Direct and Correlated Responses to Selection for Increased Weaning and Yearling Weights in Hereford Cattle II. Evaluation of Response

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Story in Brief

This portion of the study dealt with estimating phenotypic and genetic response to selection for increased weaning (WWL) and yearling weight (YWL) in two lines of Hereford cattle from 1964 to 1978. An Angus control line was also maintained to monitor year-to-year environmental variations. Data was collected on a total of 1273 Hereford calves and 723 Angus calves. Each line maintained 50 cows, with two bulls and 10 heifers selected each year. The basis for selection was heaviest weaning weight (WW) in the WWL and heaviest 365-day weight for bulls and 425-day weight for heifers in the YWL. Bulls and heifers in the control line were selected to have as close to zero selection differentials for both WW and YW as possible.

Negative phenotypic trends for WW and YW were observed in all three lines, indicating a negative or degenerating environmental trend. However, a larger negative phenotypic trend in the control line indicated genetic progress had occurred in the selection lines. Genetic change estimated as deviations of WWL vs control line showed direct response for WW of 3.06 lb/year for bulls and 1.68 lb/year for heifers. Correlated response for WW in the YWL was 2.16 lb/year for bulls and 1.94 lb/year for heifers. The direct response for YW in the YWL was 3.27 lb/year and 2.67 lb/year for bulls and heifers, respectively, while as a correlated response in the WWL, it was considerably lower in bulls (1.50 lb/year) and similar in heifers (2.23 lb/year). Realized heritabilities were .20 for WW and .14 for YW. All genetic responses and realized heritabilities were probably underestimated as some selection pressure was indicated in the control line for WW and YW. Positive correlated genetic changes occurred in all other traits measured in both selection lines.

Introduction

Producers often place considerable emphasis on growth rate in order to improve their efficiency of beef production. The alterations that selection produces in the genetic makeup of a herd or population are difficult to see or directly measure, but these changes are cumulative over generations. Changes made by selection often are difficult to evaluate as they often are coupled with the impact of improved management practices as well as large environmental variations which influence levels of performance.

Few studies have dealt with the long-term effects of selection on a cattle population although information is needed to quantify how much improvement can be made in economically important traits through selection. The cattle selection research at OSU was initiated in the early sixties with the objectives of: (1) estimating direct response to selection for weaning and yearling weights in Hereford cattle and (2) estimating correlated responses in other economically important traits. Hopefully, information gained from this study will aid the industry in developing selection programs aimed at choosing cattle genetically superior for economically important traits.

Materials and Methods

Performance records of 1273 purebred Hereford calves, 239 selected Hereford cows and 57 selected Hereford bulls were analyzed for this study. These records were collected over the 15-year period from 1964 to 1979 at the Oklahoma Agricultural Experiment Station. Records of 723 purebred Angus calves, 126 Angus cows and 31 Angus bulls from an unselected control line were also analyzed.

Two Hereford lines, one selected for increased weaning weight (WWL) and one for increased yearling weight (YWL), and the unselected Angus control line (CL) were each maintained as 50 cow lines. Each year, on the average, two bulls and 10 heifers were selected. An animal was considered "selected" if it produced at least one offspring in the selection line.

Prior to 1969 the Angus line had been maintained as a progeny test line with selection criteria based on increasing yearling weight. In 1969 the line was converted to a control line in which animals with selection differentials as near zero as possible for WW and YW were used as replacements. Up to this point only two calf crops had been sired by progeny tested bulls, so very little selection had been practiced.

Every effort was made to keep the environment similar for all lines. Cattle were pastured on native range typical of central Oklahoma during most of the year. Calves were born in the spring and remained with their dams until weaning at an average age of 205 days. Following weaning, bull calves were placed on a 140-day feedlot gain test after a 2-week warm up period. Heifers were placed on pasture gain tests, including wheat pasture when available, to gain from .75 to 1.00 lb/day, and long yearling weights were taken at an average of 425 days of age.

Complete performance records were collected on all calves. Birth weights (BW) were obtained within 24 hours of birth. In addition, preweaning average daily gain (WADG), 205-day adjusted weaning weight (WW), weaning grade (WG), weaning condition (WC), yearling weight (YW), postweaning average daily gain (YADG), yearling grade (YG) and yearling condition (YC) were all collected. YW was adjusted to 365 days for bulls and 425 days for heifers. WG and YG are both indicators of calf conformation or muscling degree while WC and YC are indicators of fatness.

