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Summary

Performance records from 1982 to 1992 on 1365 calves for birth weight (BW) and 1492 calves for weaning weight (WW) were analyzed to estimate relationships of purebred sire expected progeny difference (EPD) values for BW and WW to actual crossbred progeny performance. Sires of the calves were Polled Hereford, Simmental, Angus, Salers, Tarentaise, or Charolais. The pooled-across-breed regressions (lb/lb ± SE) of BW and WW of calves on sire EPD were 1.17 ± .31 and .75 ± .28, respectively. Residual correlations of BW with BW EPD and WW with WW EPD were .16 ($P<.01$) and .05 ($P=.10$), respectively. Additional regression and residual correlation analyses were conducted in which records from progeny of low-accuracy sires (Acc. <.50) were deleted. The reduced data set included 967 records for BW and 962 records for WW. The pooled-across-breed regressions (lb/lb ± SE) of BW and WW of calves on higher-accuracy sire EPD were 1.28 ± .35 and .71 ± .31, respectively. Residual correlations using higher-accuracy sire data of BW with BW EPD and WW with WW EPD were .18 ($P<.01$) and .09 ($P=.02$). Breeders who use BW and WW EPDs as a selection tool should expect such selection to be effective, on average, and reasonably consistent with theoretical expectation. However, some sires and small progeny groups may not rank as expected based on sire EPDs.

Key Words: Cattle, Expected Progeny Difference, Birth Weight, Weaning Weight

Introduction

Herd sire selection represents the major directional force available to the beef producer for creating genetic improvement. Expected progeny differences (EPDs) enhance the accuracy of selection decisions by establishing an evaluation of the relative genetic value of a sire within a breed for traits of economic importance.

It is important to validate tools such as EPDs under typical commercial production conditions. The impact of such an effective selection resource potentially would allow commercial beef cattle producers to make more appropriate choices of sires for particular production environments, improving the economic productivity of the commercial cow-calf producer. The purpose of this study was to evaluate the relationship of birth weight and weaning weight EPDs of purebred beef sires to actual performance of crossbred offspring.

Materials and Methods

Performance records of calves born from 1982 through 1992 at the Antelope Range Livestock Station in northwestern South Dakota were analyzed. Calves were born in the spring, weighed at birth, and male calves were castrated at birth. Calves were not creep-fed, and weaning weights were taken in the fall when the entire group averaged approximately 7 mo of age. Progeny dam breeds evaluated in this study were considered representative of females typically available to commercial producers. Progeny dam breeds included straightbred Hereford, F_1 Salers x Hereford, and

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three two-breed rotations (Simmental x Hereford, Angus x Hereford, and Tarentaise x Hereford). For purposes of analysis, each record was assigned to one of eight dam breed groups, based upon breed percentages. Sires of the calves were Polled Hereford, Simmental, Angus, Salers, or Tarentaise (rotational matings) or Charolais (terminal sire matings).

The only records retained for analysis were for calves whose sires' 1993 EPD values were available from the respective breed associations, except that Tarentaise EPD values were from a Fall 1991 analysis. A new Tarentaise analysis was not performed until Fall 1993. To be included in the analysis, at least two sires of the same breed must have been represented by progeny in the same year. Numbers of records remaining after editing were 1365 for birth weight and 1492 for weaning weight in the overall data set. There were 95 sires represented, of which 77 had semen available through commercial outlets. The remaining 18 sires were purchased for use as natural-service "cleanup" sires from various seedstock producers.

No data from this herd were reported to breed associations. Therefore, the data used in these analyses were independent of those used in the calculation of sire EPD values. No attempt was made to practice divergent selection of sires for birth weight or weaning weight in this herd. Rather, a range of EPDs has been used for most sire breeds. This sire sampling may be more representative of typical commercial herds in the United States than if sires of extreme high and low EPD values had been chosen.

