EFFECTS OF LONG-TERM SELECTION FOR 365-DAY WEIGHT ON MATERNAL PERFORMANCE OF BEEF COWS[1]

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SUMMARY

Data describing first parity reproductive and maternal performance and herd longevity of 655 cows, born over a 20-year period, were used to estimate genetic response in these traits, associated with selection for increased 365-day weight. The data were analyzed by least squares with the effects of year of cow birth, management regime during cow growth to 365 days of age, age of the cow's dam and regression on weaning age included in the model. Annual genetic change was estimated by comparing successive progeny groups of individuals with the remainder of the population. The only significant genetic trends were for 365-day weight (6.83 kg/yr; $P \leq .05$), dystocia score (-.40 units/yr; $P \leq .05$) and number of calves weaned in a standardized lifetime of 5.17 years (.33 calves; $P \leq .01$). Though the data did not allow definitive conclusions concerning changes in maternal and longevity traits, there was evidence that selection solely for weight may be associated with increased mature body weight, delayed sexual maturity, decreased dystocia rate, increased progeny weights and decreased herd longevity.

INTRODUCTION

Maternal performance of beef cows has been defined as reproductive efficiency (Milagres _et al_., 1979), progeny weaning weight (Boston _et al_., 1975; Hays and Brinks, 1980), most probable producing ability for progeny weaning weight (Kress and Burfening, 1972; Hays and Brinks, 1980) and span of life (Fleck _et al_., 1980; Martin _et al_, 1981). Pre-weaning growth rate of replacement heifers was negatively associated with cow performance measured as weaning weights of progeny (Mangus and Brinks, 1971; Martin _et al_., 1981) and longevity (Fleck _et al_., 1980; Martin _et al_., 1981).

Martin and Alenda (1982) estimated annual genetic change over a period of 21 years for growth traits in a herd of Angus cattle subjected to selection for increased 365-day weight. Annual changes were observed in birth weight, 205-day weight, 365-day weight and post-weaning daily gain, respectively, of 0.14 kg, 2.56 kg, 4.06 kg and 14 gr/day.

Considering the effectiveness of selection for body weight increase observed by Martin and Alenda (1982) and the negative association between pre-weaning growth of heifers and maternal ability expressed later in life (Mangus and Brinks, 1971; Martin _et al_., 1981), a question was posed concerning the effects of such selection on maternal traits. The objective of this study

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was to estimate the changes in reproductive, maternal and longevity traits of cows associated with the observed changes in growth rate of calves.

MATERIALS AND METHODS

Reproductive and maternal performance data were recorded on 655 cows born between 1959 and 1978 in an Angus herd selected for increased 365-day weight. This represented 25.4% of calves, of both sexes, included in the earlier analysis (Martin and Alenda, 1982). Characteristics included in the analyses were: weights of the cows at birth and at 120 days, 205 days, 365 days and 54 mo of age; first parity pregnancy rate, calf birth and weaning rates; first parity calving date and dystocia score; first parity progeny weights at birth and at 120 and 205 days of age; longevity expressed as years in the herd and lifetime performance measured as numbers of pregnancies, calves born and calves weaned in a lifetime.

Progeny weights were adjusted to a female basis by multiplicative factors (.90, .92 and .90, respectively, for birth, 120-day and 205-day weights of male calves) derived from the data. Both cow and progeny weights at 120 and 205 days were adjusted to no-creep-feed basis in the years 1959 to 1967 (Martin *et al*., 1981) and to 205 days of age at weaning in the years 1968 to 1973 (Richardson *et al*., 1978) by using within-year additive factors derived from the data. In 1977 and 1978 birth years, the females were subjected to four dietary energy levels in the post-weaning period. Cow weights at 365 days of age were adjusted to a constant energy level by additive factors derived from the data.

There was very little selection of heifers in the years 1959-1963 and 1977-78. In the years 1964-1976, approximately 40% of available heifers were retained based on 365-day weight. Heifers were bred to calve at 2 years of age and cows were not culled based on previous progeny weaning weights. The cow removal patterns in the herd were summarized by Etienne and Martin (1979). Cows were removed from the herd for twice failing to wean a calf or for being unsound in feet and legs, udder, teeth, or age and body condition.

The model for least squares analyses was:

$$X_{ijkm} = \mu + Y_i + T_j + A_k + YT_{ij} + bZ_{ijkm} + e_{ijkm}$$

where X_{ijkm} was the dependent variable, μ was the least squares mean, Y_i was the i^{th} year of cow birth, T_j was the j^{th} management treatment of the cow, A_k was the k^{th} age of dam, YT_{ij} was the interaction between Y_i and T_j, b was the regression of X_{ijkm} on age at weaning (Z_{ijkm}) and e_{ijkm} was the error.

Average annual genetic change was estimated for each trait by comparing successive progeny groups of individuals with the remainder of the population (Smith, 1962; Martin and Alenda, 1982). Phenotypic change (ΔP) was equated with the sum of change due to sire selection (ΔG_S), dam selection (ΔG_D) and environment (ΔE). Nineteen separate, but not independent, estimates of annual change between adjacent years were averaged to obtain the average annual change in each characteristic. The sum of ΔG_S and ΔG_D was interpreted to be total genetic change (ΔG).

According to Syrstad (1974), there were two sources of possible bias in these data due to: (1) selection of sires for future use based on earlier progeny performance and (2) differential selection rates for males and females.

Expected values for responses (EΔG) correlated with selection for 365-day weight were calculated by using the value 4.06 kg/yr (Martin and Alenda, 1982) as the observed change in 365-day weight. Additive genetic standard deviations for cow traits and genetic correlations between 365-day weight and the other cow traits were derived from the data.

