Selecting for Feed Conversion

R. R. Schalles, Josef K. Blum and Walter H. Smith

Summary

Selecting animals for decreased feed per unit of gain has made small changes in feed conversion over a four-year period. Adjusting for maintenance requirements by using mid weight to 0.75 power was not entirely satisfactory as that ignores differences in growth patterns. Favorable genetic relationships were found between feed conversion and most other economically important traits, especially yearling growth traits.

Introduction

Energy costs increasing make efficient energy use more important. There has always been some natural selection for animal efficiency because animals not able to convert available feed efficiently often failed to reproduce or reproduced at a reduced rate.

In recent years more cattlemen have become interested in direct selection for improved feed conversion. Selecting for feed conversion is expensive because it is necessary to know individual feed intake. Also some common mistakes need to be avoided.

This experiment was initiated to study genetic changes in a herd selected for efficient feed conversion and to evaluate the feasibility of such selection.

Experimental Procedure

Performance data were collected on 257 bull calves and 247 heifer calves from the Polled Hereford herd from 1969 through 1975. This herd was initiated in 1967 when Polled Hereford breeders donated cattle from 34 herds. These cows were used to build the Polled Hereford herd to its present size of about 160 cows in the selection herd and 73 in the control herd.

For the 1971 breeding season cows were randomly assigned to either the selection or control line. Since 1969 two bulls with the best feed conversion have been selected annually for the selection herd and used for two consecutive years.

Bulls for the control herd were randomly selected and remained in the herd six years or as long as possible. Since 1970 both lines have been closed, and no other breeding material has been introduced. To reduce the increase of inbreeding, least related matings have been used. Cows were

maintained on native pasture all year, and different energy and protein levels have been fed during the winter (1974 Cattlemen's Day Report).

Cows were bred to calve in March and April, and calves were weaned when approximately 200 days old. After a 3- to 4-week weaning period, bulls were put on a 140-day, individually-fed performance test. The ration was 25% prairie hay, 15% dehydrated alfalfa, 43% corn, 12½% soybean meal, 4% molasses and ½% salt. At the end of the test, two bulls were selected for the selection herd. The criterion selected for was feed conversion (F/G_{adj}) adjusted for both maintenance (mid weight to 0.75 power or metabolic size) and age on test. We have computed partial regression coefficients every year, using all previous data to make adjustments for each individual's F/G ratio to an average age and average maintenance requirement.

Heifers were group fed. Bulls were weighed monthly; heifers, bi-monthly. Heifers were not selected for feed conversion. Essentially, all heifers have been kept to build up the herd and for replacements. Culling was according to the following criteria: (1) not pregnant at the end of the breeding season, (2) severe structural damages, and (3) horned.

Results and Discussion

The individual's deviation from the herd's average feed conversion was calculated within years. In 1969, 1970, and 1971 selection and control line were a single herd. Therefore, individual deviations have been calculated as deviations from the entire herd. In 1972 the two lines were completely separated, then individual deviations became the difference between the selection line mean and the individual's performance. Year-to-year fluctuations have been large. Individual deviations of selected bulls tend to decrease in later years.

From 1969 to 1971 the mean accumulated selection differential of the parents was zero, because they were unselected. It was also zero for one bull in 1972 because he was selected from the control herd. In 1974 offsprings of selected bulls started calving, giving an increase in the mean accumulated selection differential from the dam side.

Table7.1 shows least square means and differences in feed conversion between selection and control herd. The differences are genetic because both herds are kept under the same environment, and no genetic changes are assumed to have taken place in the control herd. Selected bulls improved feed conversion about 0.35 lb. per lb. gain. With an average 400 lb. gain on test, that is 140 lb. less feed consumed on a 140-day test. The regression of least square means on years indicates a decrease per year of 0.141 ± .567 lb. feed per lb. of gain in the selection line and 0.067 ± .551 in the control line (figure 7.1).

