GROWTH OF CROSSBRED PROGENY OF POLLED HEREFORD SIRES DIVERGENTLY SELECTED FOR YEARLING WEIGHT AND MATERNAL ABILITY


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ABSTRACT

Polled Hereford sires (n = 47) were divergently selected on published yearling weight (YW) and maternal (MAT) expected progeny differences (EPD) and mated to grade Angus cows to produce 457 calves in five spring calf crops. Sires selected for high and low YW differed by an average of 6.3 kg in YW EPD and those selected for high and low MAT differed by an average of 4.0 kg in MAT EPD based on 1989 EPD values. Calves by high-YW sires were heavier at birth (2.2 kg; P < .01) and weaning (7.5 kg; P < .01) and as yearlings (16.4 kg; P < .01) than calves by low-YW sires and were taller at weaning (1.90 cm; P < .01). Regressions of calf performance on corresponding 1989 EPD were 1.18 f .20 kg/kg for birth weight, .75 f .24 kg/kg for weaning weight and 1.79 f .42 kg/kg for YW. Expected progeny differences for individual sires were calculated from the data collected in this study and had correlations with published EPD of .53 for birth weight, .37 for weaning weight and .54 for YW. These corresponded to expected correlations based on accuracies of evaluation of .68, .61 and .58, respectively, and yielded estimates of the genetic correlation between performance in the environment of the study and the environment of the purebred herds where the published EPD were derived of .78 for birth weight, .61 for weaning weight and .93 for YW. The very large regression of YW on YW EPD (1.79 ± .42 kg/kg) may have resulted from bias in published EPD due to culling of calves at weaning in purebred herds. Use of multiple traits analyses to account for such culling is recommended.

(Key Words: Cattle, Selection, Sire Evaluation, Growth.)


Introduction

Use of national sire evaluation (NSE) procedures in purebred beef cattle herds has been cited as a positive force for increasing performance within those herds (Benyshek, 1986). Positive genetic trends for live weight have been reported within the Angus (Zollinger and Nielsen, 1984; Wilson and Willham, 1986; Nadarajah et al., 1987), Hereford (Nadarajah et al., 1987) and Simmental breeds (Elzo et al., 1987). Purebred cattle represent the genetic nucleus that supplies germ plasm to the commercial beef industry; therefore, similar genetic changes are expected in commercial herds. However, commercial beef herds usually are less intensively managed than purebred herds and often utilize some form of crossbreeding. These differences between the two segments of the beef industry may partially invalidate the premise that genetic change from the use of NSE in purebred herds will be reflected directly in the performance of commercial cattle when the same sires are used in commercial herds.

The objective of this study was to examine the utility of NSE estimates of sire genetic value as a tool for predicting animal perfor-
TABLE 1. DISTRIBUTION OF CALF RECORDS AND SIRES OVER YEARS

<table>
<thead>
<tr>
<th>Year</th>
<th>No of calf records at:</th>
<th>Distribution of sires*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>42</td>
<td>0</td>
</tr>
<tr>
<td>1984</td>
<td>123</td>
<td>104</td>
</tr>
<tr>
<td>1985</td>
<td>103</td>
<td>102</td>
</tr>
<tr>
<td>1986</td>
<td>113</td>
<td>110</td>
</tr>
<tr>
<td>1987</td>
<td>76</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>457</td>
<td>379</td>
</tr>
</tbody>
</table>

*Diagonal values are the total number of sires used in each year. Off-diagonals are the numbers of sires that are common to each pair of years.

Performance in commercial crossbreeding. Specifically, actual and expected progeny differences in calf growth were compared when grade Angus cows were mated to Polled Hereford sires divergently selected on estimated genetic merit for yearling weight and daughters' maternal ability.

Materials and Methods

This study was conducted at the Shenandoah Valley Experiment Station, Steeles Tavern, VA. A total of 457 calves born in five calf crops (1983 through 1987; Table 1) were studied.

