

Cow weights and other correlated responses to yearling or 18-month weight selection

Peso de la vaca y otras respuestas correlacionadas a la seleccion por peso a los 13 0 18 meses de edad

C.A. MORRIS *
R.L. BAKER **

NEW ZEALAND

INTRODUCTION

The experiment has two objectives, to evaluate the responses to selection for increased body weight under pasture conditions, and to compare two selection lines. Previous work in New Zealand (Carter, 1971) has established that worthwhile selection responses are possible under pasture conditions, selecting for 5-month weaning weight or yearling weight. However, the cooperative nature of that trial precluded the establishment of a control herd, and thus the estimation of correlated responses to selection may be difficult.

The purpose of this paper is to report preliminary estimates of the correlated changes in cow weight and reproduction, in response to body weight selection.

MATERIALS AND METHODS

Two Selection lines were established, AS1 an Angus herd selected on adjusted yearling weight (approximately 13 months of age), and AS2 an Angus herd selected on adjusted rising two-year-old weight. Adjustments were made for birth date and age of dam.

The experiment is being run at Waikite, about 30 km SE of Rotorua in the Central North Island of New Zealand. As a guide to production levels on pasture, mean 5-month weaning and yearling weights are approximately 150 and 200 kg.

Fifty-three bulls were used in this herd in the four years prior to the trial, from a wide cross-section of industry sources.

Bulls and heifers in the AS1 herd were first joined as 'yearlings' at 14 to 15 months of age and in the AS2 herd as 'two-year-olds' at 26 to 27 months of age. Selection herd bulls were selected as the top son per sire. An Angus control herd (ACO) was also set up, with replacements chosen at random, and first joining two-year-olds. Bulls in each line were used for one season only.

All lines were run together at all times except for joining and calving (but calvings were together in 1980). Cow groups were rerandomised to single-sire mating groups at the beginning of each joining season. In the AS1 herd, yearling heifers were run in the same paddocks as cows for joining, so that sire and age of dam effects were not confounded. These heifers were however run separately from older cows for part of their gestation period.

* C.A. Morris, Ruakura Animal Research Station, Private Bag, Hamilton, New Zealand

** R.L. Baker, 126 Animal Science Laboratory, University of Illinois, Urbana 61801, U.S.A.

The first cycle of selection was applied to 1970-born animals, in 1971 for AS1, and 1972 for AS2 and ACO. Joinings were for 8 to 9 weeks in late spring (November to early January), with calving in the following late winter/early spring. The trial design is summarised in Table 1. Herd sizes of selected or control stock for breeding were of 165 females per line, although the mating-management design meant that only 125 cows per line were joined in AS2 and ACO. To correspond with this on the bull side, there were 6 and 5 bulls respectively in the AS1 and AS2 lines.

To minimise inbreeding, more ACO bulls were used than in the selection lines. Also, there were single-sire matings with bull replacement part-way through the season in the ACO herd. Thus, in total 10 to 12 ACO bulls were used each year, with careful record of mating and calving dates being kept for sire pedigrees of calves.

Barren cows were culled in the autumn/early winter after pregnancy diagnosis (PD).

The cow weights reported here are those taken in winter, about six weeks before calving. A least squares model was used for each year of data separately, fitting effects for age of cow, line and their interaction. Only pregnant cows were included, with a covariate fitted either for previous calving date or current calving date. There were empty subclasses, due to mating management in the AS2 and ACO herds. Nine years of precalving weight data (1972 to 1980) were analysed in this preliminary study. Each year was considered separately, in view of the increasing responses to selection expected with time. After more years of data are collected, a more complete model could be fitted, including generation number.

With overlapping generations, beginning at generation 0 in calving year 1970 (range 1970-72, average 1971), the calves had advanced approximately 3.0 (AS1) and 2.3 (AS2 and ACO) generations by calving year 1980. Since the cows lag one generation behind their calves in terms of selection applied, this study is concerned with approximately 2.0 generations of correlated responses in body weight for AS1 cows and 1.3 generations for AS2 and ACO cows.

Conception rates (%) by PD were analysed for the same generations of cows as above, those joined in 1971 to 1979. A linear model was fitted to account for the effects of line, age of cow and their interaction.