Pooled-across-breed analyses which accounted for the effects of breed of sire, dam breed group, cow age, year calf born, calf sex, and either calf date of birth or calf weaning age were conducted to compute the regression of progeny birth weight or weaning weight on sire EPD. Regressions were computed for each breed and then averaged across breeds in the pooled analysis. The theoretical expected value for each regression coefficient was 1.0. That is, for each 1-lb difference in sire EPD, we theoretically expect a 1-lb difference in progeny performance. Residual correlation coefficients among calf birth weight, sire birth weight EPD, weaning weight, and sire weaning weight EPD also were obtained. A second set of analyses was conducted on a subset of the data in which records of progeny of low accuracy (Acc. $<.50$) sires were deleted.

Results and Discussion

Overall means for calf birth weight (BW) adjusted to 82-day Julian calving date and 208-day calf weaning weight (WW) in the present study were 91.2 lb and 531.5 lb, respectively. Table 1 presents the ranges and averages of within-breed EPDs for all active sires reported by breed associations from Spring 1993 sire summaries (Fall 1991 for Tarentaise). The ranges in BW EPD and WW EPD reported for active sires were largest in Charolais and Simmental.

Table 2 examines ranges and means of sire BW EPD sampled in the study. BW EPD means of Polled Hereford, Simmental, Salers, and Tarentaise sires used in this study were similar to or slightly less than breed averages for active sires. Angus and Charolais sire BW EPD means in this study were slightly greater compared to overall breed means.

Table 3 examines ranges and means of sire WW EPD sampled in the study. WW EPD means of Polled Hereford and Salers sires were less than breed averages for active sires. Simmental, Angus, Tarentaise, and Charolais sire WW EPD means in this study were similar or slightly greater compared to overall breed means.

The overall pooled-across-breed regression for calf BW on sire EPD was 1.17 ± .31 lb/lb of BW EPD and was similar to its expected value of 1.0 (Table 4). Table 4 also presents individual breed regression coefficients for BW on sire EPD. These regression coefficients were all positive as per expectation. Only the value for Tarentaise (2.05 ± .47 lb/lb) differed significantly from the expected value of 1.0. It may be important that Tarentaise sire EPD values were only available from a Fall 1991 analysis. The present results suggest that prediction of BW based on published sire EPD agrees closely with the expected value of 1.0 when averaged across breeds, although

Table 1. Ranges (lb) and accuracies for expected progeny differences (EPDs) for all sires in each breed[a]

Breed	Birth wt EPD range	Birth wt EPD mean	Weaning wt EPD range	Weaning wt EPD mean
Polled Hereford	-4.41 to 13.88	3.96	-20.93 to 61.89	25.99
Simmental	-9.91 to 15.42	.66	-29.74 to 85.24	5.07
Angus	-6.61 to 12.56	3.52	-40.97 to 66.08	22.91
Salers	-5.51 to 7.71	.88	-23.57 to 40.97	7.49
Tarentaise	-3.96 to 9.91	1.98	-55.07 to 48.90	2.64
Charolais	-12.11 to 11.67	1.10	-76.43 to 63.44	5.07

[a]Reported by respective breed association in Spring 1993 sire summaries, except that Tarentaise ranges and means were from all sires in a Fall 1991 summary.

Table 2. Numbers of sires and progeny evaluated, range and mean values for 1993 BW expected progeny difference (EPD), and mean accuracy values for full and reduced data[ab]

Item	No. of sires	No. of progeny	Sire BW EPD, lb Range	Sire BW EPD, lb Mean	Mean BW EPD accuracy
Polled Hereford	22 (18)	623 (463)	-.66 to 6.83	2.36 (3.13)	.78 (.91)
Simmental	13 (12)	228 (110)	-2.42 to 2.86	-1.50	.71 (.93)
Angus	14 (11)	268 (160)	2.64 to 10.13	5.15 (4.76)	.67 (.91)
Salers	5	32	-1.76 to 1.10	-.48	.76
Tarentaise	12 (11)	99 (95)	-3.30 to 6.83	2.00 (2.05)	.89
Charolais	11 (10)	115 (107)	-5.51 to 8.15	3.08 (3.17)	.84
Overall	77 (67)	1365 (967)	--	--	.78 (.87)

[a]Tarentaise sires EPD values were only available from a Fall 1991 analysis.
[b]Values in parentheses represent reduced (higher accuracy sire) data only.