Birth weight and 205-day weight were lowered by selecting for feed conversion. Calves in the selection line were lighter at birth than calves in the control line. In 1972 the difference was 5.25 lb. ($P<0.05$) for heifers and in 1974, 4.16 lb. ($P<0.05$) for bulls. The decrease in birth weight and 205-day weight was consistent for both sexes. Yearling weight was not changed by selecting for feed conversion. Changes in shape of the growth curve from birth to yearling are shown for both sexes in

figure 7.2 . Average daily gain from birth to weaning tended to be decreased ($P<0.10$). Adjusted weaning weight was significantly decreased and average daily gain from weaning to yearling was significantly increased. Both lines had the same yearling weight. An analysis of ADG on test by 4-week intervals showed control line calves to start with higher gain per day . Toward the end of the test, however, calves in the selection line gained more rapidly than control line calves. No inference could be made about the shape of the growth curve beyond yearling.

The decrease in 205-day weight suggests that our adjustment for maintenance did not remove all the variation in feed per gain due to maintenance. Examination of individual's performances suggests that selection may have been on two independent traits. Bulls that grew slowly during the first half of the test and quickly during the last part of the test were favored because of lower maintenance requirement than we adjusted for by using $(\text{mid weight})^{3/4}$. Bulls that gained faster throughout the test or much faster during the early part of the test than at the end were selected either because of superior efficiency or because of the high correlation between ADG on test and feed conversion. We fitted a quadratic regression, for 28-day weights on days-on-test for each animal. The area under the regression curve divided by 140 was the "average weight maintained" by each bull during the 140-day test period. This appears to be a better method of adjusting for maintenance differences.

No significant changes in backfat thickness or loin eye area resulted from selecting for F/G_{adj}, although we expect future generation animals in the selection line to be less fat, because it takes seven times more energy to put on fat than protein tissue.

Total feed consumption has not been significantly changed, which agrees with the near zero genetic correlations between F/G_{adj} and feed consumption.

Yearling height was not significantly affected, but was generally lower in the selection line. The genetic correlation between F/G_{adj} and yearling height indicates a low negative genetic relationship ($r = -.23$).

Heritability estimates of 14 performance traits are given in table 7.2, Heritability for birth weight was 0.42. Estimates in the literature are similar. Age of dam, birth month, and winter nutrition of the cow affected birth weight significantly.

Weaning weight and average daily gain from birth to weaning are largely affected by the maternal ability of the dam, and genetic variation is lower than for birth weight or 365-day weight. Heritabilities found in this study were 0.31 for 205-day weight and 0.37 for ADG from birth to weaning. The heritability estimate for 365 day weight was 0.41.

Average daily gain from 205- to 365-days of age and average daily gain on test measure essentially the same. Heritability estimates for both traits were 0.30, lower than those reported by most other researchers.

Yearling height at the shoulder, a measure of body size, gained in importance the last few years as producers searched for growthier animals. Our heritability estimate was 0.56 for bulls and 0.66 for a pooled estimate of heifers and bulls.

Loin eye area (LEA) and backfat thickness (BF) measurements on live animals involve more measuring errors than those taken on carcasses, which may explain the low heritabilities for LEA (h^2 = 0.15) compared with estimates from carcass data.

Genetic correlations are primarily the result of the same genes affecting both traits. Part-whole relationships, as among birth weight and 205-day weight or 365-day weight, gave high positive genetic correlations (table 7.2). Postweaning average daily gain correlated highly with all other weight measurements. Average daily gain from birth to weaning had a low genetic correlation with birth weight (r = 0.26), ADG from weaning to yearling (r = 0.20), ADG on test (r = 0.0), and yearling height (r = -.05).

Loin eye area and growth measurements were generally positively correlated, except for the correlation between ADG from birth to weaning and LEA, where the estimated value was -.32. Backfat thickness and growth characters correlated negatively. Exceptions were correlations between ADG from birth to weaning and BF (r = 0.06) and 205-day weight and BF (r = 0.14). LEA was highly positive correlated with post-weaning daily gain (r = 0.49) and final weight (r = 0.54). Feed consumption was positively correlated with weights at all stages and also with ADG on test (r = 0.56).

F/G_{adj} correlated negatively with birth weight (r = -.15) and 365-day weight (r = -.68). On the other hand, 205-day weight correlated positively with F/G_{adj}.

The correlation between ADG on test and feed conversion were -.39 not adjusted for maintenance, and -.53 when feed conversion was adjusted for maintenance.

