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PROGENY TESTING ANGUS AND HEREFORD BULLS FOR GROWTH PERFORMANCE

R. L. BAKER, A. H. CARTER and P. R. BEATSON
Ruakura Agricultural Research Centre, Hamilton

SUMMARY

This paper summarizes progeny test results for growth from birth to 14 to 15 months of age based on four calf crops at Waikite (53 Angus and 39 Hereford sires) and three calf crops at Flock House (39 Angus sires). The findings demonstrate the wide variation among sires in progeny performance and hence the importance of accurate sire selection. In general, bulls ranking highest on their own performance are among the top bracket on progeny test. Estimates of heritability were calculated by the paternal half-sib method for different growth traits. Average heritability estimates were 0.28 for birth weight, 0.20 for weaning weight, 0.45 for yearling weight and 0.20 for post-weaning gain to the yearling stage. It is suggested that corrected yearling weight is the best trait for selection among these four growth traits. It appears that progeny test results are consistent on both male and female data.

INTRODUCTION

Published information on the progeny testing of beef bulls under New Zealand grassland farming conditions is limited to the studies of Carter (1971) and Dalton and Gibson (1974).

This paper summarizes progeny test results for growth from birth to 14 to 15 months based on four calf crops at the Rotorua Lands and Survey block, Waikite, and three calf crops at Flock House. The following matters are considered:

(1) Variation within and between sires for weights at various ages and weight gains.

(2) Between-sire correlations among alternative measures of growth performance, particularly weights and gains.

(3) Consistency and relative accuracy of progeny tests on male and female progeny.

(4) Relationships between individual performance of bulls, where available, and their progeny performance.

MATERIALS AND METHODS

SOURCES OF DATA

Waikite

The experimental breeding programme at Waikite, a Lands and Survey block 30 km south of Rotorua, is described by Carter and Cox (1973) and Baker *et al.* (1974). The analysis covers calves born 1969 through 1972. The herd comprises both Angus and Hereford females which have been mated to bulls of these two breeds to generate purebred and crossbred progeny. The numbers of Angus and Hereford bulls used per year and their sources are shown in Table 1. The industry bulls were in most cases purchased at about 20 months of age by the Lands and Survey Department from a wide range of sources. The Angus bulls from Waikeria were bred in an experimental breeding programme described by Carter (1971); all had full performance records

TABLE 1: SOURCES AND NUMBER OF SIRES AND THE MEAN NUMBER OF PROGENY PER SIRE PER PROGENY TEST

Trial	*Breed of Sire*	*No. of Sires from*				*No. of Progeny per Sire Alive to 15 months*	
		Waikeria	*Waikite*	*Industry*	*Total*	*Mean*	*Range*
Waikite:							
1969	A	2	3	9	14	17	10-22
	H	—	2	10	12	18	11-25
1970	A	2	3	11	16	20	15-24
	H	—	3	8	11	19	10-23
1971	A	1	7	9	17	16	11-21
	H	—	6	4	10	14	8-19
1972	A	—	3	3	6	19	17-20
	H	—	3	3	6	17	12-20
Total	A	5	16	32	53	18	10-24
	H	—	14	25	39	17	8-25
Flock House:							
1971	A	5	2	7	14	18	10-21
1972	A	6	4	3	13	14	9-20
1973	A	8	3	1	12	21	7-28
Total	A	19	9	11	39	17	7-28

for growth and in some cases progeny test rankings. The Waikite bulls comprised both yearlings (14 to 15 months of age) and two-year-olds which had been bred and recorded for growth on the property. A new set of bulls was used each year apart from a few (one or two) repeated to act as reference sires. A total of five Angus and six Hereford bulls had two consecutive tests over the period 1969-72. Each bull was mated to about 20 Angus and 10 Hereford cows. Cows, with their calves at foot, were re-randomized to bulls each year. Replacement heifers were mated as yearlings in all years except 1970.

Weights were recorded at 4- to 6-weekly intervals from birth to about 15 months of age, with weaning at about five months of age. For purposes of the present analysis the experiment comprises two lines, a crossbreeding line with purebred and reciprocal crossbred heifer and steer calves, and a selection line with purebred Angus or Hereford heifers and bulls. The same sires were used over both lines in the first three years, while only the crossbreeding line was included in the analysis of progeny born in 1972.

Flock House

The Ministry of Agriculture and Fisheries training farm at Flock House is located in the Manawatu. The herd comprises some 400 Angus cows, the number of sires used each year and their sources being shown in Table 1. The main objective of this programme was to compare progeny test results for growth-recorded bulls from different sources (particularly Waikeria and Waikite) and to identify superior Angus sires for use in a large-scale beef breed evaluation trial (Carter, 1972). Bulls were individually mated to about 30 mixed-age cows including yearling heifers and were re-randomized among bulls each year. Male calves were castrated either at the time bulls were joined with the cows (about 2 months of age) or at weaning (about 4 months of age). Weights were recorded at 4- to 6-weekly intervals from birth to about 15 months of age. Five of the 39 sires listed in Table 1 had been tested at Flock House in a previous year.

