THE EFFECT OF SELECTION FOR YEARLING GROWTH RATE ON THE RATE OF MATURATION AND MATURE SIZE OF COWS

J.A. Archer¹, P.F. Arthur¹, R.M. Herd² and P.F. Parnell¹,³

¹ NSW Agriculture, Agricultural Research Centre, Trangie, NSW 2823
² CRC for the Cattle and Beef Industry, University of New England, Armidale, NSW 2351
³ Present address: Angus Society of Australia, Armidale, NSW 2350

SUMMARY
Growth curves were fitted to weight and height data of cows from growth rate selection lines at Trangie and the effect of selection for growth rate on lifetime growth (from birth to maturity) was examined. Results suggested that selection for growth rate to yearling led to a correlated increase in weight and height at all ages, but no difference was found between lines for rate of maturation of height and weight. Data from crossmothered animals indicated that the lack of response in rate of maturation may have been due to conflicting direct and maternal effects.

Keywords: Selection, growth, maturity, cattle

INTRODUCTION
A number of studies have examined the realised response to selection for growth, and the correlated responses in weight and height at different ages. However, there have been few reports on the realised response in growth curve parameters obtained after selection for growth rate. The growth curve approach has advantages in that it describes growth from birth to maturity rather than weight at any one specific point. A divergent selection experiment was conducted at the Agricultural Research Centre, Trangie from 1974 to 1992 to examine the implications of selection for growth rate from birth to yearling. Data from this experiment provided the opportunity to examine the realised responses in growth curve parameters of cows to selection based on yearling growth rate.

MATERIALS AND METHODS
Data on the height and weight of Angus cows from lines selected on the basis of growth rate from birth to yearling (adjusted for age of dam effects) at the Agricultural Research Centre, Trangie were used. The first selected animals in this experiment were born in 1975, and a high growth rate (High line), low growth rate (Low line) and an unselected control line were established. Further details of the selection lines were given by Parnell et al. (1994). The data used in this paper was from cows born from 1984 to 1988. All cows in the analysis had data recorded from their birth to weaning of their calves as a four year old, with some animals having data up to weaning as a five year old. As calves, they were weighed at birth and up to 10 times until yearlings, after which cows and heifers were weighed approximately every two months. Height at the withers was recorded at birth, weaning, yearling and then yearly at weaning as heifers or cows. Cows born in 1988 did not have height records as four year olds, and were excluded from the analysis for height traits.
From 1984 to 1987 a crossmothering experiment between the high line and the low line was conducted (Herd 1990). Female calves from high and low lines were separated from their natural dam shortly after birth and crossmothered to cows from the opposite line. Crossmothered calves which joined the cow herd and remained in the herd for sufficient time to have data recorded at weaning of their calf as a four year old were included in the analyses. Thus there were five selection line/calf rearing combinations: three naturally reared combinations (High, Control and Low) and two crossmothered combinations (High reared by Low dam and Low reared by High dam).

Curve fitting. A modified Gompertz curve suggested by Pitchford (1993) was used to model the weight and height of individual cows from birth to maturity (SAS 1989). The curve was fixed though weight or height at birth (Bwt or BHt), and growth was described using two parameters representing asymptotic (mature) weight or height (A_w or A_H), and the rate of maturation of weight or height (K_w or K_H). A multiplicative error was used for weight, but not for height, after Pitchford et al. (1993). The curves fitted were:

\[ W_t = A_w \cdot e^{((\ln(Bwt) - \ln(A_w)) \cdot e^{-K_w \cdot t}) + E_w} \]
\[ H_t = A_H \cdot e^{((\ln(BHt) - \ln(A_H)) \cdot e^{-K_H \cdot t}) + E_H} \]

Where \( W_t \) = weight at time \( t \); \( E_w \) = error in weight at time \( t \); \( H_t \) = height at withers at time \( t \); and \( E_H \) = error in height at time \( t \).

Analyses. Weight and height at birth and the estimates of curve parameters (A_w, K_w, A_H and K_H) were modelled using a least squares generalised linear model (SAS 1989). The model fitted to weight and height at birth included the fixed effects of age of dam, year of birth and selection line. The model fitted to curve parameter estimates included the effects of age of dam, year of birth, whether the cow calved as a 2 year old and as a 3 year old and the effect of selection line/calf rearing combination. Cows with dams which were 5 years or older at birth were pooled for the age of dam effect. Calving as a 4 year old had no significant effect on the curve parameters and was excluded from the model.

RESULTS
The effects of selection line and calf rearing combination on growth curve parameters are given in Table 1. Selection line had a significant effect on height and weight at birth and at maturity. Calves from the high line were 9% heavier and 4% taller at birth than control line calves, and were also 10% heavier and 3% taller as mature cows. Calves from the low line were 16% lighter and 5% shorter at birth than control line calves, and were 16% lighter and 6% shorter than control line cows at maturity. There was no significant difference between selection lines in rate of maturation of height and weight.

Comparison of crossmothered calves with naturally raised animals is based on a relatively low number of observations. Mature weight of high line cows raised by low line dams was not significantly different from naturally raised high line cows. However, low line cows raised by high line dams were significantly heavier at maturity than naturally raised low line cows. Mature height
of high line cows was significantly greater when raised by low line dams than high line dams. Low line cows raised by high line dams were taller at maturity than naturally raised low line cows.