The correlation between feed consumption and F/G not adjusted for maintenance is expected to be positive, because higher feed consumption is primarily attributed to higher maintenance requirements. When we adjust for maintenance, the correlation is 0.06, suggesting feed conversion cannot be improved by selecting for feed consumption. Selecting for F/G_{adj} slightly (nonsignificantly) decreased feed consumption, which suggests a slight positive relationship.

Table 7.1 . Line averages and differences in feed conversion between selected and control line animals.

Year	No. of bulls	Selection line mean	No. of bulls	Control line mean	Response to selection for F/G_{adj}
1969			20	6.64 ± .21	
1970			23	6.83 ± .15	
1971			33	6.33 ± .13	
1972	12	5.12 ± .22	25	5.53 ± .15	- .41 ± .23
1973	27	6.03 ± .14	12	6.10 ± .21	- .07 ± .21
1974	36	6.16 ± .12	27	6.82 ± .14	- .66 ± .14
1975	36	5.87 ± .13	21	6.10 ± .15	- .23 ± .16

Table 7.2. Heritabilities (On Diagonal) And Genetic Correlations (Below Diagonal) For Growth And Efficiency Traits[e]

		BW	205 WT	365 WT	ADG(B-W)	ADG(W-Y)	ADG(T)	Y HT	FC	$F/G_{adj.}$	LEA	BF
BW	d	0.42±.21										
205 WT	a	0.96±.81	0.31±.18									
365 WT	b	0.77±.44	0.64±.26	0.41±.21								
ADG(B-W)	a	0.26±.22	0.99±.01	0.60±.27	0.37±.20							
ADG(W-Y)	b	0.87±.22	0.45±.44	0.97±.03	0.20±.42	0.30±.18						
ADG(T)	b	0.80±.25	0.24±.55	0.94±.05	0.00±.54	0.88±.10	0.30±.18					
Y HT	c	0.22±.19	0.09±.28	0.52±.30	-.05±.39	0.39±.31	0.48±.34	0.56±.31				
FC	b	0.85±.26	0.09±.16	0.59±.23	-.22±.46	0.36±.29	0.56±.24	0.11±.24	0.40±.20			
$F/G_{adj.}$	b	-.15±.41	0.08±.62	-.68±.24	0.05±.51	-.84±.19	-.53±.31	-.23±.11	0.06±.43	0.23±.16		
LEA	c	0.68±.50	0.31±.29	0.73±.44	-.32±2.2	0.93±.43	0.77±.46	0.01±1.6	0.16±.54	-1.08±.52	0.11±.13	
BF	c	-.26±.40	0.14±.75	-.07±.15	0.06±.63	-.12±.45	-.20±.51	-.54±.22	0.37±.51	-.05±.54	-.03±.52	0.18±.15

a adjusted for age of dam, winter nutrition of dam and birth weight
b adjusted for age on test and weight on test
c adjusted for age and weight at anscan
d adjusted for age of dam, winter nutrition of dam and birth month
e all traits had 257 observations except yearling height which had 154

