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# Evidence of genetic improvement in the Angus Breeding Scheme of the Department of Lands and Survey

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## ABSTRACT

Evidence of genetic improvement in the Department of Lands and Survey's Angus Breeding Scheme (ABS) was examined. Data from the ABS project and from the pilot Angus Sire Reference Scheme (ASRS) were used to estimate genetic trend in weaning weight and yearling weight in the ABS nucleus by regressing sire group values on year of birth. Estimated genetic improvement in weaning and yearling weights using the ABS data were  $1.6 \pm 0.9$  and  $0.7 \pm 0.9$  kg/year. Corresponding estimates from the ASRS data were 1.0 and 1.6 kg/year.

Initial data from comparisons of progeny sired by average merit ABS-bred bulls and by bulls normally supplied to Lands and Survey herds from industry sources (I) were also analysed. Preliminary estimates of sire source differences were non-significant, but consistently in favour of ABS sires in daughter yearling, 15-month and 18-month live weights ( $7.6 \pm 3.9$ ,  $7.0 \pm 5.2$  and  $7.7 \pm 6.1$  kg respectively) and subsequent maternal weaning weight ( $5.3 \pm 3.9$  kg).

It was concluded that the ABS project of the Department of Lands and Survey has achieved genetic progress in live weight traits, and has conferred productive benefits in Departmental herds.

**Keywords** Beef cattle; breeding; genetic improvement; index selection; live weights.

## INTRODUCTION

In 1970, the Department of Lands and Survey established an open-nucleus Angus breeding scheme (ABS) to supply sires to its predominantly Angus herds in the Rotorua Land Development District. Gibson and Dalton (1973) and Dalton and Gibson (1974) outlined the reasons behind establishing the scheme and described the female screening, recording and subsequent selection procedures in the initial years.

In the 1976-77 season the ABS recording procedures were revised (Nicoll, 1977; Nicoll *et al.*, 1979). Index selection was introduced to achieve the following breeding objective (H) described by C.A. Morris, R.L. Baker and D.L. Johnson (personal communication):

$$H (\text{net income } (\$/\text{cow lifetime}) = 0.53 LD_p (4.8F-1) + 0.06 MD_c$$

where L = live weight (kg) of surplus progeny at 30 months of age;

$D_p, D_c$  = carcass dressing out percentage ( $\times 0.01$ ) of slaughtered progeny and the culled cow respectively;

F = net fertility (average number of calves weaned/cow exposed);

M = mature cow live weight (kg) at disposal.

The coefficients of 0.53 and 0.06 represent the net income (\$/kg carcass) from the slaughter of young stock and cull cows respectively. Average cow lifetime is assumed constant (5.8 years), with the variable 4.8F indicating the number of saleable calves/cow lifetime, from which is subtracted one calf to represent the heifer retained to replace the cow.

The selection criteria to predict H include number of calves born and weaned, weaning weight and yearling weight. All progeny are retained through to the yearling stage. At this time, herd replacements of both sexes are selected on the basis of a Yearling Index which incorporates dam fertility and maternal weaning weight (weight of calf weaned) deviations, and the individual's adjusted weaning and yearling live-weight deviations. Continued selection of cows in the nucleus is based on a Cow Index, incorporating the above traits (updated for subsequent calvings of the dam) as well as the cow's own fertility and maternal weaning weight deviations.

At the time of revision of the scheme, an experiment was established in an independent Departmental herd to compare progeny sired by average-merit ABS-bred bulls and by bulls normally available to Departmental herds from private industry sources (I). ABS bulls were selected as having selection index values representative of the average value of all ABS-bred bulls distributed to Departmental herds in the Rotorua Land Development District. Each year, I bulls were purchased independently by Departmental officers from the Te Kuiti region.

The objective of the present paper was to determine whether genetic improvement had been achieved in the scheme since the institution of index selection (i.e. from the 1976 calving).

