Genetic Improvements From AI Over Natural Service

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From a genetic standpoint, sire selection is the most important decision a cattle producer makes. The vast majority of genetic improvement in beef herds is the direct result of sire selection. Genetic changes (unlike management changes) are permanent, and the impact of individual sires can be measured for a decade or longer through the performance of daughters and granddaughters. For herds with small numbers of cows and in single-sire herds, the importance of an individual sire is even further exaggerated- as one sire alone accounts for a large proportion of the genetics represented in each calf crop. Relative to other production and management decisions, sire selection is an infrequent occurrence for many producers. However, these decisions have long-term impact relative to the productivity and profitability of the beef enterprise.

The embrace of artificial insemination (AI) and Expected Progeny Differences (EPDs) by beef producers has allowed for rapid, predictable genetic improvement through sire selection in the beef industry. The use of AI vs. natural service sires impacts genetic change primarily through accuracy of selection.

Proper use and application of EPDs requires an understanding of what the EPD values represent and what they do not. Accuracy values become very relevant in this context, as they are a measure of possible change or "risk" associated with an EPD. Put another way, accuracy values are measures of the reliability of the published genetic estimates for an animal. Accuracy is defined as the relationship between an animal's unknown actual breeding value and an estimated breeding value for a trait. This relationship is expressed numerically from zero to one. As the accuracy value approaches 1.0, the EPD reported is more likely to represent the true genetic merit of the animal. Conversely, low accuracy values (closer to zero) indicate that the reported EPD is less reliable. Accuracy is primarily a function of the amount of information available to calculate an EPD for any given trait. Information, primarily in the form of performance records, is derived from several sources to estimate EPDs on a given animal. These sources include records on the animal itself, its sire and dam, collateral relatives, and progeny records. As the volume and quality of records used in the estimation of an EPD increases, so does the confidence we have that the EPD has been estimated correctly (accuracy).

Table 1. Possible change values and true EPD ranges for two Angus sires with identical Calving Ease Direct EPDs

	CED EPD	BIF Accuracy	Possible Change	"true" EPD Range
Sire A	+7	.25	±6.2	+1 to +13
Sire B	+7	.90	±0.8	+6 to +8

Table 1 demonstrates the implication of accuracy on possible change in sire EPD. Sire A and B have identical CED EPDs, but differ considerably in their accuracy values. Sire A would be typical of a yearling bull, with his EPD derived from pedigree information and his own individual performance. Sire B would be typical of a sire with a large number of progeny, and likely used AI across several herds. A practical way to evaluate accuracy is to put it in the context of associated possible change. Possible change defines how much we might expect the current EPD to change (plus or minus) as more information is collected and used in the estimation of the EPD. For Sire A, an accuracy value of .25 for CED EPD is associated with a possible change of ±6.2%. Therefore, we would expect his "true" CED EPD to be between +1 and +13 pounds 68% of the time. Sire B, with a higher accuracy value, has a much lower possible change (±0.8) and therefore smaller range that we expect his true EPD to fall within (+6 to +8). It is important to recognize that EPDs are our best estimates of an animal's genetic worth. Due to a variety of potential sources of error, we never know the "true" EPD for any trait on any animal. Accuracy values, therefore, indicate how much we know about the animal's true genetic worth and how confident we can be in the estimated EPD. Possible change tables are readily accessible from breed associations for all traits.

Accuracy differences between AI and natural service sires are a direct reflection of the amount of data in the form of progeny records included in the calculation of the EPD of interest. As more progeny records are included in the evaluation, accuracy increases. The number of progeny records required to achieve a given level of accuracy is impacted by the heritability of the trait. Traits with higher heritability require fewer progeny records to obtain a particular accuracy value compared to low heritability traits (or with the same number of progeny records, a highly heritable trait will have a higher accuracy than a low heritability trait). Table 2 provides examples of progeny records required to obtain various levels of accuracy for traits with different heritabilities.