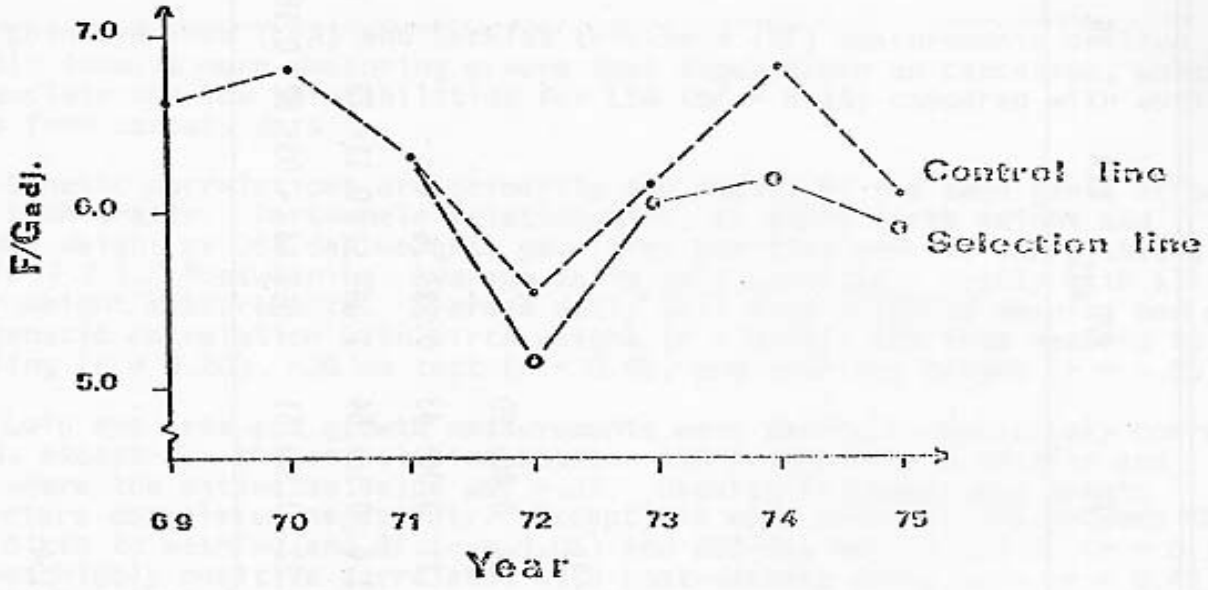

Figure 7.1. Change in feed conversion.

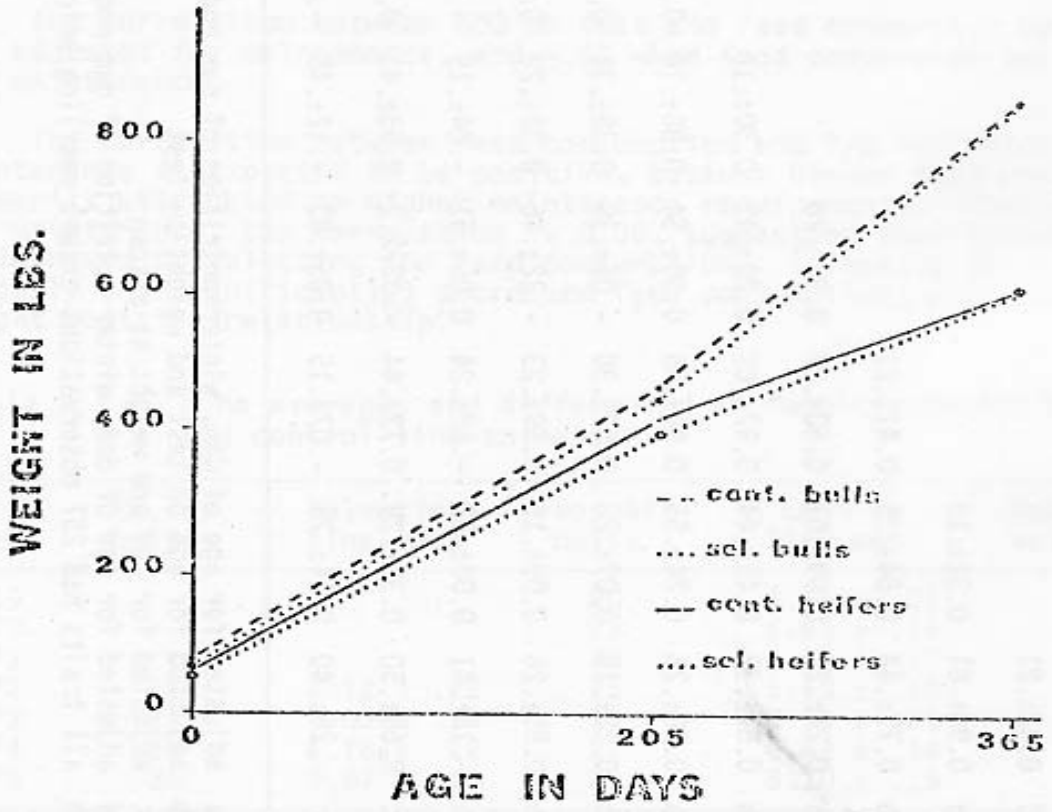

Figure 7.2. Growth curve in selection and control line by sex.