At both locations progeny remained unculled until about 14 to 15 months of age. Table 1 shows that a few bulls were sub-fertile and left fewer than 10 progeny, making the reliability of these tests very poor. Four measures of growth performance were studied: birth weight (BW), weaning weight (WW), yearling weight in October (YW), and gain from weaning to October (G(WY)).

METHODS OF ANALYSIS

The model for least squares analysis (within-seasons) for the Waikite data included the effects of sire breed (2 classes), age of dam (4), sex (2), line (2), dam breed (2), regression on age, the interactions of sire breed by dam breed and of sex by line, and sires nested within sire breed. The model for the Flock House data included the effects of sires, age of dam, sex and regression on age. Preliminary analyses within each year and location indicated that interactions of sire by sex and sex by age of dam were not significant. Heritability estimates were derived from the between-sire variance component and the residual variance—*i.e.*, paternal half-sib correlations.

RESULTS

Average progeny ages for weaning and yearling weights were 150 days and 380 days at Waikite, 140 days and 410 days at Flock House.

Variation within and between sires for birth, weaning and yearling (October) weights and the gain from weaning to yearling weights are summarized in Table 2. In the Waikite data, herit-

TABLE 2: RANGE OF SIRE CONSTANTS WITHIN PROGENY TESTS, STANDARD DEVIATIONS (S.D.) WITHIN AND AMONG SIRE CONSTANTS AND HERITABILITY FOR SOME GROWTH TRAITS (kg)[1]

Trial	*Range*		*Sire S.D.*	*Error (half-sib) S.D.*	*Heritability*
	Angus Sires (53)	*Hereford Sires (39)*			
Waikite (4 yr):					
BW	4	4	1.0	3.7	0.27
WW	21	13	3.6	17.9	0.16
G(WY)	17	13	3.0	14.2	0.17
YW	28	21	6.1	20.7	0.32
Flock House (3 yr, 39 sires):					
BW	5		1.0	3.6	0.29
WW	21		4.5	17.9	0.24
G(WY)	20		4.8	19.1	0.24
YW	34		8.8	21.0	0.60

[1] In this and following tables BW, WW, and YW denote weights at birth, weaning, and yearling stages. G(WY) is the gain from weaning to yearling weights.

abilities were calculated from sire and error variances nested within sire breed for each year and then pooled over years. Because of the broader sample of sires at Waikite (more closely approximating a random sample of sires) these estimates should be more reliable than the Flock House estimates. The general consistency of the two sets is, however, reassuring.

Correlations between sire constants among the growth traits are given in Table 3. Again the results are consistent between the two experimental locations. All correlations among birth, weaning and yearling weights are significant, but birth and weaning weights show little association with the gain from weaning to yearling weight.

TABLE 3: CORRELATIONS BETWEEN SIRE CONSTANTS FOR SOME GROWTH TRAITS

Waikite North (4 years, 92 sires) above the diagonal
Flock House (3 years, 39 sires) below the diagonal

Trait	*BW*	*WW*	*G(WY)*	*YW*
BW	—	0.55	−0.09[1]	0.40
WW	0.69	—	0.11[1]	0.76
G(WY)	0.11[1]	0.22[1]	—	0.33
YW	0.50	0.76	0.80	—

[1] Coefficient not significant.

The consistency of progeny tests on male and female offspring has been investigated in two ways. For all four growth traits considered here the sire by sex interaction term was not significant, suggesting that sires should rank similarly within male or female progeny. It has been suggested that the magnitude of a genotype by environment interaction could vary in proportion with the genetic width and environmental effects (Robertson, 1959; Hull and Gowe, 1962; Dickerson, 1962; Eisen and Legates, 1966). Since it is known that variances, and in many cases the regression of weights on age, differ among male and female progeny, analyses were undertaken separately within the two sexes and simple correlations calculated between sire constants from the two separate sex analyses. The results appear to conflict with the previous findings in that the correlations were in general quite low (< 0.5), whereas a higher correlation might be expected if there is no interaction between sires and the sex of their progeny. It may be shown, however, that, with the small numbers (5-10) of progeny for each sex and heritability of the order of 0.3, sampling errors alone could account for the low correlations obtained.

The effectiveness of performance selection should be reflected in the superiority of progeny performance of those bulls showing high performance rankings themselves. The present data allow useful progeny comparisons not only among the performance-recorded bulls from Waikeria and Waikite but also with the mainly non-recorded but presumably representative sires from industry sources.

Progeny at Waikite of all five Waikeria bulls, chosen for high weight-for-age, were well above average for progeny yearling weight in their respective groups, three of them ranking in fact either first or second. Likewise 8 out of 11 Angus and 8 out of 10 Hereford bulls selected on superior growth performance at Waikite ranked in the top half of their groups on progeny results, and were on average far superior to the industry bulls with which they were compared.

