Selection For Increased Weaning Weight and Yearling Weight In Hereford Cattle

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Story in Brief

Performance data on 827 calves raised from 1964 through 1973 were analyzed to determine the amount of selection applied and the responses obtained in two 50-cow lines of Hereford cattle. One line was selected for increased weaning weight (WWL) and the other for increased yearling weight (YWL). The average performance has been similar in the two lines over the duration of the study which suggests that similar genetic responses are occurring in both lines.

The amount of selection practiced was determined by cumulative selection differentials. Male selection accounted for 80 and 83 percent of the total selection applied for weaning weight in the WWL and yearling weight in the YWL, respectively. Thus, these results reinforce the importance of selecting genetically superior herd sires. In both lines there were substantial positive cumulative selection differentials for birthweight, postweaning ADG and weaning and yearling conformation scores as well as for weaning weight in YWL and yearling weight in WWL. These correlated selection differentials were slightly larger in the YWL.

On an independent set of cows, calves sired by selected bulls after seven years of selection were 5.6, 5.9 and 6.9 percent heavier at birth, weaning and yearling, respectively, and grew 11 percent faster postweaning than calves sired by foundation sires. Overall these results indicate that selection based on either weaning weight, yearling weight or both should result in appreciable improvement in overall performance.

Introduction

The entire beef industry is currently undergoing a critical self-evaluation with each segment taking a close look at how net profit can

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In cooperation with USDA, Agricultural Research Service, Southern Region.

be increased in spite of rising production costs. Purebred and commercial cattlemen are vitally concerned about the selection of genetically improved breeding stock since selection is the primary force available for improving the average genetic merit of breeds and herds.

Because growth rate has a major impact on net returns, breeders are currently placing considerable emphasis on growth performance when selecting breeding animals. Relatively little research information is available, however, to quantitatively evaluate the effectiveness of selection for increased growth rate for improving total beef cattle performance. Evaluation of how rapidly improvement can be attained in traits directly selected for and the magnitude and direction of changes in related traits will be of considerable value in determining which traits to emphasize in beef cattle selection programs. This study was conducted to determine the amount of selection applied and the responses obtained in two lines of Hereford cattle selected for weaning weight and yearling weight, respectively.

Experimental Procedure

The primary data used in this study were the performance records of 827 registered Hereford calves raised from 1964 through 1973 as part of the beef cattle selection project being conducted by the Oklahoma Agricultural Experiment Station. Foundation animals used to initiate the project were purchased from several herds in the midwest and southwest and were assembled at the Fort Reno Livestock Research Station, El Reno, Oklahoma starting in 1960. Selection lines were formed by random allocation of foundation females to lines in 1963 to formally initiate the project. Weaning weight, standardized to 205 days and adjusted for age of dam, was the selection criterion in one line (WWL). Yearling weight, standardized to 365 days for bulls and 425 days for heifers, was the selection criterion in the other line (YWL). Foundation females were the progeny of 16 different sires and 10 bulls were used from 1963 through 1966 as foundation sires. Subsequent to 1966 the lines were closed and all replacement breeding stock selected from within each line based on the respective selection criteria of the two lines.

Each line was maintained at 50 cows and 4 sires. Each year two bulls were selected from each line on their respective criteria and were used two years and discarded. The 13 top heifers were selected from each line each year and bred as yearlings. The top 10 pregnant heifers, based on a fall pregnancy examination, were then retained in each line. The lines were maintained at 50 cows by culling 10 cows yearly on the following criteria: (1) serious unsoundness, (2) not pregnant based on fall pregnancy examination and (3) oldest age.

The selection lines were managed as a single herd except during the breeding season and when circumstances such as pasture size and forage availability dictated otherwise. The cow herd grazed native range during the spring and summer and native range and wheat pasture, when available, during the winter. Prairie hay, alfalfa and cottonseed cake were supplemented during the winter as dictated by forage availability, weather conditions and condition of the cattle.

Bulls were placed with the cows in single sire breeding pastures on May 1 each year. Calves were born in the spring starting about February 1. All calves were tatooed, ear tagged and weighed within 24 hours of birth. Calves ran with their dams without creep feed and were weaned in the fall when the average age of all calves was 205 days. Conformation and condition scores were determined at weaning and yearling ages by a panel of at least three qualified persons.

After weaning, bull calves were given a two week warm up period prior to being placed on a feedlot performance test. Feedlot performance tests were 160 days in duration through 1971 and 140 days in subsequent years. Heifers were placed on wheat pasture after weaning and supplemented with prairie hay, alfalfa, grain and cottonseed meal so as to gain from 0.75 to 1.00 pounds per day from weaning to 425 days.

