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National Beef Cattle Genetic Evaluation

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Summary

Use of artificial insemination permits some bulls to have offspring evaluated in more than one herd. Such bulls serve as benchmarks for comparison or links between herds. For some breeds, sufficient links exist between herds that current technology may provide valid genetic comparisons between cattle from different herds, as well as within-herd comparisons. The current industry standard expression for reporting relative genetic merit of beef cattle in national evaluations is expected progeny difference (EPD). The EPD for a sire represents the expected difference in performance of a sire's offspring when compared to the average offspring performance of all sires evaluated. A corresponding accuracy value, reflecting the amount of information (pedigree performance, individual performance, offspring performance, etc.) on which the EPD value is based, is generally reported with each EPD value. Expected progeny difference values can be calculated not only for bulls listed in sire summaries, but also for cows, young bulls and even planned matings. EPDs for nonparents generally have low accuracy values compared to EPDs for parents.

(Key Words: Cattle Evaluation, Expected Progeny Difference.)

Introduction

Major developments have occurred during the past one and one-half decades in genetic evaluation of beef cattle. Use of artificial insemination, improved statistical analyses and more powerful computers allow comparisons of animals across herds.

The first national beef sire summary in the U.S. was published by the American Simmental Association in 1971 and included 13 bulls. Current national sire summaries for some breeds include evaluations of hundreds of bulls. In fact, the analyses used by some breed associations to compute national sire summary data can yield predicted genetic values for every registered animal in the breed with a sufficient record.

More performance information on beef seedstock is available today than at anytime in history. To make efficient use of this resource, producers must know what information is available and how to interpret it.

Across-Herd Evaluation

Environmental vs Genetic Influence on Performance. An individual's performance is determined by its genetic potential and the environment to which the individual is exposed. Differences in performance among animals may be due

to both genetic and environmental differences. For example, superiority in performance of a given animal may be due to greater genetic potential, more favorable treatment (such as feeding, care, growth implants, etc.) or both.

Our intent as livestock breeders should be to make selection decisions based on genetic differences among animals. Our ability to do so is hindered to the extent that genetic differences among animals are masked by environmental differences. Hence, our ability to compare animals from different herds fairly is limited.

Central test stations were devised as one means to allow performance comparisons among animals from different herds. However, the performance of animals in a central test may be affected by pretest environmental factors and a consignment often represents a selected sample. The extent to which such factors affect rankings of animals from different herds at the central test is difficult, if not impossible, to ascertain.

Genetic Links Between Herds. The reference sire concept has been utilized by several breed associations as a method to compare animals from different herds. Through artificial insemination, a single bull can be mated to a portion of the cows in different herds. Performance of offspring of such a bull (the reference sire) is compared to offspring performance of other sires used in the herd. Then, bulls from different herds can be compared by evaluating the performance of their offspring relative to the performance of calves sired by the reference bull. A reference sire provides a basis for comparisons from herd to herd. It is important that bulls are mated to a random sample of cows within each herd.

The reference sire concept is illustrated with an example in table 1. Assume that Bull A is a reference sire with calves sired in two different herds. The superior weaning weight performance of calves from Bull A in Herd 2 indicates a better environment or perhaps superior cows (or both) compared to Herd 1. Among the other four bulls, calves of Bull D had the highest average weaning weight. However, close inspection reveals that relative to progeny of the reference sire, offspring of Bull B exhibited better performance than offspring of Bull D, followed by offspring of Bull E and Bull C, respectively.

In order to be designated as a reference sire, a bull must have a large number of progeny (100-500) in many different herds (10-50) in which several other reference sires (5-10) are also represented.

Today's national sire summaries utilize two types of links between herds: 1) bulls with progeny in two or more herds and 2) genetic relationships between animals. For breeds in which use of artificial insemination is sufficiently widespread, enough links exist between herds that designation of reference sires is not necessary. Theoretically, these links allow comparisons among virtually all animals in a breed with appropriate performance records.

Interpreting Expected Progeny Difference (EPD) and Accuracy Values

EPD or EBV. For several years, some beef cattle breeds have reported genetic values for bulls in terms of estimated breeding values (EBVs) and expected progeny difference (EPD) values in national sire summaries. Breeding

value reflects the value of an individual as a parent. Expected progeny difference is defined as half the breeding value, taking into account the fact that only a sample half of an animal's genes are transmitted to the offspring. Expected progeny difference values appear to be the current expression of choice to report estimated genetic merit in national beef cattle evaluations.

An EPD value is a prediction of how well an animal's future offspring will perform relative to other animals in the evaluation. An EPD value may be calculated for each of several traits (birth weight, weaning weight, yearling weight, daughter's milking ability, etc.) for a given animal. Expected progeny difference values are generally expressed as deviations in the actual units in which the trait was measured (pounds, inches, etc.).

One way to interpret EPD values is to think in terms of differences. Suppose, for example, that Bull A and Bull B have weaning weight EPD values of -10 and +10 lb, respectively. The expectation is that calves from Bull B would average 20 lb heavier at weaning than calves from Bull A, assuming the bulls are mated to cows of similar genetic merit and calves are raised under similar environmental conditions.

An EPD value is generally accompanied by a corresponding accuracy value. The accuracy value indicates the degree of certainty one should have that the EPD value reflects the true genetic value. Accuracy values calculated according to Beef Improvement Federation guidelines range between zero and one.

An EPD value for an animal with few or no offspring will have a relatively low accuracy value, whereas an EPD for a bull with many progeny records will have a relatively high accuracy value. To limit risk, breeders may wish to limit the number of cows mated to a bull whose EPDs have low accuracy values.