Results and Discussion

Phenotypic trends

Annual phenotypic trends for each line are presented in Figures 1-3 for BW, WW and YW. Since the two Hereford lines were developed from a common foundation, they should not differ except for sampling error until 1966 when the first calves from selected parents were born. Differences between the Angus CL and Hereford selection lines until 1966 should be due mostly to breed differences. Since the CL was a progeny tested line until the 1970 calf crop, some selection pressure for growth had been applied, but from 1970 on, any increase in

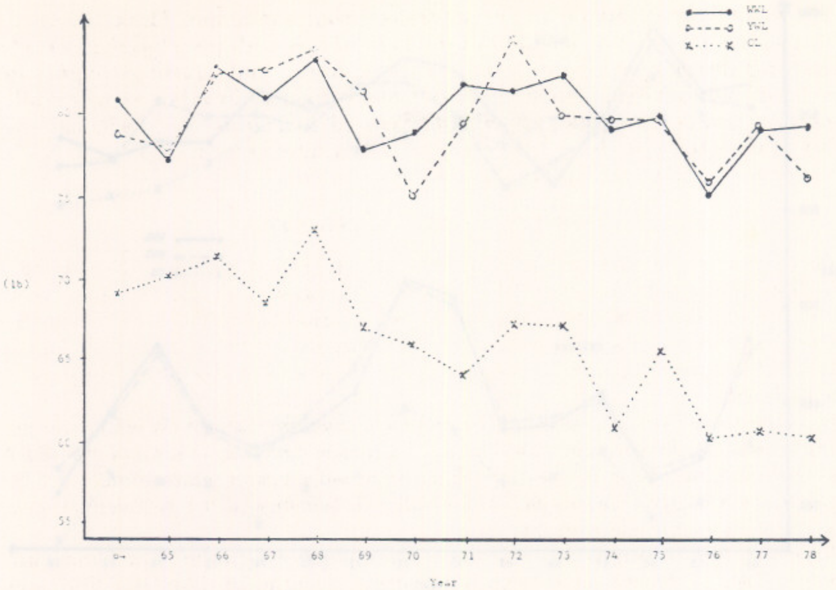

Figure 1. Annual phenotypic means for birthweight averaged over sex

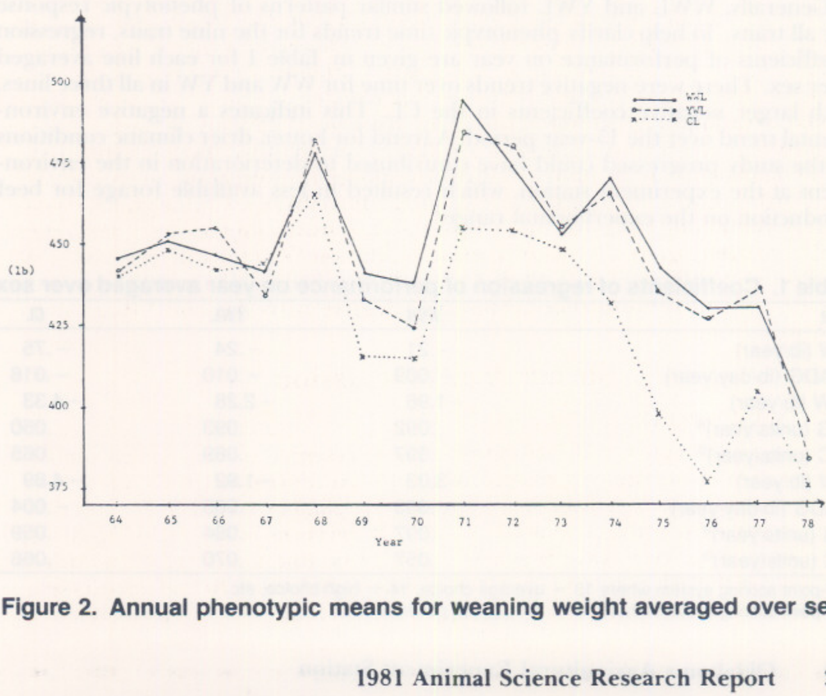

Figure 2. Annual phenotypic means for weaning weight averaged over sex

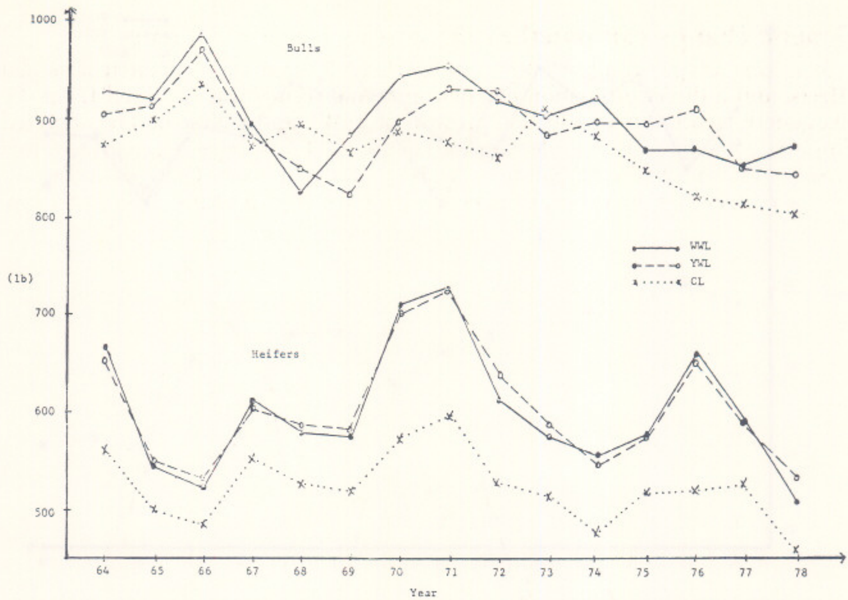

Figure 3. Annual phenotypic means for yearling weight for bulls and heifers

the differences between selection lines and CL should be due to genetic response to selection for increased weaning or yearling weights.

Generally, WWL and YWL followed similar patterns of phenotypic response for all traits. To help clarify phenotypic time trends for the nine traits, regression coefficients of performance on year are given in Table 1 for each line averaged over sex. There were negative trends over time for WW and YW in all three lines, with larger negative