Cows. A total of 157 cows representing two age groups were used. One hundred four grade Angus cows born in 1976 had been obtained as weanling heifers from six locations in Virginia and used for 5 yr in a study in which they calved in either the spring or the fall to Polled Hereford or Simmental x Polled Hereford bulls. Eighty-four of these cows entered the current study at the summer 1982 breeding; the remaining 20 cows calved in the previous study in fall 1982, and entered the study at the 1983 breeding. In addition, 53 grade Angus weanling heifers were purchased from a single source in fall 1982 and entered the study at the 1983 breeding.

Sires. In each year of the study, Polled Hereford sires were chosen from the American Polled Hereford Association (APHA) Sire Summary (1982 through 1986). The objective was to practice bidirectional selection for growth and maternal ability in order to identify four distinct groups of sires (high growth, high maternal; high growth, low maternal; low growth, high maternal; and low growth, low maternal). In all years, sire selection for growth was based on the expected progeny difference (EPD; BIF, 1986) for yearling weight (YW). Selection for sire maternal ability in 1982 through 1984 was based on pooled, within-herd maternal estimated breeding value (EBV) ratios of the sires (APHA, 1982) and did not explicitly consider the average genetic merit of the herds contributing maternal records. In 1985 and 1986, maternal EPD appropriate for across-herd evaluation of sires became available (APHA, 1985) and were used in selection. Throughout the study, maternal EBV or EPD were based on the weaning weights of the first calves produced by daughters of the sires and as such included effects of both genes for maternal performance (presumably, primarily milk production) transmitted from sire to daughter and of genes for growth transmitted from the sire to grandprogeny via his daughters.

Sire selection also was conditional on the accuracy (BIF, 1986) of the EPD (or EBV). Specifically, sires with an accuracy of .80 or greater for both YW and maternal ability were identified and the most extreme individuals corresponding to the four selection groups became candidates for selection. Final selection was conditional on the availability of semen; this precluded the use of some sires, especially in the low-growth groups.

A total of 47 bulls were used, 16 of which were used for more than 1 yr (Table 1). Figure 1 shows YW EPD and maternal EBV for the sires at the time of selection for sires used in 1982 through 1984. Figure 2 shows YW and maternal EPD for sires used in 1985 and 1986. Sires used for more than 1 yr are shown for each year of use with EPD available in that year. Clear separation of sires based on maternal EBV or EPD was achieved. Separation of sires by YW EPD was less clear, with animals assigned to the high-growth group in
Figure 1. Yearling weight (YW) expected progeny differences (EPD) and maternal EBV at the time of selection for high-growth, high-maternal (O); high-growth, low-maternal (O); low-growth, high-maternal (x); and low-growth, low-maternal (A) sires selected in 1982 through 1984.

One year occasionally being quite close to animals assigned to the low-growth group in other years. These adjacencies sometimes arose when commercial AI sires were substituted for bulls whose semen was not available or was found to be nonviable. Still, the mean within-year difference at the time of selection between high- and low-growth sires was 18.5 ± 1.4 kg in YW EPD, but only 43 ± 0.26 standard deviation (σ) units for maternal ability (data on maternal EBV and EPD were standardized before analysis using the within-sire group standard deviations to equalize maternal scales across years; the observed difference was equivalent to about 98 ratio units in EBV or 1.0 kg in EPD). Similarly, high and low maternal sires differed by 4.62 ± 0.26 σ in maternal ability (equivalent to about 10.58 ratio units in EBV or 11.0 kg in EPD) but by only 8 ± 1.4 kg in YW EPD. Interaction effects between growth and maternal selected groups were nonsignificant for both YW EPD (P < .90) and maternal ability (P < .20), suggesting similar selection intensities for YW within maternal selection groups and vice versa. The pooled within-year correlation between YW EPD and maternal ability at the time of selection was .06 (P < .65), indicating that these traits were independent within the selected sires.

