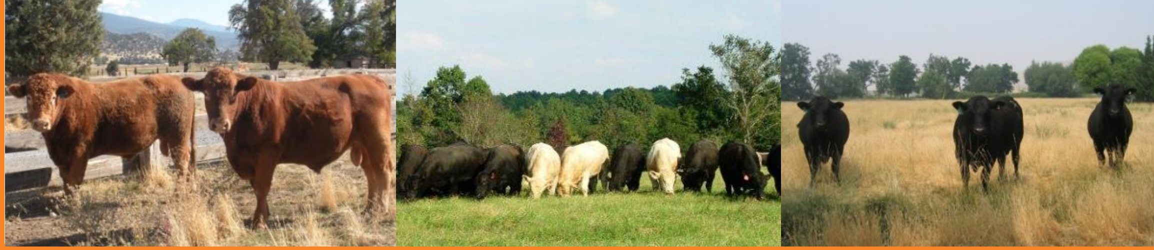

EPD Basics and Definitions

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Introduction

Expected Progeny Differences (EPDs) allow for the comparison of animals within a breed for their genetic potential as parents for a given trait. EPDs have existed in the beef industry for decades and their use has produced intended genetic change in many traits. However, some producers are still reluctant to rely on EPDs when making selection decisions; presumably because of a general lack of understanding of how EPDs are derived and their interpretation.

Basics of an EPD

Too often seedstock producers and bull buyers get caught up in the actual weights, ultrasound data, etc., when selecting sires. EPDs provide a measure by which animals within a breed can be compared to one another for their genetic potential as parents for specific traits. EPDs incorporate multiple sources of information, including full pedigree, an animal's own record, genomic data, and progeny information. As additional sources of information become available, the accuracy of the EPD value increases. Prior to a National Cattle Evaluation (NCE), animals are given interim EPDs. During a genetic evaluation, all pedigree information would be included.

Pedigree estimate:

Sire EPD = 0.20 → Dam EPD = 0.10 ←

Progeny EPD = (0.20+0.10)/2 = 0.15

Pedigree estimate + animal record:

$$EPD_I = (0.5*EPD_S) + (0.5*EPD_D) + (0.5*\text{Mendelian Sampling Effect})$$

Where EPD_I is the EPD for some individual I, EPD_S is the EPD for the sire of animal I, EPD_D is the EPD for the dam of animal I. The phenomena of Mendelian sampling arises due to the fact that each parent passes a sample half of its alleles to its offspring and every allele has an equal likelihood of being passed on. This effect can be quantified using contemporary group deviations and is a measure of how much better or worse an animal is compared to the average of his parents. One could envision a scenario in which an animal could receive only the most desirable alleles from both parents, resulting in a favorably large Mendelian sampling effect or the exact opposite, which could result in an unfavorably large sampling effect. Perhaps the best example is a set of flush mates. Although all of them have the same pedigree estimate, they differ

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considerably in terms of performance and consequently their EPDs, once they have a record, differ due to Mendelian sampling. Current methodology behind the estimation of Mendelian sampling effects can be found in the Beef Improvement Federation Guidelines at http://beefimprovement.org/content/uploads/2015/08/REVISED-MasterEd-BIF-GuidelinesFinal-08-2015.pdf.

When using EPDs, it is important to understand that the role of EPDs is to provide a measure of comparison within a breed. To compare animals across breeds, estimates from the U.S. Meat Animal Research Center (MARC) can aid in determining differences between EPDs of different breeds (*Table I*). These across breed adjustment factors, adjusted to an Angus basis, are updated annually and can be found at http://beefimprovement.org/library-2/convention-proceedings. There are across-breed genetic evaluations in existence (e.g., International Genetic Solutions; IGS) in beef cattle but producers should continue to use the USMARC derived adjustment factors if available to correctly adjust for breed effects.

EPDs Compared to Raw Data and Ratios

Many producers mistakenly place more emphasis on raw measurements than EPDs. Raw measurements include the confounded effects of genetics and environment, and consequently, the genetic ability of the animal is unknown. Below is a very simplistic equation describing the phenotype of an animal.

$$P = G + E$$

Where P is the phenotype, G is the genetic effect, and E is the environmental effect.