Previous analyses of seven calf birth years (1972 to 1978) by Baker *et al.*, (1980) have established, from regressions of calf weights on year of birth relative to the control, a direct response of 2.6 kg/year in yearling weight in AS1, and of 1.5 kg/year in 18-month weight in AS2. Assuming line means of approximately 210 kg at 13 months and 280 kg at 18 months, these preliminary responses are 1.2% and 0.5% per year.

RESULTS

Year-by-year summaries of precalving weights, subsequently combined in three-yearly blocks, are presented in Table 2. The first part of the Table reports data on pregnant cows adjusted for current calving date, a significant covariate in three of the nine years ($P < 0.05$). Yearly means in the ACO herd ranged from 372 to 422 kg.

The second part of the Table reports data adjusted for previous calving date, a significant covariate in two out of eight years ($P < 0.05$), and three

other years ($P < 0.10$). Higher means derived from this analysis were a consequence of having to omit first calvers, when previous calving date was fitted.

Correlated precalving weight responses in the last three-year block were from 0.8 to 1.5% for AS1, and from 1.2 to 2.3% for AS2, relative to ACO.

PD in-calf rates, summarised by three-yearly blocks, are given in Table 3. Least squares means for the ACO herd have ranged from 72 to 97% from year to year, and yearly differences among lines have not been stable in spite of reasonably large numbers of cows present per herd. Age effects on PD rate amount to a maximum of only 9% between females first joined as yearlings or as 5-years and older, and only 3% between yearlings and two-year-olds. Apart from calving years 1972 and 1973 (before many selected females were in the cow herd), only one significant year of interactions between line and age of cow has been found ($P < 0.05$).

DISCUSSION

The precalving weight data show that there have been correlated changes to direct selection for yearling or 18-month weight. More complete analyses will probably need to account for cow weight changes as well, obtained from weights taken on cows at four strategic times of year. Weights of all ACO cows at joining were, for example, 48 kg less than their precalving weights. Only part of the difference was accounted for by conceptus products and by the 7.5 kg difference at mating between cows subsequently barren vs pregnant in that season. Line effects on cow weight loss and gain have not been analysed yet.

In spite of the wide variation in PD in-calf rates among years and in line differences among years, the difference between selection lines and ACO has been consistently positive in sign. This shows that weight selection has at least produced no loss in conception rates, a concern among some farmers in industry. Losses from PD to subsequent weaning were small. Baker *et al.*, (1980) reported reductions for all lines of only 4 or 5% between PD rates and per cent calves weaned per 100 cows joined at 2-years of age and over.

The culling policy for barren cows may have affected the long-term trends for conception rate. The Waikite policy is however commonly found in industry.

Carter and Cox (1973) have found no differences in lifetime reproductive performance among females first joined as yearlings and classified according to phenotypic weight at 15 months in the lowest quartile, the highest quartile or average. Perhaps the finding (Table 3) of a 6% difference favouring AS1 above ACO in 1971-73 is anomalous; it is difficult to explain because this time period was before many selected females had reached breeding age. The same result was found in 1974-76. However, a number of factors must be remembered:

1. Line effects on female and male fertility are confounded in the within-line matings reported here.
2. Although small numbers of infertile mating groups have been removed from the present data set, subfertile bulls may occur more frequently in the ACO line, due to random bull selection; (it is unlikely that sick bulls or heifers could be selected in AS1 or AS2 on adjusted weights, but there is a chance of this occurring in ACO).
3. Using more bulls in the ACO line might be imagined to minimise any subfertile bull problem across the whole herd, especially since bulls changed frequently in this line.

From calving 1980 onwards, lines have been calved together. It is hoped that this should minimise any paddock effects on weight differences among lines, and any possible carryover effects to subsequent conception rates.

Table 1.