Published accuracies of YW EPD at the time of selection exceeded .80 for all but one sire (accuracy of .78) and exceeded .90 in 41 of 63 sire-year combinations. Accuracies of maternal EBV exceeded .80 for all but one sire (accuracy of .72) and exceeded .90 in 37 of 42 sire-year combinations. Accuracies of maternal EPD were lower than for within-herd maternal EBV, averaging .82 with a minimum value of .55, but with only 13 of 21 accuracies exceeding .80.

Management. Breeding began in late May and ended in late July with a mean duration of 64 d. Estrus was synchronized before the start of breeding, and all matings were by AI. In each year, sires were assigned to cows at random within cow age groups with the constraint that no cow was bred to a sire of the same sire group in consecutive years. Fescue was the predominant forage for grazing and was stockpiled for winter feed. Supplemental hay, corn silage and (or) broiler litter was fed as needed in winter.

The average calf birth date was in the 2nd wk of March in all years. Calves were weighed
at birth and males were castrated shortly thereafter. Calves were weaned and weighed in late October (mean date of October 25). For the last four calf crops, calves also were weighed shortly after the end of breeding (average date of July 31), and hip height was measured at weaning.

Several preweaning treatments were superimposed on the study. Calves were assigned to treatments at random within selected sire groups and cow ages. In 1983 and 1984, steer calves either received a zeranol or an estradiol-17β implant at about 4 mo of age or remained unimplanted. In 1985 and 1986, male calves either creep-grazed a fescue-clover pasture or a fescue pasture treated with mefluidide (a plant growth regulator) after the breeding season, or were denied creep grazing. In 1987, all calves creep-grazed fescue, fescue-clover or mefluidide-treated fescue after the breeding season.

After weaning, heifer calves were managed together on fescue pasture with supplemental corn, corn silage and(or) broiler litter provided at levels necessary to support breeding at about 15 mo of age. Steers were wintered on basal diets of hay and(or) stockpiled fescue supplemented with a variety of N sources. In 1983, broiler litter was compared with straw treated with ammonia, ammonia plus sulfur or urea as a N source. In 1984, broiler and turkey litter were compared. In 1985 and 1986, hay treated with ammonia or urea was compared with untreated hay. In 1987, calves received either hay or a mixture of corn and broiler litter.

Statistical Procedures. Additive adjustment factors for effects of preweaning and postweaning calf treatments were calculated separately for each year of the study and were applied to the data before final analysis. Thus, steer weaning weights in 1983 and 1984 were adjusted to a nonimplanted basis; weaning height and yearling weight were not affected by implant treatment. Steer weaning weights in 1985 were not affected by creep grazing, but 1986 weights were adjusted to a non-creep-grazed basis, and 1987 weights were adjusted to the mean of the group that creep-grazed fescue. Yearling weights of steers were adjusted to the mean of the set of diets imposed in each year except 1986, when effects of postweaning diet were not significant.

Calf weights at the end of breeding, weaning and near 365 d of age were adjusted to 135, 205 and 365 d, respectively, by linear interpolation between weight at birth and at each weighing. Weaning hip height (WH) was adjusted to 205 d of age using the pooled, within-year, cow age and calf sex regression of WH on age of .094 ± .011 cm/d.

Effects of sire selection on observed calf birth weight (BW), 135-d weight (W135), weaning weight (WW), WH and YW were assessed by comparing the performance of progeny of selected sire groups and by regressing observed progeny performance on sire EPD from the 1989 APHA summary. The model used to compare sire groups was

\[
Z_{ijkmn} = \mu + Y_i + A_j + G_k + S_{kl} + X_m + \beta(WPA_{jn} - WPA) + E_{ijkmn}
\]

where \(Z_{ijkmn}\) is the observed performance of a calf born in the \(i\)th year (Y) to the \(n\)th dam in the \(j\)th cow age group (A), sired by the \(k\)th sire (S) of the \(l\)th selected sire group (G) and of the \(m\)th sex (X); \(\mu\) is a constant common to all observations, \(\beta\) is the regression of \(Z\) on the weaning weight-producing ability (WPA) of the dam expressed as a deviation from the WPA of the appropriate cow age group (WPA) and \(E_{ijkmn}\) is residual error.