The phenotype is what is seen, or measured, such as the actual scan data for REA or IMF. Both genetics and the environment influence these values, and because we are interested in identifying animals based on their potential as parents, the environment should not be included in the tool used to select animals. Furthermore, actual scan figures are not comparable from animal to animal since they have not been adjusted nor do they provide any clue as to how much better or worse an animal is compared to others. A contemporary group ratio does allow for comparison of animals and provides an idea of how much better or worse a particular animal's adjusted record is compared to others within the same contemporary group. The problem is that a ratio is not useful in comparing animals across herds or outside of the defined contemporary group.

The genetic and environmental components of phenotype can be further divided into additive (A), dominance (D), and epistatic (I) genetic effects and both permanent (P) and temporary (T) environmental effects.

$$P = G_A + G_D + G_I + E_P + E_T$$

Generally speaking, we only become concerned with permanent environmental effects when we think about the environmental influence a dam has on her offspring (e.g., a young dam develops mastitis and loses function in one quarter, resulting in reduced weaning weights of subsequent offspring). Contemporary groups account for some of the temporary environmental effects. In genetic evaluations we are able to predict the additive genetic component, which is presented as an EPD. This is used in determining the heritability (h^2), which is simply the fraction of the variance in phenotype (σ^2_P) that is explained or caused by variation in additive values (σ^2_A). The heritability can be thought of as the average phenotypic differences or superiority that is likely to be passed on genetically to the next generation.

$$h^2 = \sigma^2_A/\sigma^2_P$$

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The objective of buying a bull is to purchase an animal that will enhance the genetics of his offspring. Selection based on a raw phenotypes such as actual weights or ultrasound scan values places selection pressure not only on the genetic potential of an animal but also on environmental influences (herd, year, season, management, etc.). If you look at two drastically different management scenarios: 1) forage tested bulls, and 2) high concentrate fed bulls, it would be expected that the high concentrate bulls would have greater intramuscular fat percentage (IMF) figures. The question remains, are the more desirable IMF scan figures due to genetics or the fact that they received more feed? We know that the environmental benefits will not be passed from parent to offspring, only the genetics. Consequently, selection based on EPDs will help sort the wheat from the chaff in that EPDs eliminate environmental differences and quantify genetic differences.

EPD Definitions

	BULL A	BULL B
Calving ease direct	10	6
Birth weight	2.0	3.5
Weaning weight direct	20	22
Yearling weight	40	52
Yearling height	0.3	0.6
Milk	3	-2
Maternal weaning weight	13	9
Gestation length	-0.1	1.1
Calving ease maternal	4	6
Mature daughter height	0.5	1.0
Mature daughter weight	0	30
Scrotal circumference	0.1	-0.45
Heifer pregnancy	6	9
Udder	0.4	-0.1
Teat	0.5	0
Carcass weight	2.0	20
Percent retail cuts	0	0.2
Marbling	0	-0.3
IMF	3.0	1.0
Rib-eye area	0.06	1.6
Fat thickness	-0.01	-0.09
Rump fat thickness	-0.03	-0.10
Tenderness	-0.01	0.1
Days to finish	15	10
Residual average daily gain	-0.1	0.05
Residual feed intake	-0.05	0.10
Dry matter intake	0.2	0.4
Stayability	10	6
Maintenance energy	0	10
Docility	6	2

Calving ease direct — Bull A should have 4 percent more unassisted births from first-calf heifers than Bull B. While birth weight is an indicator of calving ease, it does not tell the whole story. Calving ease is an economically relevant trait. Producers should not use both birth weight and calving ease EPDs together since the birth weight EPD is already used in the calculation of calving ease.

Birth weight — Bull B's calves would be on average 1.5 pounds heavier at birth. Keep in mind that when crossing breeds, heterosis or hybrid vigor can increase birth weights over a straightbred average. When selecting bulls to use on heifers,

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the economically relevant trait is calving ease and producers should focus on calving ease EPD rather than birth weight EPD.