Table 3. Numbers of sires and progeny evaluated, range and mean values for 1993 WW expected progeny difference (EPD), and mean accuracy values for full and reduced data[ab]

Item	No. of sires	No. of progeny	Sire WW EPD, lb Range	Sire WW EPD, lb Mean	Mean WW EPD accuracy
Polled Hereford	25 (18)	750 (463)	-.44 to 42.73	20.75 (26.28)	.72 (.89)
Simmental	13 (11)	228 (105)	-3.52 to 21.81	5.53 (4.60)	.72 (.94)
Angus	14 (11)	268 (160)	.22 to 51.81	28.35 (26.19)	.66 (.90)
Salers	5	32	-16.08 to 4.19	-7.16	.68
Tarentaise	12 (11)	99 (95)	-21.81 to 26.43	5.29 (5.31)	.87
Charolais	11 (10)	115 (107)	-11.23 to 25.55	9.65 (9.85)	.83
Overall	80 (66)	1492 (962)	--	--	.75 (.85)

[a]Tarentaise sires EPD values were only available from a Fall 1991 analysis.
[b]Values in parentheses represent reduced (higher accuracy sire) data only.

Table 4. Regression coefficients for calf BW on sire EPD for full and reduced[a] data sets

Breed	Regression coefficient, $b \pm$ SE	P-value ($Ho : b = 1$)
Overall (average)	1.17 ± .31 (1.28 ± .35)	.59 (.43)
Polled Hereford	1.16 ± .36 (.89 ± .53)	.66 (.84)
Simmental	1.90 ± .66 (2.37 ± 1.14)	.18 (.23)
Angus	.38 ± .36 (.84 ± .40)	.08 (.68)
Salers	1.12 ± 1.51 (1.05 ± 1.46)	.94 (.97)
Tarentaise	2.05 ± .47 (2.09 ± .46)	.03 (.02)
Charolais	.40 ± .54 (.42 ± .52)	.26 (.27)

[a]Values in parentheses represent reduced (higher accuracy sire) data.

individual breed coefficients were somewhat variable.

The overall pooled-across-breed regression of calf WW on sire EPD was .75 ± .28 lb/lb of WW EPD (Table 5). This value is not significantly different from the theoretical expected value of 1.0. Table 5 also presents the individual breed regression coefficients for calf WW on sire EPD. These regressions were positive except for Polled Hereford sires (-.29 ± .33 lb/lb) which was significantly different from the expected value of 1.0. Note that Polled Hereford sires were mated to several different dam breed groups. Nevertheless, a negative regression coefficient was unexpected.

Results from residual correlation analysis from the overall data set are presented in Table 6. Positive significant correlations were obtained for calf BW with sire BW EPD (.16, $P<.01$) and sire WW EPD (.12, $P<.01$). A lower positive significant correlation of calf WW with sire BW EPD was observed (.08, $P=.02$). The correlation of calf WW with sire WW EPD only approached significance (.05, $P=.10$). Larger positive and significant correlations were observed between BW and WW and BW EPD and WW EPD (.48 and .64, $P<.01$, respectively).

To examine the effect of deleting data from progeny of low-accuracy sires on the results of this study, additional regression and correlation analyses were conducted in which records from progeny of low-accuracy (Acc. <.50) were deleted. Data remaining after editing included 67 sires of 967 progeny for calf BW and 66 sires of 962 progeny for calf WW. The mean accuracy value for sire EPD increased to .87 (Table 4) and .85 (Table 5) for BW and WW respectively, compared to .78 and .75 using the full data set. The overall pooled-across-breed regression coefficient for BW on higher accuracy sire EPD increased from 1.17 to 1.28 ± .35 lb/lb and remained similar to the expected value of 1.0 (Table 4). For individual breed regression coefficients, Polled Hereford and Angus sires approximated closer to their theoretical expectation of 1.0. Salers, Tarentaise, and Charolais sires regression coefficients remained similar since only 12 records were deleted from the full data set.