Dam WPA were calculated for all cows using data from both the current and previous study. Use of dam WPA as a covariate in model 1 was preferred to simultaneous fitting of discrete dam effects to simplify the model and to facilitate use of information from the previous study. To calculate WPA, calf weights from the current study were deviated from the year-sex-sire means before analysis to attempt to maintain independence between dam WPA estimates and main effects in model 1. Calf weights from the previous study were similarly deviated from their year-sex-sire group (Polled Hereford or Simmental × Polled Hereford) means.

Weight-producing ability then was estimated from a mixed model including fixed effects of dam age group and calving season (spring or fall in the previous study; spring only in the current study) and random effects of dams nested within cow age groups. The cow section of the mixed model coefficient matrix was augmented by adding the ratio of the within- to between-cow variance in WW to the diagonals and WPA were estimated by direct inversion of the resulting matrix. The variance component ratio of 1.70 corresponded...
to an intrasire repeatability of WW of .37, which was obtained from the data using a least squares model that included fixed effects of birth year and season, cow age group and calf sex and random effects of calf sire (or sire group for the previous study) and cow. Calculations for variance component estimation were performed using the General Linear Models procedure of SAS (1985). Because culling of cows on calf WW was not practiced and relationships among purchased cows were unknown, this relatively simple least squares procedure was sufficient to approximate repeatability. The resulting estimate agreed closely with the repeatability estimates of .34 and .36 reported by Nadarajah et al. (1987) for WW in repeated mating involving Angus and Hereford cattle, respectively, and with the mean repeatability of WW across 16 studies of .44 reported by Petty and Cartwright (1966).

Mean squares and least squares means from model 1 were calculated as described by Harvey (1982). Effects of sire group were tested with the between-sire mean square. Individual effects of YW and maternal selection groups and of their interaction were tested using orthogonal contrasts.

Regressions of observed calf performance on sire EPD were obtained using models of the form:

\[ Z_{ijklm} = \mu + A_i + Y_j + X_k + AY_{ij} + \beta_1(EPD_I - EPD) + \beta_2(WPA_m - WPA_d) + E_{ijklm} \]  

where \( \beta_1 \) and \( \beta_2 \) are the regressions of calf performance on sire EPD and dam WPA, respectively, and other terms are as defined in model 1. The most recent available sire EPD (APHA, 1989) were used for the regression analysis (Table 2). Specifically, calf BW, W135, WW, WH and YW were individually regressed on sire EPD for BW, WW, YW, maternal milk (MILK) and total maternal contribution (MAT).

Milk EPD were first presented for Polled Hereford sires in the 1988 Sire Summary (APHA, 1988); they reflect the contribution of the sire to calf WW that is attributable solely to the maternal environment provided by his daughters and are corrected for transmitted effects on growth. Beginning in 1988, MAT EPD were no longer estimated directly; instead, they were calculated as the sum of the MILK EPD plus one-half of the WW EPD to reflect total effects of genes for both WW and MILK. Also, beginning in 1988, all calf WW records (as opposed to only first-calf records) were used in estimation of MILK and MAT EPD. In retrospect, sire selection ideally would have been based on YW and MILK EPD, but this information was not available at the time the sires were selected. However, to ascertain joint effects of growth and MILK EPD on calf performance, model 2 was expanded to simultaneously estimate effects of WW and MILK EPD or of YW and MILK EPD on calf traits.

Sire EPD specific to this study were estimated for BW, WW, WH and YW but not for W135 because sire effects were not significant for W135. The mixed model used to estimate EPD included fixed effects of cow age group, year and calf sex and random effects of sire and dam. Diagonal elements of the sire and dam sections of the mixed model coefficient matrix were augmented by adding ratios of residual to sire and dam variances, respectively, and sire and dam effects were estimated by direct inversion of the resulting coefficient matrix. Dam variance component ratios were 2.34 for BW, 1.42 for WW, 1.58 for WH and 11.04 for YW. These ratios were calculated using data from the current study in a least squares model that included fixed effects of year, cow age group and calf sex and random effects of sire and cow (General Linear Models procedure; SAS, 1985) and corresponded to repeatabilities of cow performance of .27 for BW, .39 for WW, .37 for WH and .08 for YW.

