EPD Basics

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Understanding and using EPDs continues to be a popular topic among cattle producers because of their effectiveness when properly used in genetic selection. Use of EPDs, as with many other standard management tools, is not required to survive in the beef cattle business, but those who do will excel in terms of genetic improvement. With so many traits to monitor in a cow herd, producers should not limit themselves to selecting a herd bull based primarily on his own individual weight traits. More than one producer has found out bigger is not always better.

The main objective of this paper is to describe how the wealth of information associated with EPDs should be used to make selection decisions which accurately reflect each producer's long term breeding objectives.

What Are EPDs?

Hopefully, giving what the acronym stands for is far too basic for most cattle producers, but I have on several occasions seen it written incorrectly or heard someone incorrectly say what it stands for. EPD stands for Expected Progeny Difference. It is a minor error to say estimated instead of expected, but that does not account for all of the errors made. An EPD is a prediction of the difference between the average performance of an individual's future progeny and the average progeny performance of another individual whose EPD is zero. The definition refers to an individual's progeny because many of the breed associations use an animal model, resulting in EPDs for bulls, cows and calves (or nonparents). Each EPD is an estimate of the individual's genetic merit for producing future progeny, usually reported in the same units the trait is measured in. The underlying assumption when comparing two bulls, for example, is that each bull is bred to a comparable group of cows.

Information used in computing an individual's EPD includes pedigree and performance of relatives, self and progeny. Because calves do not have progeny, their EPDs are limited to pedigree and own performance information. Thus, the emphasis on each type of information for computing an individual's EPD shifts as it gets older. Popular A.I. sires have EPDs based primarily on progeny information turned in by producers from all over the U.S. That is why the definition of an EPD indicated it is a prediction of the average progeny performance. Knowing that may concern you initially, unless you already know that the best linear unbiased prediction (BLUP) methods used to compute EPDs account for: 1) environmental and management differences among contemporary groups; 2) genetic merit of cows a bull is bred to; 3) his own performance and that of relatives and progeny; and 4) genetic trend. Occasionally, the question of what equations are used to compute EPDs is posed. The misunderstanding is that one could calculate an EPD much the same way as 205-day adjusted weaning weight of a calf -- with a simple equation. It is true that you can calculate a pedigree index to use as an estimate of an EPD for a calf without any performance information, if you have EPDs for his parents, by simply halving each parent's EPD and summing them. However, it is an extremely complicated statistical procedure to compute EPDs for all recorded animals in the breed. For large breeds such as Angus, more than one million equations must be solved simultaneously. It is not important that you know about EPDs to that degree of detail unless you are extremely interested in the topic. It is important, however, to use EPDs as they are the most accurate selection tool available.

Table 1 is a mini sire summary taken from the 1991 Polled Hereford Sire Summary. The table was chosen for example purposes strictly as a matter of convenience. Table 1 will be used for various examples throughout this paper. Assume we want to compare bulls C and D for birth weight, weaning weight and scrotal circumference (Table 2). As was mentioned earlier, these are the progeny differences that would be expected if these two bulls were bred to a comparable group of cows. To test the validity of these expected differences, one would need to take the average of several progeny before being able to draw any reasonable conclusions. Hypothetical progeny averages are also given to show the observed difference may be different than expected, but it is important that you notice there is a relatively minor deviation from expected, primarily because these bulls have fairly high accuracy values associated with each EPD, except scrotal circumference.

A bull with "superior" EPDs does not guarantee you superior calves. There are several reasons why it is possible for the observed difference to be dissimilar to that expected. Recall that EPDs are predicted values based on information reported by producers, indicating how critical good information is to the process. There are approximately 1,073,000,000 different eggs and sperm possible in a typical cow and bull, implying there are theoretically 1.15×10^{18} genetically different progeny possible from a single mating because each calf could have a different sample of genes. Thus, the potential for variation exists! Some of the calves a bull sires will be raised in the best managed herds in the U.S. and others in herds where management needs considerable improvement. Because many of the traits of interest have low to moderate heritabilities, much of the variation in calf performance can be explained by differences in the type of environment (management, weather, sickness, parasites) the calf is raised in.

Table 1. Mini sire summary

	Birth Weight		Weaning Weight		Yearling Weight		Scrotal Circum.		Maternal Wean Wt.	Maternal Milk	
Sire	EPD	ACC[a]	EPD	ACC	EPD	ACC	EPD	ACC	EPD	EPD	ACC
A	3.4	.80	28.7	.86	49.6	.80	.42	.45	26.6	12.2	.74
B	7.8	.75	38.8	.78	60.6	.78	-.02	.32	20.4	1.0	.72
C	10.8	.81	45.4	.82	76.5	.75	.35	.25	14.3	-16.8	.70
D	-1.5	.73	12.4	.90	23.5	.85	.10	.57	32.0	22.8	.80
Active Sire Avg.	3.1		19.3		28.7		-.02		10.7	1.1	

