Interpretation and Use of Expected Progeny Differences

Matthew L. Spangler, University of Nebraska-Lincoln

Expected Progeny Differences (EPD) are the most reliable tools to generate directional change in traits. However, like all tools, they must be used correctly and require some degree of background knowledge to ensure proper use.

Breed Averages

Every breed provides breed averages for every trait with a published EPD. Breed average, as the name implies, is the average EPD for a given trait within a specific population (e.g., breed). Breed averages are rarely zero, but instead reflect a point in time or a set of historic animals. Some breeds further delineate breed average to subsets of animals, such as sires, dams, non-parent animals, and based on breed fractions (i.e., hybrids, purebreds, full bloods).

Percentile Ranks

Breed averages can serve as a barometer relative to how an animal compares to other animals in a breed. Percentile ranks serve as a more refined gauge of how an animal compares to other animals in the same breed. Like breed averages (50th percentile), percentile ranks are available for every trait with an EPD. Depending on the breed association, percentile ranks may be available for sub populations (e.g., parent animals, non-parent animals, breed makeup). Percentile ranks indicate what proportion of animals have an EPD that is better or more desirable than a given value. As an example, an animal with an EPD in the 10th percentile means that 90% of the population has an EPD for that trait that is considered less desirable than the EPD of this animal. Note that depending on specific goals of a breeding program, extreme values may not be desirable and animals that have higher percentile ranks (e.g., 50th-99th percentile) may be desirable. An example percentile rank table is presented in Table 1. Assume a bull available at auction has a calving ease EPD of +13.0. Based on the values in Table 1, this bull would be in the top 40th percentile of the breed for calving ease. If the same bull had a yearling weight EPD of 111, he would be in the 50th percentile (breed average) for yearling weight.

Possible Change

Possible change values allow producers to construct confidence intervals or ranges around an animal's EPD. Possible change is inversely related to accuracy; as accuracy goes up, possible change goes down. As compared to accuracy, possible change represents a more tangible tool to determine the risk associated with the possibility of an EPD deviating from the animal's true genetic merit as a parent. Most breed associations publish a possible change table. Possible change values are unique to each breed and each trait. To use a possible change table, the user needs to know the correct breed, trait, and the accuracy value associated with a particular animal's EPD.

Mechanically, possible change can be thought of as a standard deviation and the EPD as a mean. Given this, the EPD +/- the possible change can provide a confidence interval in which the true genetic merit is expected to be contained. Assume a bull has an EPD of 2.0 and possible change value of 0.5. We expect his true EPD to be within the interval of 1.5 to 2.5 (EPD +/- 1 * PC) 68% of the time. Likewise, we would expect his true EPD to be within the window of 1 to 3 (EPD +/.- 2 * PC) 95% of the time and from 0.5 to 3.5 (EPD +/- 3 * PC) 99% of the time. The implementation of confidence intervals allows producers to visualize both the impact of improved accuracies but also enable selection whereby an animal attains some minimum or maximum threshold with some predetermined level of confidence. Confidence intervals can be very effective genetic risk management tools.

Economically Relevant Traits and Indicator Traits

The key questions that every farmer/rancher needs to answer are:

- What are my breeding/marketing goals?
- What traits directly impact the profitability of my enterprise?
- Are there environmental constraints that dictate the minimum, maximum or optimal level of performance that is acceptable for a given trait in my enterprise?

Table 1. Example percentile rank table for calving ease (CE), birth weight (BW), weaning weight (WW) and yearling weight (YW).

%	CE	BW	WW	YW
1	19.0	-5.0	100	150
5	17.0	-3.0	89	140
10	16.0	-2.5	88	133
15	15.0	-1.9	85	128
20	14.5	-1.1	82	125
25	14.0	-0.7	80	122
30	13.8	-0.5	78	120
35	13.2	-0.2	77	118
40	12.7	0.1	76	115
45	12.5	0.3	74	113
50	12.2	0.5	73	111
55	11.9	0.8	72	110
60	11.6	1.1	71	107
65	11.1	1.5	69	105
70	10.6	1.9	68	103
75	10.1	2.0	67	100
80	9.5	2.6	65	97
85	9.1	2.8	63	94
90	8.0	3.1	59	90
95	7.2	3.7	57	85

Once these three questions are answered, sire selection becomes much simpler. The answers to these questions inherently lead a producer to the traits that are economically relevant to their enterprise. We call these traits economically relevant traits (ERT; Golden et al., 2000). Fundamentally these are traits that are directly associated with a revenue stream or a cost. All traits that are not ERTs are indicator traits, or a trait that is genetically correlated to an ERT but not an ERT itself.