Sire variance component ratios could not be derived from the data due to divergent selection of sires, and instead were calculated assuming heritabilities (\( h^2 \)) of .41 for BW, .26 for WW, .22 for WH and .33 for YW. Resulting sire variance component ratios were 6.14 for BW, 8.30 for WW, 10.43 for WH and 10.11 for YW. The \( h^2 \) estimate for YW was similar to that used to derive YW EPD (.36; APHA, 1989). The \( h^2 \) estimate for WW was lower than that used to derive APHA WW EPD (.43; APHA, 1989) but similar to that derived from Simmental field data using restricted maximum likelihood procedures (.23; ASA, 1989) and larger than the value of .10 derived from Koch et al. (1982). The \( h^2 \) estimate for BW was similar to the value of .43 reported by Koch et al. (1982) and to that used in analysis of Simmental field data (.41;
ASA, 1989) but was smaller than that used by APHA (19.56; APHA, 1989). The $h^2$ estimate for WH was obtained from Brown (1978), who reported $h^2$ estimates of WH of .21 and .22 in Hereford and Angus calves, respectively.

Relationships among cows were not known and therefore could not be included in the mixed model analysis. Relationship did exist among some sires but were not included in the analysis because selection of sires on EPD calculated with relatively high accuracies would affect the weightings that should be applied to progeny records of related sires.

Accuracies (ACC) of EPD estimates were calculated as:

$$ACC = 1 - \sqrt{PEV/\sigma_s^2}$$

where $\sigma_s^2$ is the between-sire variance component and $PEV$ is the prediction error variance, which was approximated as the ratio of the residual variance ($\sigma_E^2$) to the diagonal element of the mixed model coefficient matrix for each sire (BIF, 1986). Estimates of $\sigma_E^2$ were 14.9 kg$^2$ for BW, 9.4 cm$^2$ for WH, 310.3 kg$^2$ for WW and 1,363.0 kg$^2$ for YW and were obtained from the same analysis used to derive repeatabilities for cow performance. The ACC does not correspond directly to the expected correlation between true breeding value and EPD ($r_E$). Instead, $(1 - r_E^2)$ is approximately equal to $(PEV/\sigma_E^2)$; therefore, $r_E$ can be estimated from ACC as:

$$r_E = \sqrt{1 - (1 - ACC)^2}$$

The observed correlation between EPD derived in this study and APHA EPD ($r_G$) is expected to equal the product of the $r_E$ associated with each EPD estimate if the genetic correlation ($r_G$) between production in the two environments is 1.0. Thus, $r_G = r_E1r_E2$, where $r_E1$ and $r_E2$ are $r_E$ values for the two EPD. Values of $r_G$ between environments were thus estimated as $r_G = r_G/r_E1r_E2$, where $r_E1r_E2$ was the mean product of $r_E$ values for individual bulls.

The 1989 APHA EPD were obtained from a reduced animal model (Quaas and Pollak, 1980), whereas the EPD used to select the sires (e.g., APHA, 1986) were derived from separate sire and maternal grandsire models without consideration of relationships among animals. The EPD from the two procedures were compared by correlating EPD from the current data to the 1986 and 1989 APHA EPD and by recalculating regressions of calf performance on 1986 APHA EPD.