Some of the matings included contemporary Waikite- or Waikeria-bred bulls of average or below average, as well as of superior growth performance. In the 1971 test at Waikite, for example, the seven Angus and six Hereford Waikite-bred bulls spanned a range of performance test rankings. The progeny test results for these

TABLE 4: THE CORRELATION BETWEEN PERFORMANCE AND PROGENY TEST RANKINGS FOR YEARLING WEIGHT
(1971 born calves at Waikite)

Bull Name	*Performance Ranking (Dev. from Mean)*	*Progeny No.*	*Mean*	*Rank*
Angus Sires:				
WN 545-8	+122	15	203.6	2/17
WN 592-8	+ 92	18	197.5	7/17
WN 510-8	+ 62	17	201.4	3/17
WN 509-8	+ 16	11	195.0	9/17
WN 581-8	+ 5	18	198.3	5/17
WN 549-8	− 43	15	189.9	13/17
WN 518-8	− 55	19	180.8	17/17
G 537-8	+133	18	189.3	14/17
Hereford Sires:				
WN 147-8	+107	18	210.4	1/10
WN 136-8	+ 49	13	192.2	9=/10
WN 140-8	+ 16	12	207.6	2/10
WN 118-8	− 14	17	202.9	4=/10
WN 117-8	− 44	11	202.9	4=/10
WN 139-8	− 45	8	198.6	8/10

bulls are shown in Table 4. Rank correlations between performance and progeny results were 0.88 for the Angus and 0.43 for the Hereford sires. The high performance-ranked bull G537-8 was a registered Angus which had been purchased *in utero* and subsequently given preferential feeding at Waikite. The poor progeny test ranking of this bull provides a good illustration of how preferential treatment can invalidate estimates of true breeding value.

Similar results were obtained in the Flock House progeny tests. In the first test (1971-born calves) there was a total of seven Waikite- and Waikeria-bred bulls of superior growth performance together with seven industry bulls. All but one of the performance-selected bulls ranked in the top half on progeny test. In all tests a number of both high and low performance ranked bulls from Waikite and Waikeria were included specifically to check on the efficiency of performance selection. In five out of six such comparisons, the higher performance ranked bulls were also the better bulls on progeny test results.

Some limited information on the repeatability of progeny tests is available from the repeat matings over consecutive years. In five out of seven cases the repeated bulls ranked in the same order on progeny test from one year to the next.

DISCUSSION

The results given here demonstrate the wide variation among sires in progeny performance and hence the importance of accurate sire selection. In general, bulls ranking highest on their own performance are among the top bracket on progeny test. Similar results were reported by Carter (1971) in a herd of Angus cattle in New Zealand, and by Koch and Clarke (1955), Carter and Kincaid (1959), Rollins *et al.* (1962), and Lessels and Francis (1968) in overseas studies.

The average heritability estimates of 0.20 for weaning and 0.45 for yearling weight (Table 2) are in good agreement with those derived by Carter (1971), from the regression of progeny performance on sire's own performance which were of the order of 0.25 and 0.40, respectively. By contrast, the present heritability of 0.20 for post-weaning gain was higher than Carter's (1971) estimate of virtually zero. From both studies, however, it can be concluded that yearling weight is a more effective selection criterion than post-weaning gain for improving progeny growth performance. Dickerson *et al.* (1974), in a comprehensive evaluation of selection criteria for efficient beef production, also consider yearling weight to be a good selection criterion, and almost as effective as direct selection for improving feed conversion efficiency to a constant final age.

Petty and Cartwright (1966) summarized most of the numerous estimates of genetic parameters in beef cattle (mostly from American sources) up to 1965. Their average value for heritabilities for birth weight was 0.44, weaning weight 0.28, feedlot gain 0.52, pasture gain 0.30, final feedlot weight 0.58, and yearling pasture weight 0.41. Some more recent estimates by Koch *et al.* (1974), and Dickerson *et al.* (1974) are broadly in agreement with these values. The New Zealand estimates of heritability to date are lower for birth weight, similar for weaning and yearling pasture weight, but lower for pasture gain from weaning to the yearling stage. Dickerson *et al.* (1974) obtain a heritability estimate of 0.26 for post-weaning gain which they note is lower than most other estimates. It should be noted that the New Zealand results are based on an earlier weaning regime than is common in most overseas beef studies.

Relative gains from selection can be deduced from the heritability estimates given in Table 2 and the correlations between sire constants shown in Table 3. The latter agree closely with corresponding estimates of Carter (1971) from the Waikeria herd. Since their environmental component is considered to be small, these between-sire relationships can be taken to approximate true genetic correlations.

Assuming equal selection intensities for the traits considered, it can be concluded from the heritabilities in Table 2 and the genetic correlations in Table 3 that selection on birth weight, weaning weight or post-weaning gain to improve yearling weight will lead to about 35, 50 and 30% less genetic response, respectively, than direct selection for yearling weight itself.

In conclusion, it should not be construed from this paper that widespread progeny testing in beef cattle is being advocated for genetic improvement in New Zealand beef herds. While progeny testing will give the most accurate estimate of an animal's breeding value, it will also increase the generation interval, and reduce the selection intensity (Dickerson and Hazel, 1944) as well as being a very costly procedure. Performance recording must be the essential base on which genetic improvement should be based, with progeny testing a possible final link in an efficient selection chain. It should be a necessary link before a bull is used for artificial breeding.

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