Complete performance records were collected on each calf through a year of age for bulls and through 425 days of age for heifers. The records used in this study were birth weight, weaning weight, postweaning ADG, yearling weight and weaning and yearling conformation score. Weaning weights were standardized to a 205-day mature dam basis using additive correction factors of +84 pounds, +37 pounds and +5 pounds for calves from 2, 3 and 4-year old dams, respectively. The correction factors used were developed in an earlier study involving a substantial portion of this same data (Cardellino and Frahm, 1970, Okla. Agr. Exp. Sta. Misc. Pub. 84:5). Yearling weights were 365-day weights for bulls obtained by multiplying 160 times postweaning ADG and adding the adjusted weaning weight. Yearling weights for heifers were 425-day weights obtained by multiplying 220 times postweaning ADG and adding the adjusted weaning weight.

Selection differentials, the difference in the performance of the selected individual compared with the average performance of the group from which it was selected, were used to measure the amount of selection applied. In closed herds under long term selection, selection differentials accumulate over time since calves selected in a given year may be offspring of parents that were also selected. Therefore, to measure the total amount of selection applied in the lines, a cumulative selection differential was calculated for each selected animal. The cumulative selection differential for an individual was the average of the cumulative selection

differentials of its parents plus the individual's own selection differential. A cumulative selection differential quantitifies the total selection pressure applied to a particular selected animal relative to the original foundation herd. Foundation animals have cumulative selection differentials of zero.

Estimates of genetic changes were obtained from comparisons of performance of calves produced by foundation sires with performance of calves produced by selected sires. Semen that had been collected and stored from two foundation sires and semen from four selected bulls (two from WWL and two from YWL) born in 1970 was used to inseminate a herd of Angus cows to produce calves in 1972. The four selected sires represent the product of seven years of selection. A total of 103 calves, 61 steers and 42 heifers, were produced by these matings.

Results and Discussion

Time Trends

To establish the trends in average performance of the lines over the duration of this study, annual means for weaning weight, yearling weight and weaning and yearling conformation score are plotted on year in Figures 1, 2 and 3, respectively. Bull and heifer performances were averaged for determining the yearly average performances. Although there has been considerable fluctuation in performance from one year to the next, the average weaning weight, yearling weight and conformation scores have been quite similar for the two lines. Since the two lines are managed together under the same environmental conditions each year,

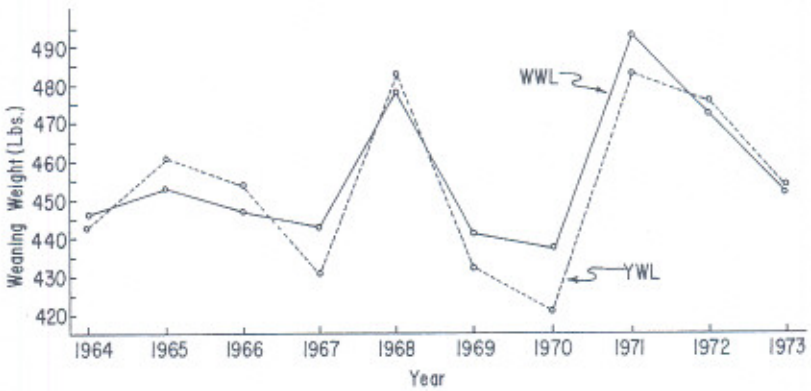

Figure 1. Annual Weaning Weight Means Plotted on Year.

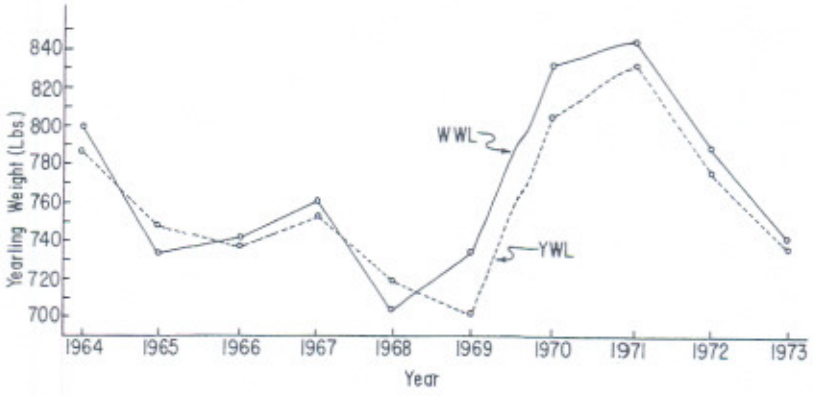

Figure 2. Annual Yearling Weight Means Plotted on Year.

the environmental effects in any year would be expected to be very similar on both lines. Thus, the close agreement in performance through yearling age for the two lines suggest that the genetic improvement to date for weaning weight and yearling weight has been quite similar in both lines.