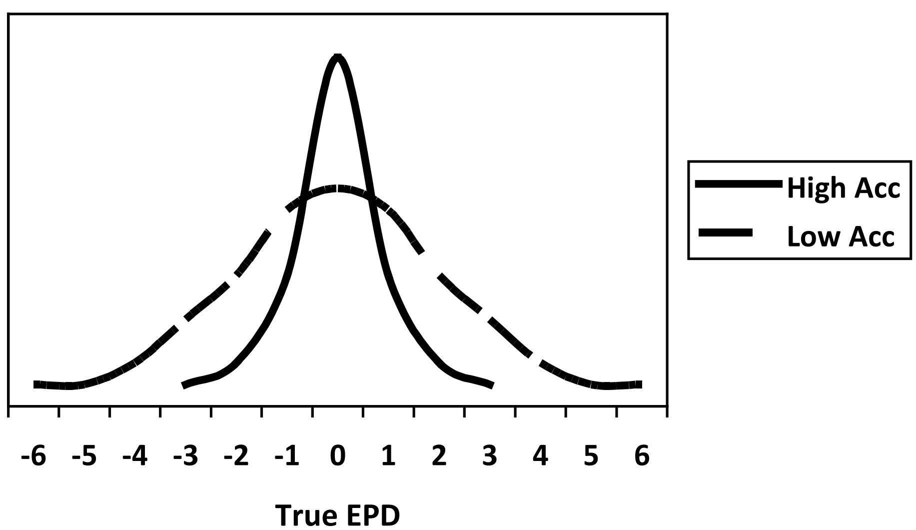
Table 2. Number of progeny records required to obtain accuracy values for traits with differing heritabilities

	Heritability		
BIF Accuracy	Low (0.1)	Moderate (0.3)	High (0.5)
0.05	4	2	1
0.20	22	7	4
0.40	70	22	13
0.56	167	53	30
0.99	3800	1225	700

The incorporation of molecular data obtained through genomics into genetic evaluation programs also impacts accuracy. As an example, an Angus calf with no ultrasound record and a parental average EPD with default accuracy 0.05, addition of genomic information increases accuracy to 0.28 – 0.38 depending on the carcass trait (Northcutt, 2010). Through the incorporation of DNA information, young sires can obtain higher accuracy values even without progeny information.

Implications of EPD accuracy deal with associated risk, and accuracy of selection should be considered when choosing herd sires. Since EPDs are not precise predictors of true breeding values, they are subject to change after each evaluation, depending upon newly accumulated data. High accuracy sires are likely to produce progeny whose average merit closely corresponds to their EPDs, whereas low accuracy sires may produce progeny whose average merit may either be below or exceed expectation. If the two bulls previously discussed were being considered for use on heifers, there would be much lower risk associated with Sire B. Even with the inclusion of substantial amounts of additional data, it is unlikely that his CED EPD will go up (or down) significantly. Comparatively, Sire A has a larger possible change and there is more risk that his EPD could change with additional information (the primary risk would be that his CED EPD become substantially lower than estimated). This example illustrates a primary advantage of using high accuracy sires through AI in comparison to natural service. For all practical purposes, high accuracy sires are available only through AI. Figure 1 illustrates graphically the potential distribution of true EPD values for a high vs. low accuracy sire. Similar examples can be given for all EPD traits.

Figure 1. Distribution of true EPD for sires with high vs. low accuracy values



Keep in mind when evaluating possible change that there is an equal chance that an EPD will go higher as opposed to go lower (or get "better" vs. "worse"). When evaluating young bulls, small differences in WW and YW EPD become less significant due to accuracy and possible change (large overlap in the range of their "true" EPDs). A common misconception is that accuracy is an indicator of expected variation in a resulting calf crop. Accuracy and possible change are not related in any way to progeny variation. High accuracy EPD animals (AI sires) would not be expected to have any more or any less variation in their calf crop compared to low accuracy EPD animals (natural service sires).

In summary, the primary advantage to AI vs. natural service sires from a genetic improvement perspective is realized through selection accuracy and associated management of risk. Due to increased accuracy, the average genetic merit of progeny resulting from the use of high accuracy, AI sires will be more predictable compared to the average genetic merit of lower accuracy, natural service sires. Consequently, genetic progress can be achieved more rapidly.

References

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