Results and Discussion

The YW and MILK EPD for selected sires from the 1989 APHA Sire Summary are shown in Figure 3, and mean EPD and accuracies are shown in Table 2. Some overlap between YW EPD of high- and low-growth sires was observed, based on the results of the 1989 Sire Summary, but the amount of overlap was small. Differences between high- and low-growth sires in YW EPD averaged 6.3 ± .9 kg, which was considerably less than the mean difference of 18.4 kg between these two groups based on YW EPD achieved at the time.
of selection. In comparing the YW EPDs of selected sires between the 1986 Sire Summary (which was the last APHA Sire Summary produced using the methodology under which the sires were selected) and the 1989 Sire Summary (which was produced using results from an animal model), the variation among selected sires in YW EPD was much less in the 1989 Sire Summary (standard deviation of 4.6 kg vs 10.4 kg in the 1986 Sire Summary). The reasons for this reduction in variation in YW EPD are not completely clear. Some reduction in variation in YW EPD among divergently selected sires would be expected as additional data accumulated or whenever new evaluation procedures were used. However, accuracies of YW EPD already were high for these bulls at the time of selection; it seems unlikely that decreases in variation of the magnitude observed could simply be due to the accumulation of additional progeny records.

On the basis of 1989 Sire Summary, high- and low-maternal sires differed by an average of 4.0 ± .8 kg in MAT EPD. Again, this difference was much less than the difference of about 10.8 kg present at the time of selection. However, procedures for calculating MAT EPD in the 1989 Sire Summary were quite different from those used in earlier summaries. Maternal EPD upon which selection was based were calculated directly using only first calving records of the sires' daughters. In contrast, 1989 MAT EPD were calculated as the sum of the MILK EPD plus one-half the WW EPD and were calculated using all available WW records. Thus, considerable changes in maternal EPD were not surprising. The mean difference in MILK EPD between high- and low-maternal sires was 3.5 ± .4 kg. Some overlap existed between MILK EPD of high- and low-maternal groups, based on the 1989 Sire Summary (Figure 3). Although differences between high- and low-maternal sires were similar for high- and low-growth bulls at the time of selection, differences between high- and low-maternal bulls in MAT and MILK EPD from the 1989 Sire Summary were larger for low-growth bulls (6.0 ± 1.1 and 4.5 ± .8 kg, respectively) than for high-growth bulls (2.1 ± 1.0 and 2.4 ± .7 kg, respectively).

Despite the lower selection differentials that were realized based on the 1989 Sire Summary, the selected bulls still expressed considerable variation in EPD. Overall ranges in EPD were -1.4 to 4.3 kg for BW, -8.7 to 8.4 kg for WW, -12.9 to 12.8 kg for YW, 1.2 to 15.3 kg for MAT and 3.2 to 15.4 kg for MILK. Correlations among EPD of selected sires from the 1989 Summary (Table 3) revealed that YW and MILK EPD were independent (r = .03), but that YW EPD was positively correlated with BW (r = .73), WW (r = .96) and MAT (r = .54) EPD. The correlation between WW and MILK EPD was positive but not significant (r = .21).

Progeny means for each sire group are shown in Table 4. Individual sire effects nested within sire groups were significant for BW (P < .01), WW (P < .05) and WH (P < .01) but not for W135 or YW. Thus, selection on YW EPD yielded groups of bulls that were homogeneous in terms of progeny YW but still differed in progeny BW, WW and WH.

Birth weight averaged 2.1 kg more (P < .01) for progeny of high-YW sires than for progeny of low-YW sires, but differences between MAT EPD groups were not significant. Sire group did not affect W135, but at weaning calves from high-YW EPD sires averaged 7.5 kg heavier (P < .01) than calves from low-YW EPD sires. WW did not differ
between MAT EPD groups. WH and YW were correspondingly 1.90 cm and 16.4 kg, respectively, more for high-YW EPD sires than for low-YW EPD sires (P < .001), but were unaffected by MAT EPD group.

The regression of observed BW on sire BW EPD was 1.18 ± .20 kg/kg and did not differ significantly from the expected value of 1.00. For postnatal weights (Table 5), W135 was not significantly associated with any sire EPD, although the relationship was positive in all cases. Weaning weight, WH and YW were all significantly related to WW, YW and MAT EPD. This result was expected because all of these EPD include components related to calf growth. In contrast, MILK EPD was not related to calf WW, WH or YW.