Annual changes in performance were determined by calculating the regression coefficients of yearly means on years for each of the traits. The regression coefficients obtained are summarized in Table 1 and measure the average change in performance per year. These changes, as well as the yearly changes shown in Figures 1, 2 and 3, are the combined result of genetic and environmental changes. Consequently, interpretation of these results in terms of quantifying genetic responses to selection is not possible.

Table 1. Coefficients Of Regression Of Average Annual Performance On Year

Trait	Weaning Weight Line	Yearling Weight Line
Birth Weight (ls.)	0.0±0.26	0.0±0.44
Weaning Weight (lbs.)	2.2±2.01	1.6±2.52
Weaning Score[1]	0.1±0.04	0.1±0.04
Postweaning ADG (lbs./day)	0.0±0.03	0.0±0.03
Yearling Weight (lbs.)	3.9±5.22	2.2±4.7
Yearling Score[1]	0.1±0.05	0.1±0.05

[1] A 17 point scoring system was used where 13 = average choice, 14 = high choice, etc.

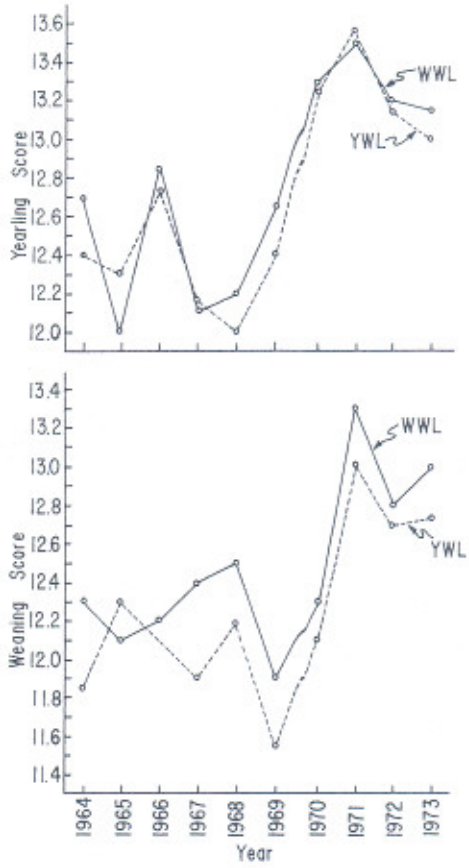

Figure 3. **Annual Weaning and Conformation Score Means Plotted on Year**

There was considerable year to year fluctuation in average weights in the two lines. On the average, weaning weight increased 2.2 pounds per year in the WWL and 1.6 pounds per year in the YWL. Yearling weight increased an average of 3.9 pounds per year in the WWL and 2.2 pounds per year in the YWL. The regression coefficients reinforce the apparent similar genetic responses that have occurred in these two lines.

Concern has been expressed by some cattlemen that intense selection for growth performance will result in deterioration of conformation. Therefore, it is of interest to evaluate time trends in weaning and yearling conformation score in these lines. The plots in Figure 3 indicate that

substantial improvement in average conformation was realized over the years studied, though there was some year to year variation. Although these results can not be attributed totally to genetic causes, selection for growth performance in these lines apparently has resulted in improved conformation rather than a deterioration in conformation.

Selection Applied

Generation interval, the average age of the parents when the calves are born, affects the rate of progress from selection since it is the interval of time needed to complete a cycle of selection. Average age of the parents was similar in the two lines, averaging 4.1 years in both lines. The average ages indicate that generation intervals were somewhat shorter than generally observed in beef cattle herds. The shorter generation intervals were due primarily to higher annual replacement rates in the lines than normally found in commercial herds and the use of yearling age bulls.

In beef cattle herds there is considerable overlap in generations producing calves in any year. Generations of selection were measured in this study by calculating generation coefficients for each calf crop. The coefficients measured the average number of generations or cycles of selection that had been practiced in the ancestry of the calves born in any given year. By 1973 an average of 2.0 and 2.1 generations of selection had been practiced in the WWL and YWL, respectively.