RESULTS AND DISCUSSION

Observed annual phenotypic, environmental and genetic changes and expected genetic changes for cow weights are in Table 1. The values for ΔG/yr did not differ significantly from either expectation for these data or the observed and expected values in the more complete data set (Martin and Alenda, 1982). The phenotypic trends for 120-day and 365-day weights and the genetic trend for 365-day weight were greater than zero ($P \leq .05$).

Observed genetic changes in the first parity pregnancy, calving and weaning rates (Table 2) did not differ ($P \geq .10$) from either zero or expected genetic changes. Calving date for the first parity was indicative of age at sexual maturity and, though the estimate of genetic change was strongly positive and indicated later maturity, the trend was not different ($P > .10$) from either zero or expectation. Both environmental and genetic changes in first parity dystocia score differed from zero ($P \leq .05$) and were of opposite signs.

Table 1. Observed Annual Phenotypic (ΔP), Environmental (ΔE) and Genetic (ΔG) Changes and Expected Genetic (EΔG) Changes for Cow Weight Traits.

Trait	ΔP	ΔE	ΔG	EΔG	ΔG[a]	EΔG[a]
Birth wt, kg	.23 ± .21	- .15± .68	.38 ± .65	.15	.14 ± .06	.22
120-day wt, kg	1.93**± .67	2.05±2.25	-.12 ±2.15	1.33	---	---
205-day wt, kg	1.30 ± .87	.95±2.96	.35 ±2.83	2.17	2.56**± .61	1.94
365-day wt, kg	2.35* ±1.11	-4.48±3.67	6.83*±3.50	4.06[a]	4.06**±1.10	4.05
54-mo wt, kg	4.01 ±2.83	- .11±9.22	4.12 ±8.78	2.38	---	---

[a]Reported by Martin and Alenda (1982).
**$P \leq .01$; *$P \leq .05$.

Table 2. Observed Annual Phenotypic (ΔP), Environmental (ΔE) and Genetic (ΔG) Changes and Expected Genetic Change (EΔG) for First Parity Cow Performance Traits.

Trait	ΔP	ΔE	ΔG	EΔG
Pregnancy rate, %	.9 ±2.3	- .7 ± 9.6	1.6 ± 9.4	-1.0
Calving rate, %	2.1 ±2.4	1.0 ± 9.9	1.1 ± 9.6	- .3
Weaning rate, %	3.7 ±3.2	4.1 ±11.1	-.4 ±10.6	- .1
Calving date, days	.73± .83	-1.80 ± 2.62	2.53 ± 2.48	-1.15
Dystocia score[a]	.05± .06	.45*± .19	-.40*± .18	- .00
Progeny birth wt, kg	.00± .24	.58 ± .84	-.58 ± .80	.18
Progeny 120-day wt, kg	- .43± .96	-2.00 ± 3.01	1.57 ± 2.85	.87
Progeny 205-day wt, kg	-1.40±1.93	-3.58 ± 4.62	2.18 ± 4.41	1.73

[a]No assistance = 1, slight assistance = 2, major assistance = 3.
*$P \leq .05$.

Environmental changes promoted increased dystocia rate while genetic changes promoted decreased dystocia rate. First parity progeny weights did not exhibit changes which differed (P≥.10) from either zero or expectations. Based on the limited data set used in this study, there was little or no influence of correlated response on first parity reproductive and maternal traits associated with selection favoring increased 365-day weights. The trends suggest that delayed sexual maturity, decreased dystocia rate and increased progeny weights could be influenced by such selection.

Observed and expected changes in longevity traits are in Table 3. Number of years herd life and numbers of pregnancies, calves born and calves weaned are highly correlated and the trends were expected to be similar. Though none of the genetic trend estimates were different (P≥.10) from zero, all were negative indicating that productive life in the herd was shortened.

Table 3. Observed Annual Phenotypic (ΔP), Environmental (ΔE) and Genetic (ΔG) Changes and Expected Genetic Changes (EΔG) for Longevity Traits.

Trait	ΔP	ΔE	ΔG	EΔG
No. years in herd	-.08 ± .19	.25 ± .60	-.33 ± .57	-.21
No. pregnancies[a]	-.03 ± .20	.31 ± .63	-.34 ± .60	-.19
No. pregnancies[b]	.06* ± .03	.12 ± .11	-.06 ± .11	.00
No. calves born[a]	-.04 ± .19	.41 ± .60	-.45 ± .57	-.20
No. calves born[b]	.05 ± .04	.27* ± .13	-.22 ± .12	.01
No. calves weaned[a]	-.02 ± .19	.18 ± .59	-.20 ± .56	-.14
No. calves weaned[b]	.10* ± .04	-.23† ± .13	.33** ± .12	.05

[a]Total number in lifetime.
[b]Total number in lifetime adjusted to average number of years in the herd (5.17).
**P≤.01; *P≤.05; †P≤.10.

The numbers of pregnancies, calves born and calves weaned in a standard lifetime (5.17 years) were indicative of production per year in the herd. The positive trend (P≤.01) in number of calves weaned would indicate an increase of .06 calves weaned per cow year.

The limited sample size involved in this study did not allow the authors to make definitive conclusions concerning the effects of long-term selection for 365-day weight on reproductive, maternal and longevity traits. However, this study did yield evidence that such selection may be associated with increased mature body weight, delayed sexual maturity, decreased dystocia rate, increased progeny weights and decreased herd longevity. If these changes do in fact occur, lines or breeds of beef cattle to be used primarily as maternal lines should not be selected solely on growth rate or body weight at a constant age. Maternal traits should be emphasized in the selection of maternal lines.

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