coefficients in the CL. This indicates a negative environmental trend over the 15-year period. A trend for hotter, drier climatic conditions as the study progressed could have contributed to deterioration in the environment at the experiment station, which resulted in less available forage for beef production on the experimental range.

Table 1. Coefficients of regression of performance on year averaged over sex

Trait	WWL	YWL	CL
BW (lb/year)	−.21	−.24	−.75
WADG (lb/day/year)	−.009	−.010	−.018
WW (lb/year)	−1.96	−2.28	−4.33
WG (units/year)[a]	.092	.093	.050
WC (units/year)[b]	.097	.089	.065
YW (lb/year)	−3.03	−1.92	−4.89
YADG (lb/day/year)	−.003	.003	−.004
YG (units/year)[a]	.097	.084	.059
YC (units/year)[b]	.057	.070	.066

[a]17-point scoring system where 13 = average choice, 14 = high choice, etc.
[b]17-point scoring system where 13 = average fat cover, etc.

Genetic change estimated as deviations for control line

Since phenotypic trends are the combined result of genetic and environmental effects, and a direct estimation of environmental trends was obtained from the CL, genetic trends due to selection pressure in WWL and YWL could be obtained simply by deviations of the selection lines from the CL. Figure 4 portrays annual genetic trends in WW averaged over sex for WWL and YWL. Genetically the two lines progressed at similar rates over time, improving until the 1977 calf crop.