The amount of selection applied was measured by total cumulative selection differentials of the parents of each calf crop. Total cumulative selection differentials include the selection differentials of parents, plus the average selection differentials of the parents from previous generations and measure the total amount of selection applied from the time selection was initiated. In a herd under long term selection, the total cumulative selection differentials of both sires and dams are the combined result of male and female selection in previous generations. A larger proportion of the females must be kept each year for replacements, consequently the cumulative intensity of male selection would be expected to be much larger than the cumulative effects of female selection. To independently measure the amount of selection realized from male and female selection, respectively, the total cumulative selection differentials were partitioned into two components, a male cumulative selection differential and a female cumulative selection differential.

Weaning weight and yearling weight were the selection criterion in the WWL and YWL, respectively. Consequently, intensity of selection for these traits is of primary interest. Table 2 summarizes male, female and total cumulative selection differentials for weaning weight in the WWL and yearling weight in the YWL. Increase in total cumulative selection differentials was quite regular for both weaning weight and yearling

Table 2. Male, Female And Total Cumulative Selection Differentials For Weaning Weight And Yearling Weight

Year	Weaning Weight Cumulative Selection Differentials[1] (lbs.)			Yearling Weight Cumulative Selection Differentials[2] (lbs.)		
	Male	Female	Total	Male	Female	Total
1964-1965	0	0	0	0	0	0
1966	0	1.4	1.4	0	2.2	2.2
1967	7.4	4.5	11.9	37.1	3.3	40.4
1968	24.2	2.5	26.7	63.5	3.8	67.3
1969	30.9	6.4	37.3	57.3	7.9	65.2
1970	30.6	8.5	39.1	91.7	13.2	104.9
1971	45.2	11.0	56.2	129.3	14.7	143.9
1972	62.5	13.3	75.8	138.3	22.7	161.0
1973	78.5	19.7	98.2	162.2	34.1	196.3

[1] Weaning weight selection differentials from weaning weight line.
[2] Yearling weight selection differentials from yearling weight line.

weight. By 1973, total cumulative selection differentials of 98.2 pounds for weaning weight in the WWL and 196.3 pounds for yearling weight in the WWL had been obtained. These results indicate that appreciable selection was accomplished for both weaning weight and yearling weight and suggest that positive genetic responses should be expected from selection.

In 1973, the total cumulative selection differential of 98.2 pounds for weaning weight in the WWL was made up of a male cumulative selection differential of 78.5 pounds and a female cumulative selection differential of 19.7 pounds. Thus, male selection accounted for 80 percent of the total selection for weaning weight. In like manner, male and female cumulative selection differentials for yearling weight in the YWL in 1973 were 162.2 and 34.1 pounds, respectively, for a total cumulative selection differential of 196.3 pounds. Thus, of the total selection for yearling weight, 83 percent was due to male selection. These results support the often quoted phrase "that from 80 to 90 percent of the genetic improvement made is the result of sire selection" and emphasize the importance of sire selection and evaluation.

Table 3 summarizes cumulative correlated selection differentials for birth weight, weaning weight, postweaning ADG, yearling weight and weaning and yearling conformation scores. It is important to evaluate correlated selection differentials for these traits since total improvement in productivity is influenced by changes that may occur in these traits as a correlated response to selection for increased weaning of yearling weight. Of particular interest is correlated cumulative selection differentials for yearling weight in the WWL. If animals with the heaviest wean-

ing weights have above average yearling weights, also, considerable savings in feed costs could be realized by being able to cull some animals at weaning rather than waiting until all animals reach a year of age.

In 1973 the yearling weight cumulative selection differential in the WWL was 130.0 pounds. In the YWL in 1973 the total cumulative selection differential for yearling weight was 196.4 pounds (Table 2). Thus, when selection was based on weaning weight, correlated selection differentials for yearling weight were 66 percent as large as cumulative selection differentials obtained by direct selection for yearling weight. These figures indicate that those animals selected on the basis of heavy weaning weights had above average yearling weights and suggest that weaning weight is a fairly good indicator of yearling weight. Thus, considerable culling on the basis of weaning weight could be practiced with small likelihood of culling animals with the potential for above average yearling weight.

In 1973 the correlated cumulative selection differential for weaning weight in the YWL was 94.0 pounds and was 92 percent as large as the total cumulative selection differential of 98.2 pounds obtained in the WWL. Thus, correlated selection for weaning weight was almost as intense when selection was based on yearling weight as when selection was based on weaning weight.