[a] ACC = Accuracy

Table 2. Comparison of sires C and D for selected traits

Trait	Sire	EPD	Actual progeny average
Birth weight (lb)	C	10.8	84
	D	-1.5	73
	Difference	12.3	11
Weaning weight (lb)	C	45.4	605
	D	12.4	570
	Difference	33.0	35
Scrotal circumference (cm)	C	.35	33.30
	D	.10	33.05
	Difference	.25	.25

Accuracy

EPDs are accompanied by an accuracy value between zero and one which should be used as a measure of reliability. EPDs with low accuracy values are less reliable than those associated with accuracy values closer to one. Accuracy values increase as the amount of information known for a particular bull increases. Potential sources of information include what is known about his own performance, the performance of relatives and that of any progeny. Therefore, young bulls will almost always have lower accuracy values than older bulls, resulting in the probability of their EPD changing with additional information being greater (Table 3). The magnitude of change possible will be discussed later.

Another way to think about using accuracy values is to think of them as the amount of risk associated with the currently reported EPD being representative of the bull's true genetic merit (Table 3). Low accuracy values indicate there is a high risk the EPD does not completely reflect true genetic merit and that it will likely change with additional information. Thus, you need to develop a risk management strategy of selecting bulls much the same way you would for investing your money. Most financial advisors suggest diversifying one's portfolio to include investments associated with varying degrees of risk. Normally, as the degree of risk increases, so does the potential for a greater return or loss on your investment. Similarly, using low accuracy, high risk young bulls may result in faster genetic improvement. Assuming your operation is large enough to use more than one bull, you can diversify or reduce your overall risk by also using proven bulls. You can justify using some higher risk bulls that are younger if genetic selection in your breed is effective, resulting in younger animals being superior to their parents.

Table 3. Accuracy categories: their meaning and associated risk level

Accuracy	Meaning	Risk Level
less than .40	very likely to change with more information	high
.40 to .60	some change likely, records on few progeny	moderate
.60 to .80	small change possible, records on numerous progeny	low
greater than .80	not likely to change much	very low

The amount of possible change associated with different accuracy values for each trait EPD can also be used to estimate how much risk is involved. Most sire summaries include a table in the front labeled possible change or standard errors of prediction for various levels of accuracy. Table 4 gives the possible change values for bulls in the mini sire summary (Table 1). Notice that the magnitude of possible change decreases as accuracy value increases. This should be expected because accuracy of prediction increases as additional information is available on an animal. Theoretically, approximately 67% of bulls' EPDs with a given level of accuracy will not change more than plus or minus the possible change value when re-evaluated with additional progeny information. From Table 1, the scrotal circumference EPD of bull C is .35 cm with an accuracy of .25. The possible change value from Table 4 is .515 cm. Therefore, when this bull is re-evaluated with additional information, you can reasonably expect his updated EPD to be within plus or minus .515 cm of the current EPD. Thus, the possible range for the updated EPD is -.165 to .865 cm. If you are looking for a low birth weight EPD bull to use on your heifers, it is wise to use the possible change value to see just how high the bull's birth weight EPD could be.

Be sure to get the most recent sire summary available from each breed association. Most of the larger breeds are updating their sire summaries twice a year because of the large amount of data they receive. As was indicated earlier, the accuracy of a bull's EPD increases with additional data and the actual EPD value will generally change from one evaluation to the next until his accuracy is very high.

Table 4. Possible change for various accuracy values (plus or minus)

ACC[a]	Birth Weight	Weaning Weight	Yearling Weight	Scrotal Circum.	Maternal Milk
0.0	3.9	17.2	25.4	0.68	19.9
0.1	3.5	15.5	22.9	0.61	17.9

0.2	3.1	13.8	20.3	0.55	15.9
0.3	2.7	12.1	17.8	0.48	13.9
0.4	2.4	10.3	15.3	0.41	11.9
0.5	2.0	8.6	12.7	0.34	10.0
0.6	1.6	6.9	10.2	0.27	8.0
0.7	1.2	5.2	7.6	0.20	6.0
0.8	0.8	3.4	5.1	0.14	4.0
0.9	0.4	1.7	2.5	0.07	2.0
1.0	0.0	0.0	0.0	0.00	0.0

[a] ACC = Accuracy

Study the information preceding the sire summary. It can be very helpful in learning about what type of bulls are currently available and how much genetic progress is being made by the breed. Typical information included are the minimum, average and maximum EPDs for each trait and sometimes for the previous year's bull calves. The distribution of EPDs may be given graphically and(or) in a percentile breakdown table (e.g., Figure 1 and Table 5). The birth weight EPD distribution in Figure 1 indicates there are very few bulls evaluated with a birth weight EPD less than -5 lb, and the inset shows the lowest bull is -12.4 lb.

Table 5 is useful for determining how a particular bull or EPD value ranks in the breed. For example, a bull with a birth weight EPD of -.5 lb ranks in the top 5 to 10% of all bulls included in the main listing. If a distribution for the previous year's bull calves is included, use it when selecting a yearling bull. Use as much of this information as possible to determine what minimum and maximum EPDs are acceptable for each trait in your selection program and that correspond to your breeding goals and production objectives.