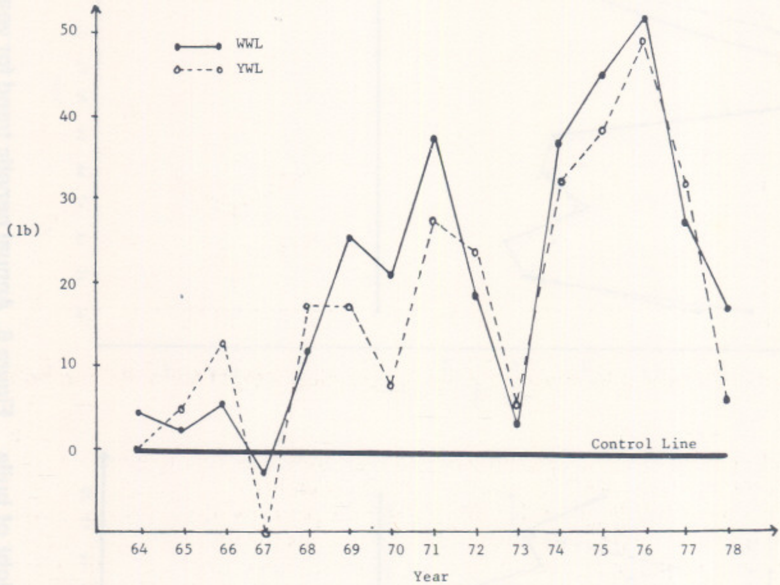

Figure 4. Annual genetic trend for weaning weight averaged over sex as deviations from control

Figures 5 and 6 represent genetic trends for YW of bulls and heifers, respectively, in WWL and YWL. Again the annual genetic means for both Hereford lines followed similar patterns; however, there was considerably more fluctuation in genetic trends of bulls than heifers.

Table 2 gives the genetic trends realized per year of bulls and heifers and averaged over sex for the nine traits of primary interest. Direct genetic response for WW in the WWL was estimated to be 3.06 lb/year in bulls and 1.68 lb/year in heifers for an average of 2.37 lb/year. Correlated response of WW when selecting for YW was 2.16 lb/year and 1.94 lb/year for bulls and heifers, respectively, averaging 2.05 lb/year. More genetic response in WW was realized by direct selection than indirect selection in bulls while the opposite was true for heifers. When considering YW, direct genetic response was 3.27 lb/year in bulls and 2.67 lb/year in heifers (average 2.97 lb/year) while correlated response was considerably lower in bulls (1.50 lb/year) and similar in heifers (2.23 lb/year).

Realized heritabilities based on genetic response and mean accumulated selection differentials were .20 for WW and .14 for YW. These realized heritabilities

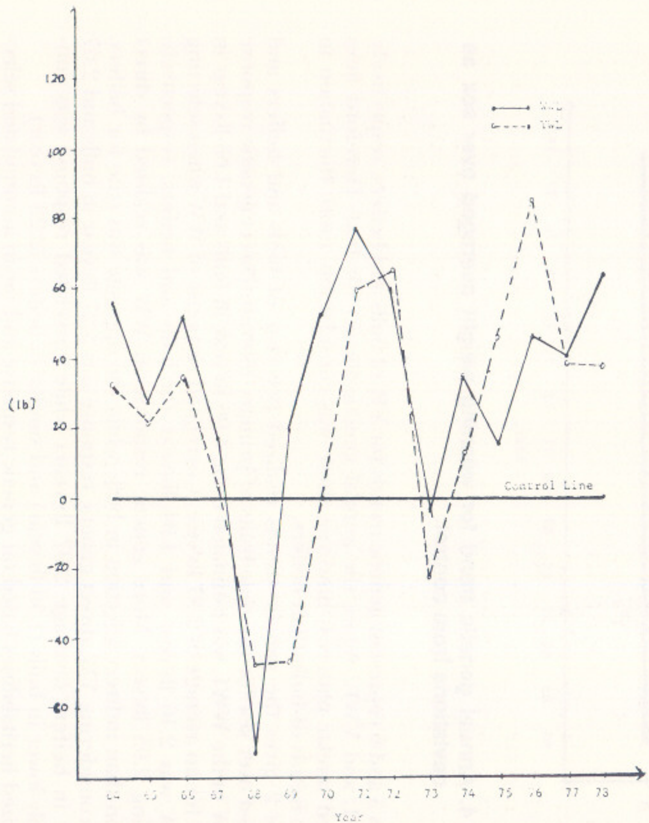

Figure 5. Annual genetic trend for yearling weight of bulls as deviations from the control