## MATERIALS AND METHODS

Three sources of information were examined:

1. ABS data for calf birth years 1976 to 1984;
2. the pilot Angus Sire Reference Scheme (ASRS; Morris and Gibson, 1981); and
3. preliminary data for calf birth years 1977 to 1984

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from the experimental comparison of ABS- and I-sired progeny.

### ABS Data

Mixed model techniques (Henderson, 1973) were used to obtain estimates of genetic trend in weaning and yearling weights by regressing ABS nucleus sire group estimates on year. Sires were grouped according to the following years of birth:  $\leq 1973$ , 1974, ... , 1982. A relationship matrix was established incorporating 177 sires with 6326 and 6111 weaning and yearling weight records respectively. The repeated use of 42 sires occurred over the 9 calf birth years studied.

### ASRS Data

Mixed model techniques were also used to estimate genetic trend in weaning and yearling weights by regressing ABS-bred sire group estimates on year. Sires were grouped according to year of birth as follows:  $\leq 1972$ , 1973-75, 1976-77, 1978-79, 1980-81 and 1982, involving 158 sires with 6324 weaning records. For progeny yearling weight, 142 ABS sires with 5299 records were grouped as above (excluding 1982-born sires).

### Experimental Comparison

The Restricted Maximum Likelihood technique (Patterson and Thompson, 1971) was used to compare source of sire effects (i.e. ABS v. I sires). Live-weight data were used from first-generation progeny out of base cows from 1977 to 1982 (1538 calves, 646 yearling heifers), and sired by 56 ABS and 55 I bulls. Live-weight and maternal weaning weight data of first-generation cows were also used to obtain estimates of sire source effects (1297 cows and 1230 weanings) for the years 1980 to 1984.

## RESULTS

### ABS and ASRS Data

Estimates of single trait genetic trends for weaning weight (WW) and yearling weight (YW) were  $1.6 \pm 0.9$  and  $0.7 \pm 0.9$  kg/year respectively. Corresponding estimates from the ASRS data were 1.0 and 1.6 kg/year.

### Experimental Comparison

The 55 I bulls used to sire first-generation progeny were purchased from at least 10 sources, at an average current equivalent price of \$1250 (5% discount rate over 7 years). The mean index value of the corresponding 56 ABS sires was  $\$8.7 \pm 1.2$ , which did not differ significantly from the mean index of ABS bulls distributed to Departmental herds in the Rotorua Land Development District ( $\$8.9 \pm 1.3$ ).

Sire source differences (ABS-I) for the first-generation progeny live weights to 18 months of age,

and the annual trends in these differences obtained by regressing source difference on year, are presented in Table 1. Although the differences between ABS and I sire sources showed a consistent 7.0 to 7.7 kg advantage to the ABS source for yearling and subsequent weights in heifers, only the advantage in yearling weight approached significance ( $P < 0.10$ ). The within-year differences in these traits showed positive, but non-significant trends over time in favour of the ABS sire source, indicating that the ABS source advantage over I was increasing with time.

Table 2 shows preliminary estimates of sire source differences in live weights, maternal weaning weight and calving day of first-generation cows. Source differences were not significant for any trait, although ABS-sired cows tended to have heavier maternal weaning weights than I-sired cows. These first-generation cows weaned calves (second generation) sired by either ABS or I bulls. Although the cow sire source x calf sire source interaction for maternal weaning weight was not significant, it was of interest to look at the subclass estimates (Table 3). Relative to ABS-sired cows weaning calves sired by bulls from the same source, I-sired cows had the lightest maternal weaning weight when they weaned I-sired calves. This was also the case when maternal weaning weight was expressed relative to cow weight.

**TABLE 1** Source of sire differences and their annual trends, in live weights of first-generation progeny sired by average merit ABS bulls and by I bulls normally available to Department of Lands and Survey herds.