The regression of WW on WW EPD was .75 ± .24 kg/kg and was somewhat smaller (P < .40) than expected, even though the heifers in this study averaged 55 kg less as yearlings than heifers in APHA herds. Differences among sires in WW EPD can be underestimated if a substantial proportion of calves are culled on WW and are not weighed as yearlings (Pollak and Quaas, 1981). In the data that were used to calculate the APHA EPD, the number of YW records was only 29% of the available WW records. Thus, considerable selection apparently occurred before taking yearling weights and may have resulted in underestimation of true WW EPD differences among sires. These results suggest that multiple-trait evaluation procedures (Henderson, 1976; Pollak and Quaas, 1981) should be considered in the future to alleviate potential bias due to culling.

Because EPD for WW or YW and MILK were independent in this study, results of multiple regression analyses were essentially the same as those shown in Table 5. In most cases, effects of MILK EPD were reduced even more with simultaneous adjustment for WW or YW EPD.

### Table 4. Means and Standard Errors for Calf Performance by Sire Groups

<table>
<thead>
<tr>
<th>Trait</th>
<th>High YW, high MAT</th>
<th>High YW, low MAT</th>
<th>Low YW, high MAT</th>
<th>Low YW, low MAT</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of calves</td>
<td>115</td>
<td>112</td>
<td>115</td>
<td>115</td>
<td>457</td>
</tr>
<tr>
<td>Birth wt, kg&lt;sup&gt;b&lt;/sup&gt;</td>
<td>35.6 ± .6</td>
<td>35.5 ± .6</td>
<td>33.9 ± .6</td>
<td>32.9 ± .6</td>
<td>34.5 ± .3</td>
</tr>
<tr>
<td>135-d wt, kg</td>
<td>146.8 ± 2.0</td>
<td>142.0 ± 1.9</td>
<td>142.8 ± 1.9</td>
<td>142.8 ± 1.9</td>
<td>143.6 ± 1.0</td>
</tr>
<tr>
<td>Weaning wt, kg</td>
<td>192.0 ± 2.3</td>
<td>185.6 ± 2.2</td>
<td>181.4 ± 2.2</td>
<td>181.2 ± 2.2</td>
<td>185.1 ± 1.1</td>
</tr>
<tr>
<td>Weaning height, cm&lt;sup&gt;b&lt;/sup&gt;</td>
<td>105.4 ± .5</td>
<td>104.0 ± .5</td>
<td>103.0 ± .5</td>
<td>102.6 ± .5</td>
<td>103.8 ± .2</td>
</tr>
<tr>
<td>Yearling wt, kg</td>
<td>282.2 ± 4.1</td>
<td>282.6 ± 4.2</td>
<td>265.8 ± 4.1</td>
<td>265.2 ± 4.0</td>
<td>274.2 ± 2.0</td>
</tr>
</tbody>
</table>

<sup>a</sup>YW = yearling weight, MAT = maternal.

<sup>b</sup>YW expected progeny difference groups differ (P < .01).
TABLE 5. SIMPLE REGRESSIONS OF POSTNATAL CALF TRAITS ON SIRE EXPECTED PROGENY DIFFERENCES (EPD)

<table>
<thead>
<tr>
<th>Trait</th>
<th>Weaning wt</th>
<th>Yearling wt</th>
<th>Maternal wt</th>
<th>Maternal weaning wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>135-d wt, kg</td>
<td>.42 ± .24</td>
<td>.32 ± .19</td>
<td>.57 ± .40</td>
<td>.51 ± .26</td>
</tr>
<tr>
<td>Weaning wt, kg</td>
<td>.75 ± .24</td>
<td>.67 ± .19</td>
<td>.26 ± .37</td>
<td>.55 ± .25</td>
</tr>
<tr>
<td>Weaning height, cm</td>
<td>.20 ± .05</td>
<td>.17 ± .04</td>
<td>.11 ± .08</td>
<td>.17 ± .05</td>
</tr>
<tr>
<td>Yearling wt, kg</td>
<td>1.82 ± .52</td>
<td>1.79 ± .42</td>
<td>-.05 ± .78</td>
<td>.97 ± .55</td>
</tr>
</tbody>
</table>