Design of the selection experiment

Line	Number of cows of different calving age (year)					No. of bulls (replaced annually)	Expected Values of:					
	2	3	4	>4	Total		Generation Int. (yr)			Prop. selected Inbreeding		
							Male	Female	Average	Male	Female	% per year
AS1	40	34	31	60	165	6	2	4.0	3.0	0.11	0.70	0.23
AS2	-	34	31	60	125	5	3	4.6	3.8	0.11	0.75	0.17
ACO	-	34	31	60	125	10-12	3	4.6	3.8	-	-	0.07

Table 2. Precalving weights and weight differences (kg) of pregnant cows in the selection and control lines, classified by year of calving (least squares constants).

	ACO		AS1		AS2	
	No. of cows	Weight	No. of cows	Weight diff., AS1-ACO	No. of cows	Weight diff., AS2-ACO
With regression on calving date in current year						
1972-74	202	392.4	364	-1.0	285	-12.9
1975-77	286	408.2	417	3.9	273	1.4
1978-80	273	396.2	437	6.1	345	9.1
With regression on calving date in previous year						
1973-74	151	393.6	194	2.9	127	-2.2
1975-77	218	415.5	313	0.8	197	-6.7
1978-80	195	400.0	307	3.3	256	5.3

Table 3. Conception rates (%) by pregnancy diagnosis (PD) achieved in the selection and control lines, classified by year of joining and by age of cow at joining (least squares constants)

	ACO		AS1		AS2	
	No. of cows joined	% PD in calf	No. of cows joined	Diff. in PD%, AS1-ACO	No. of cows joined	Diff. in PD%, AS2-ACO
Line effect						
1971-73	241	83	428	6	216	5
1974-76	348	81	481	8	287	11
1977-79	346	85	526	2	423	1
Cow age at joining (years)						
	1	2	3	4	>4	
Age effect						
Number of cows joined	678	1069	890	701	1342	
% PD in calf	-4	-1	-1	2	5	

Comparing numbers of records in the last two three-yearly data blocks (Table 2; top half) gives an approximate comparison of line, age and management effects jointly on numbers of pregnant cows.

Overall, the present results suggest that PD in-calf rates were at least as good in the selection lines as in the control herd.

SUMMARY

Angus selection herds with 165 cows each were established in 1971 to compare the effectiveness of selection either on 13-month live weight (the AS1 line, first joining at 14 to 15 months of age) or on 18-month live weight (the AS2 line, first joining at 26 to 27 months). A control herd (ACO) was also set up, with first joining at 26 to 27 months. Direct responses of 2.6 kg/year and 1.5 kg/year were achieved in the first seven years, in AS1 and AS2 respectively. Precalving cow weights for nine years have been analysed in a model fitting line, calving year and calving date (in either previous or current year). Least squares differences were summarised separately for each three year period. The AS1 and AS2 herds were 6 and 9 kg above ACO in the third period, when analysed with current calving date as covariate, or 3 and 5 kg above ACO, with previous calving date as covariate. Percent conception rates by pregnancy diagnosis have been variable, but average line differences in each three year period have always favoured the selection lines over the control.

R E S U M E N

En 1971 se establecieron establos de selección Angus con 165 vacas para comparar la efectividad de la selección tanto al peso vivo a los ~~14-15~~¹³ meses (la línea AS1, con la primera monta, a los 14-15 meses de edad), como ~~al peso vivo de 18 meses~~^{al peso vivo de 18 meses} (la línea AS2, con primera monta de 26 a 27 meses). Un establo control (ACO) tuvo la primera monta a los 26-27 meses. Se obtuvieron respuestas directas de 2,6 kg/año y 1,5/kg año en los primeros siete años en AS1 y AS2, respectivamente. Se analizó el peso antes del parto en vacas durante nueve años en una línea modelo, así como el año del parto y su fecha (en el anterior o en el corriente año). Las diferencias cuadráticas se resumieron separadamente por cada periodo de tres años. Los establos AS1 y AS2 tuvieron 6 y 9 kilos por encima del ACO en ~~el~~^{este} tercer periodo, cuando se analizaron en relación con los datos normales de parto como covarianza, o 3 y 5 kg sobre ACO, cuando la fecha del año anterior del parto es la covarianza. Los tipos de concepción porcentual por diagnóstico de gestación fueron variables, pero las diferencias medias en cada periodo de tres años favorecieron siempre a las líneas de selección sobre control.

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