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PRELIMINARY RESULTS OF SELECTION FOR YEARLING OR 18-MONTH WEIGHT IN ANGUS AND HEREFORD CATTLE

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SUMMARY

Selection herds were established in 1971 to compare in Angus cattle the effectiveness of selection on 13-month liveweight (with the first mating at 14 months of age) with selection on 18-month weight (with first mating as 2-year-olds). A control herd of Angus cattle is also maintained with random selection of replacement bulls and heifers and first mating as 2-year-olds. A yearling mated Hereford herd selected on 13-month weight is also kept. Relative to the random-bred control line, the Angus and Hereford herds selected for 13-month weight improved in both 13-month and 18-month weight at about twice the rate at which the 18-month selection line improved. Sires from the 13- and 18-month selection lines are also evaluated against Angus sires from the industry. Bulls bred in these selection herds leave progeny of equal merit for growth and carcass weight to those from a "superior" sample of industry sires.

INTRODUCTION

Carter (1971) found that worthwhile genetic gains in progeny liveweights and carcass weights could be achieved by sire selection on yearling (14-month) or weaning (5-month) weight, with much less response to selection on weaning to yearling weight gain.

Mating beef heifers to calve first at 2, rather than the more traditional 3, years of age can substantially increase calf production from the beef herd and permit earlier identification and culling of the less productive females (Carter and Cox, 1973). When coupled with selection and mating of yearling bulls, annual genetic progress should be enhanced through speeding up the generation turnover. Carter and Cox (1973), from a large volume of data collected at four experimental locations, showed that yearling mating of heifers does not adversely affect production at 3 years and older ages. Nevertheless, yearling selection and mating are not commonly practised in either bull-breeding or commercial beef herds. The present study compares the effectiveness of selection and mating at the yearling stage with 18-month selection and mating at 2 years.

MATERIALS AND METHODS

Foundation Stock

In the initial 4-year phase of this collaborative experiment with Lands and Survey Department, Rotorua, 53 Angus and 42 Hereford bulls representing a wide cross-section of industry sources, but without performance records, were single-sire mated to balanced groups of Angus and Hereford cows to generate straightbred and reciprocal crossbred offspring born 1969-72. The derived foundation stock for this selection study were thus of broad genetic origin.

Design

The experiment comprises the following herds:

HS1: Hereford herd selected for 13-month weight; first mated at 14 months

AS1: Angus herd — selected and mated as HS1.

AS2: Angus herd selected for 18-month weight; first mated at 26 months.

ACO: Angus random-bred control herd; first mated at 26 months.

Test: Predominantly Angus mixed-age progeny-test herd.

Planned herd numbers, generation intervals, selection intensities and inbreeding rates are shown in Table 1. The AS1, HS1 and AS2 herds were established in 1971, and the ACO herd in 1972. The first experimental matings were in 1971 for the AS1 and HS1 herds and 1972 for the AS2 and ACO herds (with the first selection in all herds among heifers and bulls born in 1970). thus the first year when progeny of selected sires were available in all herds was 1973.

TABLE 1: DESIGN OF THE SELECTION EXPERIMENT

	Number of Cows				*No.*	*Expected Values for:*					
						Generation Interval			*Selection Intensity*[1]		*Inbreeding*
Line	*2 yr*	*3 yr*	*4-7 yr*	*Total*	*Bulls*	*M*	*F*	*Herd*	P_M	P_F	*per yr (%)*
AS1) HS1)	40	34	91	165	6	2	4.0	3.0	0.11	0.70	0.23
AS2	—	34	91	125	5	3	4.6	3.8	0.11	0.75	0.17
ACO	—	34	91	125	10–12	3	4.6	3.8	—	—	0.07
Test				240	8						

[1] P_M and P_F = proportion selected in males (M) and females (F).

The foundation Angus herds were made as comparable as possible in respect of genetic background (sires), liveweights and age distribution. From 1973 to 1976 the proportion of older cows was higher in the ACO herd than in the other herds. All bulls are replaced annually while surviving cows are culled at 8 years. Cows are pregnancy tested after mating, those twice dry being culled. All matings are in single sire groups over 8 to 9 weeks. The different numbers of sires used per year in the AS2 (five) and the AS1 and HS1 (six) herds were designed to approximately standardize expected selection intensity and rate of increase of inbreeding per year in all selection herds. In the ACO herd, 10 to 12 sires per year are used.

Calves are weaned at about 5 months of age and remain virtually unculled until selection is made. From 1973 to 1978, 4% of the calves were culled at weaning for obvious poor health or unknown parentage. Apart from restrictions to reduce inbreeding, selection of both bulls and heifers is based solely on 13- or 18-month-old weights, adjusted for within-year environmental effects except for the ACO herd, where selection is at random. Usually one son (and not more than two sons), and approximately equal numbers of daughters, are retained for breeding from each sire. Heifer calves from all selection lines are run together from weaning to 12 months of age. In poor seasons, AS1 and HS1 heifers may be given preferential grazing from 12 to 14 months. All bulls are grazed together through to 18 months except for those selected as yearling sires (AS1, HS1) during their 2-month mating period.