Table 5. Main listing percentile breakdown

Percent of Bulls	Birth Weight	Weaning Weight	Yearling Weight	Scrotal Circum.	Maternal Weaning Weight	Maternal Milk
Upper 5%	-1.1	38.8	59.0	0.37	27.6	19.5
10%	-0.2	34.3	51.0	0.27	24.3	14.6
15%	0.4	30.5	46.0	0.22	21.8	11.0
20%	0.8	28.0	42.9	0.18	19.2	8.9
25%	1.3	26.6	39.1	0.13	17.7	7.3
30%	1.6	25.2	36.8	0.11	16.0	5.8
35%	1.9	23.7	34.9	0.07	14.4	4.9
40%	2.2	22.1	32.9	0.04	12.7	3.4
45%	2.6	20.5	30.9	0.00	11.5	2.3
50%	2.9	19.3	28.5	-0.02	10.5	1.3
55%	3.2	18.2	26.5	-0.05	9.5	-0.1
60%	3.5	16.7	24.7	-0.07	7.9	-1.0
65%	4.0	14.9	22.4	-0.09	7.2	-2.2
70%	4.4	13.5	20.1	-0.13	6.0	-3.2
75%	4.8	11.4	17.1	-0.18	4.1	-5.5
80%	5.3	9.8	14.0	-0.22	2.6	-7.3
85%	5.9	8.1	11.9	-0.27	0.2	-9.5
90%	6.6	5.8	8.8	-0.33	-3.0	-12.6
95%	7.8	1.7	2.4	-0.39	-6.1	-15.8

Some producers may prefer to categorize what they consider low to high EPDs for the traits in their selection program by breed to avoid getting too concerned with actual EPD values. If you choose to do that, you must still realize Simmental and Angus bulls you categorize, for example, as extremely low for birth weight cannot be considered equal in terms of the magnitude of change they would contribute. You can assume a decrease in birth weights is likely with both bulls, unless you already have exceptionally low birth weights.

Use EPDs Within Breeds

Although you may have heard about across-breed EPDs, they are still in the research and development stage. Beef breed associations continue to be divided on the issue and have requested further research be conducted. Currently all EPDs on beef cattle are calculated for use in comparing animals within a singe breed. You cannot directly compare EPDs of an Angus bull to that of a Simmental bull under the current evaluation system. Table 6 may help clarify why. It provides the EPD averages and ranges for five breeds and four traits. These values are not current and are presented here only to demonstrate

how the given values vary from one breed to the next. The reason for that variation is discussed by Woodward and Lewis (1991).

Figure 1. Birth weight distribution for all sires (N = 39,751)

Table 6. EPD averages and ranges for different breeds and traits

Breeds (listing)		Birth Weight	Weaning Weight	Yearling Weight	Maternal Milk
Angus	Low	-9.7	-61.0	-61.0	-39.0
(Current Sires)	Avg	1.1	6.5	10.0	1.6
Spring 91	High	12.6	63.0	104.0	42.0
Charolais	Low	-11.5	-46.7	-46.1	-27.3
(Active sires)	Avg	1.3	3.9	5.7	-1.6
1991	High	12.6	69.6	72.0	28.2
Hereford	Low	-6.4	-11.0	-17.0	-24.0
(Proven sires)	Avg	2.2	26.0	41.0	7.0
1991	High	11.8	71.0	121.0	37.0
Limousin	Low	-7.1	-23.2	-27.5	-20.7
(Current sires)	Avg	0.5	2.4	4.3	0.2
1991	High	6.8	27.3	51.1	20.8
Simmental	Low	-11.5	-56.5	-79.7	-25.4
(Active sires)	Avg	0.1	2.1	7.1	0.8
Spring 1991	High	9.2	77.2	120.8	25.2

If you have bred Angus and Simmental bulls with known EPDs to cows of comparable genetic merit

managed under similar conditions during the same year and kept accurate performance records on their progeny, the difference in average performance of each sire's calves will give you an indication of the breed EPD differences.

Selection Examples

Table 7 includes some selection examples based on a breeding goals and specific EPD values which reflect those goals. Use it to practice some of what you have read. The target EPD values are set up to guide you toward choosing a specific bull given in the mini sire summary in Table 1. Select which bull you think is most appropriate for each scenario and then compare with someone else.

Table 7. Some selection examples

No.	Breeder Selection Goals	Birth Weight	Weaning Weight	Yearling Weight	Maternal Milk	Bull Selected
1.	Maximize growth	none	maximize	maximize	none	
2.	Improve growth and maintain adequate milking ability	none	35.0	50.0	0.0	
3.	Improve growth, improve milking ability, minimize increase in calving difficulty	4.0	25.0	40.0	10.0	
4.	Improve milking ability, increase calving ease, maintain acceptable growth	0.0	10.0	20.0	20.0	

References

Woodward, B.W. and M. Lewis. 1991. The importance of knowing breed EPD averages. Beef Cattle Management Update, Issue 19. Dept. Anim. Sci., Univ. of Minnesota.