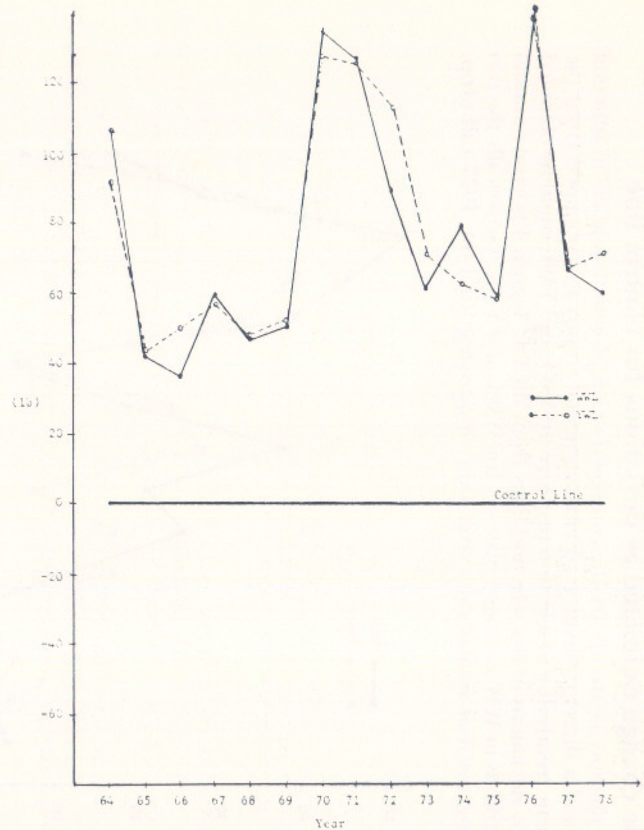

Figure 6. Annual genetic trend for yearling weight of heifers as deviations from the control

Table 2. Estimates of genetic trend per year from differences of the control line and selection lines

Trait	WWL			YWL		
	Bulls	Heifers	Average	Bulls	Heifers	Average
BW, lb	.58	.50	.54	.53	.49	.51
WADG, lb/day	.012	.006	.009	.008	.007	.008
WW, lb	3.06	1.68	2.37	2.16	1.94	2.05
WG[a]	.024	.059	.042	.021	.065	.043
WC[b]	.030	.035	.033	.014	.034	.024
YW, lb	1.50	2.23	1.86	3.27	2.67	2.97
YADG, lb/day	.002	.003	.003	.008	.004	.006
YG[a]	.031	.044	.038	.024	.025	.025
YC[b]	.001	−.019	−.009	.015	−.008	.004

[a]17-point scoring system where 13 = average choice, 14 = high choice, etc.
[b]17-point scoring system where 13 = average fat cover.

are probably underestimated as there was some selection pressure on the CL for WW and YW as previously discussed. Selection pressure realized in the CL would also tend to make the deviation for CL an underestimate of genetic trends in the selection lines.

Correlated genetic changes also occurred. BW increased in both lines by .54 and .51 lb/year for WWL and YWL, respectively. WADG also had positive correlated genetic change per year in both lines with bulls in the WWL increasing twice as much as heifers (.012 vs .006 lb per day per year). In the YWL, correlated WADG increase was similar in both sexes averaging .008 lb per day per year. This data indicates selection for WW or YW give similar effects on WADG. Correlated response for YADG was twice as large in YWL as in WWL (.006 vs .003 lb per day per year) indicating, unlike WADG, YW selection puts more emphasis on YADG than does WW selection. Also, correlated response in the YWL for bulls was twice the magnitude of response in heifers.

Other concerns of beef cattle producers are indirect responses in conformation and fatness when selecting for weight traits. Conformation or degree of muscling as a correlated response at weaning increased in both lines by a similar magnitude (.043 units/year). Correlated YG responses were greater in the WWL (.038 units/year) than the YWL (.025 units/year). Condition scores measure degree of finish at a particular weight. Correlated genetic changes in WC were similar in WWL bulls, WWL heifers and YWL heifers (average .033 units/year), while YWL bulls were lower (.014 units/year). Negative genetic changes occurred in YC for heifers of both lines (average −.013 units/year) with a positive change in YWL bulls (.015 units/year) and essentially no change in YC of WWL bulls. All correlated measures of response in conformation and condition were quite small, with more positive change occurring in degree of muscling than fatness, which is desirable from an industry viewpoint.