Classic examples of indicator traits include ultrasonic carcass measurements and birth weight. Ultrasonic carcass measurements are a non-destructive measure of traits such as intramuscular fat percentage (IMF). Producers do not receive premiums for IMF levels, rather premiums (and discounts) are applied to quality grades.

Assuming that carcass maturity values are the same, actual carcass marbling is the driver of quality grade. Although IMF is genetically correlated to carcass marbling it is not the ERT. Birth weight is another great example of an indicator trait. Selection to decrease birth weight in an attempt to reduce the prevalence of dystocia is practiced by numerous commercial bull buyers. However, birth weight does not have a direct revenue source or cost associated with it. Calving ease is the trait that has a cost associated with it. Calving ease is related to the level of assistance needed during a calving event. Although the two are related, the genetic correlation between calving ease and birth weight is between -0.6 and -0.8, suggesting that birth weight only explains 36-64% of the genetic differences between animals for calving difficulty.

Growth Traits

The earliest developed EPD for beef cattle were for birth weight (BW), weaning weight (WW), yearling weight (YW), and milk (MILK). These are still the standard EPD that are calculated for all breeds that conduct genetic evaluations.

Birth weight (BW)—Birth weight EPD reflects differences in birth weight and is used as an indicator of the probability of dystocia (calving difficulty). Birth weight is not an ERT.

Weaning weight (WW)—Weaning weight EPD predicts differences in the weight of bulls' calves at weaning. WW is an ERT for those producers who market calves at weaning.

Milk (MILK or Maternal Milk)—Milk EPD is actually maternal weaning weight, and thus reported in units of weaning weight. MILK is an ERT for producers who retain replacement females and who sell calves at weaning. In limited feed environments, selection for low to moderate Milk EPD would be warranted due to the added nutrient requirements for both lactation and maintenance.

Yearling weight (YW)—Yearling Weight EPD predicts differences in the weight of bulls' progeny at one year of age. YW is an ERT for cattle producers who might sell cattle post-weaning after a stocker program.

Dry matter intake (DMI)—Dry matter intake EPD predict differences in bulls' offspring for post-weaning feed intake. DMI is an ERT for cattle producers who retain ownership of terminal calves post-weaning.

Residual average daily gain (RADG)—This is actually an index of post-weaning gain and feed intake with changes in feed intake restricted to 0. The interpretation is differences in post-weaning gain assuming feed intake is equal. RADG is not an ERT.

Residual feed intake (RFI)—This is also an index of feed intake and post-weaning gain, but assumes changes in gain are restricted to 0. The interpretation is differences in feed intake assuming post-weaning gain is equal. RFI is not an ERT.

Total maternal (TM)—The EPD is the sum of half the weaning weight EPD and the entire milk EPD.

Yearling height (YH)—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. YH is not an ERT.

Mature height (MH)—Similar to yearling height, the mature height EPD was also developed as a frame-size selection tool and is not an ERT.

Mature weight (MW)—The mature weight EPD is another indicator for maintenance energy requirements. On average, heavier cows are expected to require more feed energy in order to maintain themselves. Mature weight is an ERT given there is revenue derived from the sale of cull cows. Absent a genetic prediction for cow feed intake, it is also the best proxy or indicator trait for feed consumption of the cow herd related to maintenance.

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 (SC)—Scrotal circumference is another indicator trait. The EPD for this trait is used as an indicator for the fertility of a bull's progeny through his sons' scrotal circumference and his daughters' age at puberty. The Scrotal Circumference EPD is expressed in centimeters with a larger number being more desirable. SC EPD is of use only in situations in which male calves are retained as bulls. Given the availability of female fertility EPD, the utility of SC as a proxy for female fertility is diminished.

Heifer pregnancy (HP)—Heifer pregnancy is an ERT. Heifer Pregnancy EPD reports differences in the probability of bulls' daughters' ability to conceive and calve at two years of age. HP EPD is also reported as a percentage where a higher value indicates progeny with a higher probability of conceiving to calve at two years of age.

Age at first calf (AFC)—This trait is defined as the age of a female when she has her first calf. A lower value is more desirable. Differences between sires' EPD reflect differences in the average age at which their daughters will have their first calf.

