levels are more optimum in most situations. While cattle that are too fat represent excessive levels of trim loss, extremely lean cattle can represent potential for fleshing ability problems in the cow herd that can lead to reproductive problems.

Marbling Score EPDs

Marbling scores are subjective evaluations of intramuscular fat in the ribeye. At present, marbling scores are the only easily measured indicator of palatability in beef carcasses. The three components of palatability include tenderness, juiciness and flavor. While level of marbling influences juiciness and flavor, marbling is not a very good indicator of tenderness.

For purposes of calculating marbling EPDs, most breed associations will use the following table (Beef Improvement Federation).

USDA Quality-Grading System and Marbling Score

Quality Grade	Amount of Marbling	Numerical Score
Prime +	Abundant	10.0 - 10.9
Prime	Moderately Abundant	9.0 - 9.9
Prime -	Slightly Abundant	8.0 - 8.9
Choice +	Moderate	7.0 - 7.9
Choice	Modest	6.0 - 6.9
Choice -	Small	5.0 - 5.9
Select	Slight	4.0 - 4.9
Standard	Traces	3.0 - 3.9
Standard	Practically Devoid	2.0 - 2.9
Utility	Devoid	1.0 - 1.9

The marbling score EPD is expressed in units of numeric marbling score, with higher values indicating the presence of genes for greater deposition of intramuscular fat. This results in higher than expected marbling scores and, thus, 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:

Example 8. Marbling Score EPD

	Sire A	Sire B
EPD in numeric score	-.20	+.20

If bred to a comparable group of cows and processed at a constant age, the average marbling score of carcasses from offspring of Sire B is expected to be 0.40 score units higher than the average of carcasses of offspring produced by Sire A.

Generally, higher marbling score EPDs are favored. Choice graded carcasses are typically more valuable than carcasses which grade Select or Standard, if other carcass characteristics are equal. When deciding how much emphasis to place on this trait, it should be remembered that a number of additional factors such as age of calf, days on feed and postmortem treatments can affect grading ability. The USDA marbling score, a subjective score for the amount of intramuscular fat in the longissimus dorsi (ribeye), is not a precise predictor of intramuscular fat. Research indicates that, generally, the correlation between marbling score and percent intramuscular fat (as determined by chemical extraction methods) is 0.70 to 0.75. It should be noted that the genetic correlation between marbling score and external 12th-rib fat is nearly zero. This means breeders can select for marbling and not have to worry about selecting for increased external fat when taking animals to an age-constant end point.

Summary

Commercial and purebred cow-calf producers have EPDs available to them as a powerful selection tool. These EPDs allow comparisons between individuals within a breed for performance traits. The purebred breeder may obtain EPDs on each member of his herd by participating in cattle evaluation services available through respective breed associations. Commercial producers may use EPDs provided to them in sire summaries, bull sale catalogs and other sources in order to make directional change in the genetics of the beef herd. Once the appropriate breed choices are made, the producer has the opportunity to use EPDs as a tool in sire selection. EPDs allow fair

comparisons of future progeny performance for bulls of the same breed. Cow-calf producers have EPDs as an opportunity to add predictability to the genetics of their cattle.

The table below provides some general guidelines for using EPDs in commercial scenarios. More limited forage conditions would probably dictate the need to avoid very high EPDs for growth or milk and even more to avoid high birth weights. Growth EPDs should be geared to the needs of the potential buyers. Reproductive traits, which may not have EPDs, still need consideration in the selection process. EPDs can be a powerful selection tool for both purebred and commercial producers if used correctly.

References

Guidelines for Uniform Beef Improvement Programs. Beef Improvement Federation. 1996.

Recommendations for EPDs for Various Commercial Scenarios

Use of individual	Breed	Birth weight	Weaning weight	Yearling weight	Milk
Terminal sire on mature cows	large carcass	not too high	high	high	not relevant
Bull to use with heifers	small to medium size	low	moderate	moderate	consider if keeping heifers
Sire replacement heifers	medium size maternal	low to moderate	moderate to high	moderate to high	varies

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