The data summarized in Table 3 indicate that positive correlated selection differentials were obtained for birth weight, postweaning ADG and weaning and yearling conformation scores in both lines. Correlated selection for birth weight may not be advantageous because of the potential increase in calving difficulty and subsequent calf losses that may be associated with increased birth weight. Correlated selection for postweaning ADG was more intense in the YWL than in the WWL. This likely would be expected because of the large effect postweaning ADG has on yearling weight. Although not large, positive correlated selection differentials were obtained for weaning and yearling conformation score. As a

Table 3. Total Correlated Cumulative Selection Differentials After Nine Years Of Selection

Trait	Weaning Weight Line	Yearling Weight Line
Birth Weight (lbs.)	9.9	11.2
Weaning Weight (lbs.)	--	94.0
Weaning Score[1]	1.3	0.7
Postweaning ADG (lbs./day)	0.2	0.6
Yearling Weight (lbs.)	130.0	--
Yearling Score[1]	1.0	0.8

[1] A 17 point scoring system was used where 13 = average choice, 14 = high choice.

result conformation would be expected to improve slightly as a result of selection for weaning weight or yearling weight rather than deteriorate as suggested by some.

The positive correlated selection differentials obtained in both selection lines indicate that improvement in total growth performance from birth to yearling age can be expected from selection for either weaning weight or yearling weight. However, the intensity of correlated selection for weaning weight and postweaning ADG in the YWL suggests that selection for yearling weight should result in more improvement in total growth performance than selection for weaning weight.

Response to Selection

Differences in performance of calves produced by foundation and selected sires were used to estimate genetic response to selection. As discussed previously, semen from two foundation sires and the four selected sires from the 1970 calf crop was used to produce calves in an Angus herd in 1972. The data collected on the calves was statistically analyzed by least squares procedures and is summarized in Table 4. The least squares means presented have been adjusted for unequal numbers of calves of the two sexes and different numbers of calves from each bull producing calves in the two sire comparison groups. The selected sires were considered together in these comparisons. That is, no differentiation was made between calves from the WWL bulls and calves from the YWL bulls since performance of the two lines was very similar over the years studied.

The data indicates that calves produced by selected sires weighed 29 pounds more at weaning and were 54 pounds heavier at yearling age than calves produced by foundation sires. In addition, selected sires' calves averaged 3.7 pounds heavier at birth and gained 0.2 pounds more per day postweaning than calves from foundation sires. Differences in conformation at weaning were not large and yearling conformation scores were not obtained with these cattle.

Table 4. Least Squares Means And Standard Errors For Progeny Produced By Foundation And Selected Sires

Trait	Foundation Sires	Selected Sires	Difference
Number of progeny	56	47	
Birth Weight (lbs.)	66 6± 1.11	70.3± 1.78	3.7 (P<.10)
Weaning Weight (lbs.)	490.0± 5.18	519.0± 8.30	29.0 (P<.01)
Weaning Score[1]	13 0± 0.09	13.5± 0.14	0.1 (NS)
Postweaning ADG (lbs./day)	1.8± 0.05	2.0± 0.08	0.2 (P<.10)
Yearling Weight (lbs.)	778.0±18.43	832.0±29.5	54.0 (P~.25)

[1] A 17 point scoring system was used where 13 = average choice, 14 = high choice, etc.

It would have been desirable to measure genetic response in terms of annual changes in average line performance. This was not possible with this data since the selected sires were the top bulls from the two lines and improvement in the cow herd was not considered. However, the results of the foundation vs. selected sires comparisons suggest that positive genetic responses were obtained from selection since seven years of selection resulted in sires capable of producing calves which were 5.6, 5.9 and 6.9 percent heavier at birth, weaning and yearling age and grew 11 percent faster postweaning than calves produced by foundation sires.

The magnitude of the cumulative selection differentials discussed previously indicates that appreciable selection was applied in both selection lines. Thus, positive genetic responses were expected. The foundation vs. selected sires comparisons indicate that positive genetic responses were obtained as a result of selection while time trends in average line performance suggest that on a per year basis the changes were small in magnitude. Although annual genetic responses apparently are small, the cumulative nature of selection indicates that over time appreciable improvement in performance should result from selection based on weaning weight or yearling weight.

Supplemental Value of Urea and Feed Grade Biuret for Heifers Wintered on Dry Range Grass

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Story in Brief

Two winter trials were conducted to evaluate the supplemental value of urea and feed grade biuret for beef replacement females grazing low quality winter forage (dry range grass).

Yearling, crossbred replacement heifers were fed supplements containing (1) 30 percent natural protein (positive control), (2) 15 percent natural protein (negative control), (3) urea, and (4) feed grade biuret. Each non-protein-nitrogen (NPN) source (urea and biuret) furnished one-half of the supplemental nitrogen. The positive control heifers lost