Weaning weight direct — Calves from Bull B should average 2 pounds more on adjusted weaning weights because of additional growth. Because of the low accuracy associated with yearling bulls, the amount of emphasis placed on such a small difference should be limited. These EPDs are virtually the same even if the accuracies were high.

Yearling weight — Bull B's calves should average 12 pounds heavier at 1 year of age.

Yearling height — Bull B's calves should be 0.3 inches taller on average at a year of age compared to the offspring of Bull A. Height measurements are taken at the hip. Height (the actual measurement and not the EPD), along with age, is used to calculate frame score.

Milk — Daughters from Bull A should produce calves that are 5 pounds (the difference between +3 and -2) heavier at weaning. This is not a measure of pounds of milk but rather weaning weight due to milk production. This 5 pounds, unlike the weaning weight figure attributed to growth from the bull, is the result of differences in the daughters' milk production and mothering ability. Excessively high milk levels in low input environments should be discriminated against due to increased nutrient requirements of cows.

Total maternal (maternal weaning weight) — Daughters from Bull A will produce calves that are 4 pounds heavier at weaning on average because of their combined genetics for growth and milk. This is a calculated figure of one-half the bull's weaning weight direct EPD plus his milk EPD. For example, Bull A has a maternal weaning weight value of 13, which is equal to half of his weaning weight direct EPD (20/2=10) plus his milk EPD (3).

Gestation length — Calves from Bull A should have a one-day shorter gestation.

Calving ease maternal — Bull B's daughters should calve as first-calf heifers with 2 percent more unassisted births (6-4) than the daughters of Bull A.

Mature height — Bull B's daughters should be .5 inches taller at maturity.

Mature weight — Bull B's daughters should be 30 pounds heavier when mature.

Scrotal circumference — Bull calves from Bull A should have 0.55 centimeters larger adjusted scrotal circumferences. Scrotal circumference is an indicator of the age of maturity of a bull's daughters. Bulls with larger scrotal circumference should have daughters that reach puberty earlier. It is also an indicator of the capacity for sperm production of a bull.

Heifer pregnancy — Daughters of Bull B are 3 percent more likely to become pregnant as heifers.

Udder score— Daughters of Bull A are expected to have udders that score 0.5 points higher on average compared to daughters of Bull B. A higher udder score is indicative of a tighter udder suspension (more desirable).

Teat score— Daughters of Bull A are expected to have teats that score 0.5 points higher on average compared to daughters of Bull B. A higher teat score is indicative of smaller (length and circumference) teats.

Carcass weight — Bull B should produce calves that have 18 pounds more adjusted carcass weight.

Percent retail product — The calves from Bull B should yield 0.2 percent more closely trimmed, boneless retail cuts from the round, loin, rib, and chuck.

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Some breeds may report a Yield Grade (YG) EPD. The same factors (back fat, ribeye area, and carcass weight) would be included, but a lower YG is more desirable as opposed to percent retail product where a higher value is more desirable. In either percent retail product or YG, fat thickness contributes the most to these two calculations. Consequently, selecting for decreased YG or increased percent retail product will lead to leaner animals so caution should be used to avoid extremely lean replacement females.

Marbling — Calves from Bull A should have a 0.3 higher marbling score. Marbling scores range from 1.0, which is devoid of marbling and a utility quality grade to 10.9, which is abundant marbling and a prime + quality grade. For example, if calves sired by Bull B had a marbling score of 5.0, then we would expect calves sired by Bull A to have a marbling score of 5.3. Ultrasound EPDs were calculated for a number of breeds for traits of rib-eye area, fat, and intramuscular fat (IMF), which is correlated to marbling, but now the majority of breeds use these ultrasound measurements in the calculation of carcass EPDs. So, instead of seeing both an IMF EPD and a marbling EPD you just see the marbling EPD, but it has ultrasound measurements included in the calculation.

IMF— Calves from Bull A should produce calves with 2% more intramuscular fat than calves sired by Bull B. Intramuscular fat percentage (IMF) is measured by ultrasound and is a proxy for carcass marbling. Most breeds incorporate this measurement into their respective carcass marbling EPD as an indicator trait.

Rib-eye area — At a given end point, calves from Bull B should have rib-eye areas that are 1.54 square inches larger than Bull A's calves.