Stayability (STAY)—Stayability, also called Sustained Cow Fertility (SCF), reflects the longevity of a bull's daughters in the cow herd. This EPD predicts differences in the probability of bulls' daughters having additional calves during their lifetime or remaining in the herd through extended ages.

Carcass EPD

Carcass weight (CW)—Carcass weight EPD quantifies differences in the expected carcass weight, in pounds, of a bulls' progeny when they are harvested at a constant age endpoint. CW EPD is an ERT.

Ribeye area (REA)—Ribeye area EPD are reported in square inches and indicate differences in the area of the longissimus muscle between the 12th and 13th ribs of bulls' offspring when slaughtered at a constant age endpoint. REA EPD is not an ERT, but is a component of Yield Grade which is the ERT.

Fat thickness (FAT)—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. This EPD is reported in inches and depicts differences in 12th rib fat thickness of bulls' progeny when slaughtered at a constant age endpoint. FAT EPD is not an ERT but is an indicator of yield grade which is the ERT.

Marbling (MARB)—The marbling EPD indicates differences in marbling of the ribeye of a bulls' progeny when slaughtered at a constant age endpoint. Marbling is generally considered an ERT given its strong relationship to quality grade.

Yield grade (YG)—Yield Grade EPD is a prediction of differences in lean meat yield of the carcass and is an ERT given premiums and discounts are applied to YG. Phenotypically, the lower the grade, the leaner the carcass. An animal receiv-

ing 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. Yield Grade EPD are derived using component EPD of REA, FAT, and CW assuming a constant KPH.

Tenderness (WBS)—The tenderness EPD is reported in pounds of Warner Bratzler Shear Force such 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. Tenderness is an ERT from an industry perspective, although producers are not currently incentivized directly for improved meat tenderness.

Management/ Convenience Traits

Calving ease direct (CED)—The calving ease EPD, both direct and maternal, are the ERT. Calving ease direct EPD are a prediction of the differences of the ease at which bulls' calves will be born. Calving ease direct EPD are calculated using information from calvings of two-year-old females only (no calvings to older cows are included) and birth weight records. CED EPD is reported as a percentage so that a higher value indicates a higher probability of unassisted calving.

Calving ease maternal (CEM)—Similar to the calving ease direct EPD, the calving ease maternal EPD is also an ERT for unassisted calving. The majority of breeds, but not all, calculate CEM as total maternal calving ease (½ direct + maternal). Contrary to calving ease direct EPD, however, the calving ease maternal EPD predicts differences in the probability of a bulls' daughters calving without assistance. CEM 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.

Pulmonary arterial pressure (PAP)—Animals with higher pulmonary arterial pressure are more susceptible to brisket (or high mountain) disease. Pulmonary arterial pressure EPD are reported in millimeters of mercury with a lower value being more desirable.

Maintenance energy (ME)—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.

Docility (DOC)—Docility EPD reflect predicted differences in the temperament of bulls' offspring. Animals are evaluated by producers on a scale of 1 to 6 with 1 meaning docile and 6 indicating extreme aggressive behavior. Docility EPD are reported as percentages such that animals with a higher docility EPD will have a higher probability of producing more docile animals.

Claw set (CLAW)—Claw EPD reflect differences in the claw set of offspring.

Foot angle (ANGLE)—Angle EPD reflect differences in the angle of the foot.

Teat size (TEAT)—Teat score is measured on a 1 (very large) to 9 (very small) scale and EPD are reported in units of the subjective scale. Differences in sire EPDs predict the difference expected in the sires' daughters' udder characteristics.

Udder suspension (UDDR)—Udder scores are measured on a 1 (very pendulous) to 9 (very tight) scale and EPD are reported in units of the subjective scale. Differences in sire EPDs predict the difference expected in the sires' daughters' udder characteristics.

Summary

The list of available EPD continues to grow. To utilize EPD correctly, producers must develop a breeding objective to identify the traits on which they should select. Given more than one trait impacts profitability at the enterprise level, selecting on multiple traits is required. Tools to enable multiple trait selection including selection indices and decision support tools will be discussed in subsequent chapters.

References

Golden, B. L., D. J. Garrick, S. Newman, and R. M. Enns. 2000. Economically relevant traits: A framework for the next generation of EPDs. In: Proc. of the Beef Improv. Federation Ann. Meet. & Symp., Witchita, KS. p. 2-13.