Trait	Sire source difference	
	ABS-I	Trend (ABS-I) (kg/yr)
Weaning weight (145d)	-0.8±3.4	-0.2±0.3
Heifers:		
Yearling weight (335d)	7.6±3.9	1.8±3.0
Mating weight (15mo)	7.0±5.2	3.3±3.6
February weight (18mo)	7.7±6.1	3.4±3.4

**TABLE 2** Preliminary source of sire differences in mature live weights, maternal weaning weight and calving day of first generation cows sired by average-merit ABS bulls and by I bulls normally available to Department of Lands and Survey herds.

Trait	Sire source difference ABS-I
Live weights (kg):	
Mating (November)	-2.4±3.0
Weaning (February)	-4.7±3.5
Maternal weaning weight (kg)	5.3±3.9
(kg/100 kg LW)	1.5±0.6
Calving day (d)	0.2±1.0

## DISCUSSION

The Department of Lands and Survey's ABS project has defined a breeding objective which incorporates live weight and female fertility traits. In contrast, most beef cattle performance recording systems are based on live-weight traits, despite general recognition of the importance of both sets of traits.

Although the standard errors from the ABS data were large, reflecting the short period under study (2.1 generations of selection, Nicoll and Johnson, 1986), the estimates indicated that genetic improvement in live-weight traits was being achieved in the ABS nucleus. There were fewer sires represented in the ASRS data than in the ABS data since the former included only ABS-bred sires, whereas the ABS data included non-ABS bulls purchased for use in the nucleus. The proportionately higher number of records for the ASRS sires relative to the ABS sires reflected the extended use of some ABS sires throughout the industry by sale or AI.

Estimated genetic responses/generation (in standard deviation units) for weaning and yearling weights were respectively 0.34 and 0.11 for the ABS data and 0.23 and 0.27 for the ASRS data. Corresponding estimates from single-trait selection lines of cattle in the United States reported by Buchanan *et al.* (1982) and Frahm *et al.* (1985) were 0.24 and 0.22  $\sigma$ /generation for animals selected on weaning weight, and 0.39 and 0.14  $\sigma$ /generation for animals selected on yearling weight. It is of interest that the gains in the present study have been achieved under index selection (albeit strongly favouring the live-weight traits) and over a short period of selection, and yet have compared favourably with longer-term single-trait weight selection experiments in the United States. Baker *et al.* (1980) estimated a genetic gain in yearling weight of 0.35  $\sigma$ /generation for Angus cattle selected solely for this trait in New Zealand.

The results of the experimental sire source comparisons indicate the productive rewards to the Department of Lands and Survey of maintaining the ABS project for the provision of bulls, compared with reverting back to the large-scale purchasing from private industry breeding herds. Given the short period of selection that has been undertaken in the ABS project to date, sons distributed as herd sires from the ABS nucleus have conferred apparent benefits in daughter live weights and maternal productivity compared with I source bulls. Although not statistically significant, these benefits were considered to be of productive relevance to Departmental herds. For example, the advantage to ABS sires in daughter yearling to 18-month live weight ranged from 2.5 to 4.0% of the mean live weight. Similarly, the maternal weaning weight advantages to ABS sires ranged from 3.2 to 4.0% of the mean. The results also indicated the potential advantages of the continued use of ABS bulls in Departmental herds relative to the continued use of

bulls from normal industry sources (Table 3). The sire source difference in maternal weaning weight for these 2 policies represented a difference of 5.1% of the mean. It is noted that responses realised in Departmental herds using ABS-bred bulls would be one half of the sire source effects estimated here, since progeny would inherit a sample half of the genes from the sire.

**TABLE 3** Preliminary relative sire source differences in maternal weaning weight of first generation ABS- and I-sired cows, each weaning second generation ABS- and I-sired calves.

Generation 1 cow sire source	Generation 2 calf sire source	Relative difference in maternal weaning weight	
		kg	kg/100 kg LW
ABS	ABS	0	0
ABS	I	-3.2	-1.0
I	ABS	-6.0	-1.8
I	I	-8.4	2.2

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