Since 1973 two bulls used in each of AS1 and AS2 herds (with comparable within-herd performance rankings) have been mated in the Test herd the following year. In addition, four Angus bulls sampled from the industry and nominated by the Lands and Survey Department (Rotorua) are mated in this herd each year. Most of these bulls had previousy shown high breeding values through progeny testing in the Waihora Angus breeding scheme (Nicoll, 1978). This permits both an alternative comparison of genetic progress in the AS1 and AS2 and a comparison of both lines with an "Industry control". Steers from the Test herd are slaughtered at about 20 months of age for carcass evaluation. Information is available on growth of all females to 13 months of age, and thereafter on lifetime reproduction and liveweight performance of those entering the herd as replacements.

Semen from the first set of selected sires (born 1970) has been stored for future use to allow another estimate of genetic progress (Smith, 1977).

Analysis

Liveweight data were first adjusted for date of birth or age, sex (where appropriate) and age of dam, using factors derived from least-squares analyses for each herd-year with sires fitted in the model. There is confounding of parity and age of dam (2-year vs. older dams) with herds (AS1 and HS1 vs. AS2 and ACO). Separate analyses were undertaken for all calves born and also excluding those from 2-year-old dams; since in all years differences among herds were similar for both analyses, results from the complete data set only are reported here.

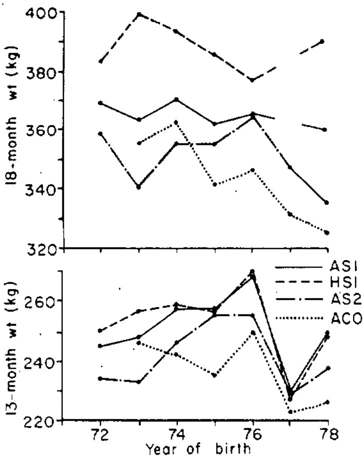
Responses to selection were measured as deviations of the adjusted line means from the contemporary adjusted control mean. Average annual responses were estimated for each line by linear regression of these deviations on numbers of years since 1970, the birth year of the first selected parents. For the Angus lines the regression was constrained to pass through the origin whereas for HS1 the intercept on the weight-axis was assumed to be the average difference, Hereford minus Angus, found in the foundation population (born 1969-71), namely 3 kg, –4 kg, 6 kg and 20 kg for weights at birth, weaning, 13 months and 18 months, respectively.

Liveweight data for the Test herd were analysed separately from the selection herds, using a least-squares model fitting sire source (AS1, AS2, Industry), year calves born (1974-77), dam breed (Angus, Hereford and Angus-Hereford crosses), age of dam, sex (where appropriate) and regression on age of calf. The interaction of sire source and year born was not significant and was deleted from the model. No AS2-sired progeny were produced in 1974.

RESULTS AND DISCUSSION

Response to Selection

Yearly line means for adjusted 13- and 18-month weight (bull calves only) are shown in Fig. 1, and for birth and weaning weights (all calves) in Fig. 2. Derived estimates of average annual response are presented in Table 2. The 18-month data for calves born in 1977 were not recorded in the AS1 and HS1 herds.



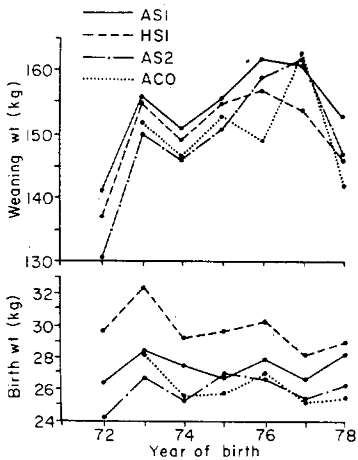


FIG. 1 *(left)*: *Mean adjusted 13-month and 18-month weights by lines plotted against year born (bulls only). The 18-month data were not recorded in the AS1 and HS1 herds in 1977.*

FIG. 2 *(right)*: *Mean adjusted birth and weaning weights plotted against year born (all calves).*

Responses to selection for 13-month weight in the AS1 and HS1 lines are not significantly different, but both are significantly different from zero. The correlated response for 18-month weight is also significant (at about 3.0 kg/yr) in both these lines. In contrast, the responses in both 18-month and 13-month weight in the AS2 line are about half those in the AS1 line and are not significantly different from zero.