Consider the example presented in table 2. For simplification, only the traits of birth weight, weaning weight and yearling weight are included.

If calving difficulty is a potential concern and since birth weight and calving difficulty are positively correlated, then use of Bull A should be considered, although some growth potential would be sacrificed. Bull B appears to have the most potential for siring calves with high growth rate, although the accuracy figures are low compared to Bull C. Bull C has moderate potential for passing on growth rate, and the high accuracy values give the breeder more confidence that the EPD values reflect the bull's true breeding value.

When additional offspring are evaluated, the EPD values of Bull B are likely to change more than those of the other two bulls. However, one doesn't know whether changes will be favorable or unfavorable. Assuming birth weight was not a consideration, a reasonable approach would be to mate some cows to Bull B and some to Bull C.

A Note on Accuracy Values. Considerable variation in performance among offspring of a given parent is common, regardless of the EPD or accuracy values. The EPD value predicts the average performance of future offspring. The accuracy value reflects the confidence one should have that the predicted average closely estimates the parent's true transmitting ability. Neither value indicates the magnitude of expected range in performance of future offspring.

Milk vs Maternal EPD. Some national cattle evaluations include EPD values for milk, others list EPD values for maternal ability and some include EPD values for both. An individual's EPD for milk reflects the ability of that individual's daughters to produce milk, expressed in pounds of weaning weight. Maternal EPD reflects ability of the individual's daughters to produce calf weaning weight based on (1) the direct genetic contribution for preweaning growth that the individual passes on to it's daughters and (2) daughters' milking ability. Maternal EPD is calculated as:

Maternal EPD = Milk EPD + 1/2 Weaning Weight EPD

Separation of growth and milk components of maternal EPD allows the breeder to be more specific in directing selection emphasis. Consider the sample data in table 3.

Based on maternal EPD, daughters from Bull A and Bull B are expected to perform similarly in terms of calf weight weaned. However, the reasons for achieving that level of expected performance are different for the two bulls. Bull A will transmit poor to moderate genetic potential for preweaning growth, but his daughters should be relatively heavy milkers. Bull B will pass on good genetic potential for preweaning growth, but his daughters are expected to produce less milk than daughters of Bull A.

Eliminating Bias. One past criticism of sire summaries has been that bulls mated to above average cows have an unfair advantage over bulls mated to cows of lesser genetic potential. Statistical procedures now used in some sire summary analyses include dam effects. Adjusting for dam effects removes much of the bias in evaluation of sires caused by nonrandom mating. The EPD value for yearling weight, for example, is adjusted downward for a bull that was mated to superior cows.

One technique recently employed in some national beef cattle evaluation analyses is multiple trait analysis, in which two or more traits are evaluated simultaneously. Among other things, this procedure removes some of the bias due to selection.

For example, consider a bull whose poor calves are culled at weaning, but his better calves are kept and evaluated for yearling weight. More progeny weaning weight records as compared to yearling weight records for the bull are sent to the breed association, and the bull's yearling weight EPD tends to be biased upward. Multiple trait evaluation removes some of this bias by including weaning weight information in calculation of the yearling weight EPD.

More Terminology. Estimated breeding values and EPD values for bulls with records on a sufficient number of offspring have been published by some breed associations for several years in national sire summaries. Performance of a bull's relatives (cows, calves, etc.) may also be included in the evaluation by taking genetic relationships into account. Since the so-called "animal model" yields genetic values for all animals for which appropriate records were reported, the expression "national cattle evaluation" is sometimes more appropriate than "national sire evaluation".

Use by Commercial Producers. Commercial producers should become acquainted with EPD terminology since performance data available at bull sales might include

EPD values. Since commercial producers often purchase sons of bulls listed in national sire summaries, it is useful to be familiar with sire summary data. Also, producers using artificial insemination can purchase semen from a number of bulls with EPD information.

Conclusion

Use of expected progeny difference values as a means of expressing relative genetic merit will likely continue to increase as a supplement or alternative to within-herd ratios. For breeds in which links between herds are sufficient, EPD values are comparable across herds within a breed. Familiarity with these concepts will aid producers to use the best information available on which to base their selection decisions.

TABLE 1. ILLUSTRATION OF REFERENCE SIRE CONCEPT

	No. calves	Average adjusted weaning wt	% of Bull A
	Herd 1		
Bull A (Reference)	15	510	100.0
Bull B	12	480	94.1
Bull C	18	440	86.3
	Herd 2		
Bull A (Reference)	12	540	100.0
Bull D	15	490	90.7
Bull E	12	480	88.9

TABLE 2. EXPECTED PROGENY DIFFERENCE AND ACCURACY VALUES FOR GROWTH TRAITS

	Birth wt		Weaning wt		Yearling wt	
Bull	EPD	ACC	EPD	ACC	EPD	ACC
A	.1	.78	-2.7	.65	-3.0	.59
B	1.9	.56	17.3	.53	28.7	.51
C	1.9	.96	8.1	.94	19.1	.88

TABLE 3. EXPECTED PROGENY DIFFERENCE AND ACCURACY VALUES FOR WEANING WEIGHT AND MATERNAL TRAITS

	Weaning wt		Milk		Maternal weaning wt	
Bull	EPD	ACC	EPD	ACC	EPD	ACC
A	-2.0	.79	7.6	.72	6.6	.75
B	19.2	.82	-3.0	.74	6.6	.78