The overall pooled-across-breed regression coefficient for calf WW on higher accuracy sire EPD decreased slightly from .75 to .71 ± .31 lb/lb but remained similar to the expected value of 1.0 (Table 5). For individual within-breed regression coefficients, Polled Herefords approximated and were similar to the expected value of 1.0 with a regression coefficient of 1.13 ± .59 lb/lb. A total of 7 Polled Hereford sires of 287 progeny were deleted from the full data set. The regression coefficient for Simmental sires also decreased from 1.63 to .12 ± .95 lb/lb but was not significantly different from expectation. Of 228 total Simmental progeny in the original data set, two sires representing 123 progeny were deleted to perform the higher accuracy analysis. Regression of actual WW on EPD for Angus sires decreased from .39 to .28 ± .37 lb/lb and differed from the expected value of 1.0. All other sire breed regression coefficients remained

Table 5. Regression coefficients for calf WW on sire EPD for full and reduced[a] data sets

Breed	Regression coefficient, $b \pm$ SE	*P*-value ($Ho : b = 1$)
Overall (average)	.75 ± .28 (.71 ± .31)	.37 (.35)
Polled Hereford	-.29 ± .33 (1.13 ± .59)	<.01 (.83)
Simmental	1.63 ± .68 (.12 ± .95)	.35 (.36)
Angus	.39 ± .34 (.28 ± .37)	.07 (.05)
Salers	1.15 ± 1.23 (1.53 ± 1.21)	.66 (.66)
Tarentaise	.65 ± .51 (.67 ± .50)	.49 (.51)
Charolais	.55 ± .59 (.55 ± .58)	.44 (.44)

[a]Values in parentheses represent reduced (higher accuracy sire) data.

Table 6. Residual correlation coefficients among sire expected progeny difference (EPD) values and calf production trait for full and reduced[a] data sets

Item	Birth weight EPD	Weaning weight	Weaning weight EPD
Birth weight	.16** (.18**)	.48** (.45**)	.12** (.17**)
Birth weight EPD		.08* (.11**)	.64** (.64**)
Weaning weight			.05+ (.09*)

[a]Values in parentheses represent reduced (higher accuracy sire) data.
+P=.10.
* P=.02.
** P<.01.

similar to those from the analysis of the full data set.

For the residual correlation analyses, trends were also similar to those from using the full data set (Table 6). Pooled-across-sire breed correlations observed between actual progeny performance and sire EPDs increased from .16 to .18 for BW and from .05 to .09 for WW. Results suggest that average relationships between sire EPD and progeny performance were not appreciably changed when data from progeny of low-accuracy sires were deleted. Genetic prediction theory indicates that the accuracy value for a mean EPD associated with a group of animals is greater than the accuracy associated with the EPD of an individual from the group.

In interpreting the results of this study, it is important to consider some of the assumptions made and potential shortcomings of the experimental methods. This analysis assumes that bulls' EPD was estimated with a high degree of accuracy, on average, and that various bulls were mated to cows of similar average genetic potential. In our study, cows were randomly assigned to bulls used within a given year and sire breed. It is uncertain how heterosis for calf preweaning growth affects the prediction of crossbred performance from purebred sire EPD compared to prediction of the performance of purebred descendants. The present study mainly utilizes records of progeny produced through rotational crossbreeding.

In summary, sire EPD was positively related to actual calf BW and WW when the sires were used for crossbreeding. The results of this study suggest that differences in BW were more adequately predicted than differences in WW based on published sire EPD among purebred sires used in crossbreeding when averaged over breeds and across large numbers of sires and progeny. Breeders who use BW and WW EPDs as a selection tool should expect such selection to be effective, on average, and reasonably consistent with theoretical expectation. However, some sires and small progeny groups may not rank as expected based on sire EPDs.