Fat thickness — At a given end point, calves from Bull A should be 0.08 inches fatter when measured at the 12th rib. This would be less desirable on a carcass animal, but extremely lean females going back into a cowherd may also be undesirable.

Rump fat thickness— At a given end point, calves from Bull A should be 0.07 inches fatter when measured between the hooks and pins. This measurement is taken solely via ultrasound.

Tenderness — Calves sired by Bull A should produce meat that is more tender than that of calves sired by Bull B by 0.2 pounds of shear force. Tenderness is measured by Warner Bratzler Shear Force (WBSF) that is reported in the pounds of force required to cut through a 1-inch thick piece of meat. A lower value is more desirable.

Days to finish — Calves sired by Bull B should spend five fewer days on feed to reach a constant fat endpoint.

Residual average daily gain — Calves sired by Bull B should gain 0.15 pounds per day more than those sired by bull A when fed the same amount of feed during the post-weaning phase.

Residual feed intake— Calves sired by Bull A should consume 0.15 pounds less feed per day than those sired by bull B given the same levels of gain during the post-weaning phase. Note that selection based on residual average daily gain and residual feed intake may not lead to the same bull selection decisions.

Dry matter intake— Calves sired by Bull B are expected to consume 0.2 pounds more feed per day on a dry matter basis compared to those sired by Bull A.

Stayability — A measure of reproductive longevity. Daughters of Bull A are 4 percent more likely to stay productive in the herd to age 6.

Maintenance energy — The Red Angus

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Association of America calculates a Maintenance Energy (ME) Expected Progeny Difference (EPD) that indicates differences in the Mcal/month needed for maintenance due to mature size (corrected for body condition score) and milking ability (The Rancher's Guide to EPDs is available at www.redangus.org). A much simpler way to think of it is that a bull with a ME EPD of +10 compared to one that is +0 will produce daughters that will require approximately 11 more pounds of average quality forage per month (assuming average quality forage = .86Mcal/lb).

Docility — Bull A should sire 4 percent more calves that have a temperament in the most docile score than Bull B. The actual measurement of docility is recorded either at weaning or yearling (depending on the breed association) and is categorized as the animals' behavior as they enter, are restrained in, and exit the chute.

Beef Improvement Federation (BIF) temperament scoring system:

1. Docile — Mild disposition; gentle and easily handled. Stands and moves slowly during processing, undisturbed, settled, and somewhat dull and does not pull on the headgate when in the chute; exits the chute calmly.

2. Restless — Quieter than average but slightly restless, might be stubborn during processing, might try to back from the chute, pulls back on the headgate, some tail flicking, exits the chute promptly.

3. Nervous — Typical temperament is manageable but nervous and impatient with a moderate amount of struggling, movement, and tail flicking as well as repeated pushing and pulling on the headgate; exits the chute briskly.

4. Flighty — Wild, jumpy, and out-of-control, quivers and struggles violently, might bellow and froth at the mouth, continuous tail flicking, defecates and urinates during processing, frantically runs the fence line and might jump when penned individually, exhibits long flight distance, and exits the chute nervously.

5. Aggressive — Similar to Score 4 but with added aggressive behavior, fearful, extreme agitation, continuous movement that might include jumping and bellowing while in the chute, exits the chute frantically and might exhibit attack behavior when handled alone.

6. Very Aggressive — Extremely aggressive temperament. Thrashes about or attacks wildly when confined in small, tight places. Pronounced attack behavior.

Summary

EPDs represent the genetic component of an animal's phenotype that is expected to be passed on to the next generation. Studies have shown that using EPDs are seven to nine times more effective than selecting based on actual phenotypes. While most producers think of increasing the economic efficiency of their operation by changing management systems (i.e., grazing schemes, calving dates, etc.) or utilizing different nutritional programs, the importance of correct genetic selection is all too often overlooked. If selection is based on nongenetic factors, as is the case when selecting on actual or adjusted measurements instead of EPDs or economic indexes, then an inefficiency is automatically built into the cow/calf enterprise. It is critical to understand how to interpret EPDs and to know breed averages, and be able to use percentile ranks in order to identify potential sires that fit the desired breeding objective.

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