Rate of maturation of weight and height were not significantly different between selection line/calf rearing combinations. However, consistent trends were observed, suggesting that the differences may have been significant had more records been available on cross-mothered animals. Cows from the same line tended to mature faster when raised by a high line dam than when raised by a low line dam. When raised by dams from the same line, low line cows tended to mature faster than high line cows.

Table 1. Least square means* (± standard error) by selection line/calf rearing combination for weight and height at birth and growth curve parameters (weight and height at maturity and rate of maturation of weight and height)

<table>
<thead>
<tr>
<th>Selection line/calf rearing combination</th>
<th>No.</th>
<th>Birth</th>
<th>Maturity (A)</th>
<th>Rate of maturation (K x 10^6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>99</td>
<td>30.4 ± 0.3^c</td>
<td>508 ± 6^d</td>
<td>45.7 ± 0.7^f</td>
</tr>
<tr>
<td>Control</td>
<td>84</td>
<td>27.8 ± 0.4^b</td>
<td>462 ± 5^c</td>
<td>45.1 ± 0.7^f</td>
</tr>
<tr>
<td>Low</td>
<td>62</td>
<td>24.3 ± 0.4^a</td>
<td>388 ± 5^a</td>
<td>45.4 ± 0.7^g</td>
</tr>
<tr>
<td>High reared by low dam</td>
<td>19</td>
<td>-</td>
<td>517 ± 10^d</td>
<td>44.1 ± 1.3^e</td>
</tr>
<tr>
<td>Low reared by high dam</td>
<td>20</td>
<td>-</td>
<td>425 ± 10^b</td>
<td>46.3 ± 1.3^e</td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>48</td>
<td>63.4 ± 0.3^c</td>
<td>119.3 ± 0.7^d</td>
<td>44.8 ± 1.2^a</td>
</tr>
<tr>
<td>Control</td>
<td>45</td>
<td>60.4 ± 0.4^b</td>
<td>115.7 ± 0.6^c</td>
<td>45.6 ± 1.1^b</td>
</tr>
<tr>
<td>Low</td>
<td>41</td>
<td>57.6 ± 0.4^a</td>
<td>108.3 ± 0.6^a</td>
<td>46.3 ± 0.9^a</td>
</tr>
<tr>
<td>High reared by low dam</td>
<td>12</td>
<td>-</td>
<td>122.1 ± 1.1^c</td>
<td>42.4 ± 1.7^a</td>
</tr>
<tr>
<td>Low reared by high dam</td>
<td>14</td>
<td>-</td>
<td>111.9 ± 1.0^b</td>
<td>44.8 ± 1.6^a</td>
</tr>
</tbody>
</table>

* Means with the same superscript do not differ (P>0.05);
^ Observations at birth on crossmothered animals are included in the High or Low line.

DISCUSSION

The results of this study showed that selection for growth rate led to a correlated increase in weight and height of cattle at all ages through to maturity. This observation has been well documented in the literature from parameter estimation studies (see review by Barlow 1978), but there have been fewer reports on the realised response in mature weight and height to selection for growth in young cattle. Morris et al. (1992) reported an increase in mature cow weight in lines selected on yearling weight or 18-month weight compared to unselected controls.

The lack of significant responses in the rate of maturation of weight and height to selection for growth rate is of interest, as it suggests that there has been no change in maturity pattern. There does not appear to be any reports of the realised response in growth curve parameters of cattle.
selected for growth rate in the scientific literature. However, this conclusion is supported by studies which found no difference between these selection lines in body composition of steers at a constant age (Parnell et al. 1994). This observation initially appears to contradict previous observations which suggests that animals with higher mature weights have lower rates of maturation (Taylor and Fitzhugh 1971) and does not support the dogma that selection for growth leads to animals which are later maturing.

The trends observed in the cross-mothered animals suggest that the apparent lack of response in rate of maturation to selection may be due to conflicting direct and maternal effects. Improved maternal environment has previously been shown to increase rate of maturation in sheep and cattle (Pitchford 1993; Pitchford et al. 1993). High line dams provided a better maternal environment than low line dams (Herd 1990), and the data here also suggested that improved maternal environment acted to increase the rate of maturation. However, when raised by dams from the same line, high line calves tended to mature slower than low line calves. When raised naturally, the increased maternal performance of the high line dams may have acted to increase the rate of maturation of high line calves, while the direct genetic effect of selection for high yearling growth rate may have decreased rate of maturation. Consequently no differences between the selection lines in rate of maturation were able to be detected. Most other growth selection experiments in cattle have selected for yearling weight or post-weaning growth rate which have low maternal effects. In this study the selection criteria, yearling growth rate, combined both pre- and post-weaning effects, and so maternal effects are likely to have been of greater importance than in other experiments. This hypothesis suggests that selection for the direct genetic component of growth only may have different implications for the production and marketing system than selection on both the direct and maternal genetic components of growth.

ACKNOWLEDGMENTS
This work was funded by the Meat Research Corporation and NSW Agriculture. The input of all the staff at Trangie who contributed to this experiment over 2 decades is gratefully acknowledged, particularly that of Dr Roger Barlow who initiated the growth rate selection lines.

REFERENCES