The only significant correlated response for birth or weaning weight is in the AS1 herd, where both birth weight and weaning weight are increasing concurrently with the increase in 13-month weight. These are broadly similar to the direct and correlated

TABLE 2: DIRECT AND CORRELATED RESPONSES TO SELECTION[1]

Line	*Birth Wt*	*Weaning Wt*	*13-month Wt*	*18-month Wt*
HS1	0.08 ± 0.04	0.88 ± 0.45	*1.65 ± 0.56**	3.10 ± 1.39*
AS1	0.25 ± 0.05**	0.98 ± 0.38*	*2.56 ± 0.55***	2.71 ± 1.01*
AS2	0.04 ± 0.06	0.34 ± 0.32	1.22 ± 0.65	*1.48 ± 0.96*

[1] Responses expressed in terms of kg/yr ± standard error. Direct responses are italicized.

responses from 11 years of selection for yearling weight in two replicate herds of beef Shorthorns (Newman *et al.*, 1973; Andersen *et al.*, 1974), amounting for bull calves to 4 kg/yr for yearling weight, 0.3 kg/yr for birth weight and 1.1 kg/yr for weaning weight.

REPRODUCTIVE PEFORMANCE AND COW JOINING WEIGHTS

Data are presented in Table 3 for average calving and weaning percentages by lines for calves born 1973-78. Mating groups with infertile or subfertile bulls (three in AS2, four in HS1) have been removed from this summary. Although it is too early in this selection study to determine genetic trends for reproductive performance, results to date both at 2 years and at older ages are satisfactory in all herds.

TABLE 3: HERD AVERAGE JOINING WEIGHTS AND CALVING PERFORMANCE (1973-78)

	2-year				*3-year +*			
Line	*N*	*JW*	*C%*	*W%*	*N*	*JW*	*C%*	*W%*
HS1	220	248	80	65	616	363	84	78
AS1	241	259	80	70	720	355	89	84
AS2					648	345	88	84
ACO					708	363	83	79

N = Number of cows surviving to a known outcome of mating.
JW = Joining weight in kilograms.
C% = Total cows calving, including abortions but excluding cows with twins, as a percentage of N.
W% = Calves alive at weaning as a percentage of N (excluding twin births).

The similarity of reproductive performance in the AS1 and AS2 herds supports the evidence of Carter and Cox (1973) that yearling mating and selection need have no detrimental effect on lifetime reproductive performance. Weaning percentages at all ages were slightly lower in the HS1 herd than in the AS1 herd, consistent with differences between Hereford and Angus cows found by Baker and Carter (1976).

Weights of mature cows (3 years and older) are slightly higher (2%) in the HS1 than in the AS1 herd. The heavier cows in the ACO herd than the AS2 herd reflect age differences between herds.

PROGENY TESTING INDUSTRY AND AS1 AND AS2 BULLS

The progeny test results for calves born 1974-77 are given in Table 4. Of the 16 industry sires (four per year), 13 were included in a subsequent published ranking of some 250 Angus bulls with recorded progeny tests (Morris and Baker, 1978; Baker, 1978). Their published results show clearly that they were an above-average sample in terms of progeny weaning and yearling weights.

TABLE 4: RANKING OF SIRE SOURCES IN THE PROGENY TEST HERD (CALVES BORN 1974-77)[1]

		No. Progeny		*Steers and Heifers*			*Steers*	
Sire Source	*No. Sires*	*Born*	*Slaughter*	*Birth Wt*	*Weaning Wt*	*Yearling Wt*	*Final Wt*	*Carcass Wt*
AS1	8	227	102	28.0	164	232	365	195
AS2	6	143	59	27.7	161	229	356	189
Industry	16	354	151	29.1	166	231	361	193

[1] All weights in kilograms.

Except that the Industry sires left progeny with heavier birth weights, there was no significant difference between the performance of the Industry- and AS1-sired progeny. Although based on a small number of sires, the AS1-sired progeny grew faster than the AS2-sired progeny, consistent with the earlier results from the selection lines relative to the control line.

CONCLUSIONS

Recently reported selection studies with beef cattle, with experimental designs adequate to detect genetic progress, have shown positive selection responses for growth (*e.g.*, Carter, 1971; Newman *et al.*, 1973; Koch *et al.*, 1974a, b; Seifert, 1975; Barlow *et al.*, 1978). The importance of a control line is clearly demonstrated both here and by Newman *et al.*, (1973). The present study is unique in that in addition to a random-bred control line there is also an Industry control (comparing selection line sires with industry sires by progeny testing) and semen laid down from foundation sires.

There is now ample evidence that weaning weight and yearling weight are moderately heritable and will respond to selection. New Zealand and Australian studies would suggest that adjusted weight per day of age at the yearling stage (Carter, 1971) or at 18 months (Seifert, 1975) are better measures of growth potential in beef cattle than post-weaning gain to these later ages. To date there is very limited information from selection studies on the relative levels of heritability of yearling and 18-month weight and the genetic correlation between these growth traits.

Little is known also of genetic correlations among growth and other traits of importance in beef cattle, *e.g.*, carcass attributes, reproductive and maternal traits, efficiency of production for both calves (growth) and cows (number and weight of calves weaned), and cow weights. In the long term this study will provide much-needed information on at least some of these genetic correlations.

There is an urgent need to persuade the beef cattle industry of the advantages of yearling mating over 2-year-old mating. On the preliminary evidence of this study, selection at the yearling stage will result in as much, if not more, response in growth to the traditional slaughter age of 18 to 20 months.

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