Means, accuracies and expected correlations with true breeding value for EPD calculated in this study are shown in Table 6. Correlations between these EPD and 1989 APHA EPD were .53 for BW, .37 for WW and .54 for YW and have mean expectation when \( r_G = 1.0 \) of .68, .61 and .58, respectively. Thus, estimated genetic correlations between performance in this study and performance in APHA herds were .78 for BW, .61 for WW and .93 for YW. These estimates were reasonably close to 1.0 for BW and very close to 1.0 for YW, but the \( r_G \) for WW was considerably smaller, suggesting that genetic mechanisms controlling WW may differ for the two environments.

Correlations between EPD from the 1986 and 1989 APHA sire summaries for bulls used in this study were .91 for BW, .77 for WW, .81 for YW and .67 for MAT. Thus, correspondence between the sire summary procedures was excellent for BW but modest for other traits. Correlations of EPD calculated in this study with 1986 APHA EPD were .56 for BW, .36 for WW and .65 for YW. Thus, correlations of 1986 APHA BW and WW EPD with EPD from the current study were similar to those observed for 1989 APHA EPD. However, 1986 APHA YW EPD had a somewhat higher correlation with our EPD than did the 1989 APHA YW EPD. Regressions of observed calf performance on 1986 EPD were 1.02 ± .16 kg/kg for BW, 40 ± .14 kg/kg for WW and .90 ± .18 kg/kg for YW. The value for BW did not differ from the expected value of 1.00 and was similar to that for 1989 BW EPD. However, the regression of WW on WW EPD was .30 kg/kg lower than that based on 1989 EPD and was significantly less than 1.00, suggesting improved predictability for 1989 WW EPD. In contrast, the YW regression was very close to 1.00 and was much smaller than that based on 1989 YW EPD. The substantial decrease in variation in YW EPD among the selected bulls between 1986 and 1989 is mathematically responsible for the observed increase in the regression coefficient of observed YW on YW EPD and for the increase in the standard error of the regression coefficient.

Implications

Selection of sires based on expected progeny differences published by beef cattle breed associations had significant, positive relationship to calf performance when the sires were

TABLE 6. MEAN SIRE EXPECTED PROGENY DIFFERENCES (EPD) BY SIRE GROUP FROM DATA COLLECTED IN THE CURRENT STUDY

<table>
<thead>
<tr>
<th>Trait</th>
<th>Mean EPD (kg)</th>
<th>Mean accuracy</th>
<th>Mean ( \hat{r}_G )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth wt, kg(^c)</td>
<td>.6 ± .3</td>
<td>.29</td>
<td>.68</td>
</tr>
<tr>
<td>Weaning wt, kg(^c)</td>
<td>3.3 ± .9</td>
<td>.23</td>
<td>.62</td>
</tr>
<tr>
<td>Weaning height, cm(^c)</td>
<td>.69 ± .03</td>
<td>.20</td>
<td>.58</td>
</tr>
<tr>
<td>Yearling wt, kg(^c)</td>
<td>2.9 ± 1.5</td>
<td>.20</td>
<td>.59</td>
</tr>
</tbody>
</table>

\(^a\)YW = yearling weight, MAT = maternal.

\(^b\)\( \hat{r}_G \) = expected correlation between estimate of EPD and true breeding value.

\(^c\)Effects of YW EPD group (\( P < .01 \)).
used for crossbreeding. Polled Hereford sires selected for high or low yearling weight expected progeny differences were mated to Angus cows and the progeny were evaluated. Each 1-kg increase in sire yearling weight expected progeny difference corresponded to a 1.79-kg increase in calf yearling weight. Increases of 1.18 kg actual birth weight/kg birth weight expected progeny difference and of .75 kg weaning weight/kg weaning weight expected progeny difference also were observed.

Literature Cited


BIF. 1986. Guidelines for Uniform Beef Improvement Programs. Beef Improvement Federation, Raleigh, NC.


