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## Modelling herd efficiency in liveweight-selected and control Angus cattle

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### ABSTRACT

Direct selection for 13-month live weight in NZ Angus cattle for 15 years has resulted in 17% heavier yearlings and 12% heavier adults when compared with unselected control animals. The mean daily food intake of growth-selected bulls is higher on a per head basis but is similar when adjusted for differences in live weight. The objective of this paper is to model the efficiency of a breeding cow herd, including replacements, derived from selected and control lines. The index of efficiency used is weight of calf weaned per unit weight of winter feed required. Published performance data from the 2 herds are used to quantify calf output and feed requirements are based on published growth patterns in the 2 herds.

Our analyses show that, for the same winter feed requirement, the selected herd when compared with the control herd would have: 88 vs 100 cows wintered; 65 vs 72 calves weaned, and mean calf weaning weight would be 174 vs 158 kg per head. Efficiency was estimated to be 99.8 vs 100 units. These results indicate that while selection for yearling weight has resulted in heavier calves and breeding cows, the calculated extra winter feed costs associated with the heavier selected herd makes them no more efficient than the randomly bred control herd. For the selected herd to be more efficient, either a reproductive advantage well in excess of the 3 percentage point advantage achieved would be required, or the metabolic efficiency of the selected cows would need to increase. In economic terms, the selected herd may be more efficient than the control herd for 2 reasons. Firstly, since herd size is lower, total herd costs are likely to be lower. Secondly, if a premium exists for heavier calves, the calves from the selected herd are likely to be worth more per head.

**Keywords** Breeding cows, selection lines, feed requirements, weaning weight, Angus cattle.

### INTRODUCTION

Biological efficiency in a meat producing enterprise can be defined as the ratio of output (e.g. body weight, carcass weight, lean meat) to input (total weight of food consumed). Biological efficiency is considered important because of its high apparent correlation with economic efficiency. Biological (i.e. beef) output in a beef breeding herd is made up of both the contribution of the calf and the contribution of the breeding female. In most herds, the contribution of the calf is much more important. In New Zealand Angus beef cattle, genetic selection lines were initiated in 1963 and 1971 to study the consequences for biological efficiency of selecting for early growth (respectively Carter *et al.*, 1990; Baker *et al.*, 1991). The results after 18 and 15 years respectively of selection for adjusted 13-month (i.e. yearling) live weight indicate that weaning weight is increased when compared with randomly bred control animals, and weight at most ages is also increased. Higher early growth and heavier mature size may offer advantages in a finishing production system, and hence the contribution of Continental breeds and Friesians as terminal sires. The contribution of heavier mature size cows to improving efficiency in beef breeding herds is equivocal. To be equally efficient, such herds would have to produce heavier calves, more calves, or eat less to maintain a unit of live weight. The main purpose of this paper is to model the biological efficiency of a herd of Angus cattle selected for yearling live weight and a randomly-bred control herd (Baker *et al.*, 1991). The efficiency index chosen was kg of calf weaning weight per unit of winter feed (McMillan and McCall, 1991). The selected herd and the control herd have been referred to as AS1 and ACO in previous publications. A comparison of yearling heifer mating and 2-year-old first mating was also carried out.

### MATERIALS AND METHODS

#### Live weights

Mean conceptus-free May 1st and September 1st live weights (i.e. winter live weights) were obtained by extrapolation from published weights (Morris *et al.*, 1992), using appropriate adjustments for stage of pregnancy depending on expected mean calf birth weight (McCall, unpublished). Mean calving date was taken as 1 September.

#### Birth weights

Mean birth weights for calves born to 2-, 3-, and 4+ year-old cows were assumed to be 23.6, 24.3 and 26.5 kg for control cows and 25.7, 26.5 and 28.9 kg for selected cows (derived from Baker *et al.*, 1991). These birth weights show the same relative increase with age as those used in Angus cows in a previous publication (McMillan and McCall, 1991).

#### Reproductive performance and cow death rates

Published estimates of reproductive performance and cow and calf death rates in the 2 herds were used (Morris *et al.*, 1992). Calving rates for 2-, 3- and 4+ year old selected cows were 78, 82 and 88%. Comparable figures in control cows were 74, 79 and 86%. Cow death rates were low (0-2% depending on age, 0.6% overall).

#### Herd age structure

Reproductive performance data and cow death rate data were used to generate 2 herds at the start of the winter with all ages from rising 1-year-old to rising 10-year-old represented. First

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calving was at 2 years of age and compulsory culling was at 10.5 years of age at weaning time. Only pregnant animals and the minimum of young replacements (i.e. sufficient replacements as determined by mean death rates and mean pregnancy rates with no surplus for 'over-mating') were wintered. Animals which calved but failed to wean calves were retained for the following winter provided they were pregnant. Angus bulls from the respective selection lines were used, and calves were weaned at a mean of 5 months of age.

### Age at first mating

Yearling heifer mating and calving at 2 years of age was assumed to have no carry-over effect on subsequent reproductive performance. Live weight gain over the first winter (May to September) in heifers first mated at 2 years of age was assumed to be nil in control heifers, and 0.067 kg/d in selected heifers so as to maintain the appropriate relativity between herds. Approximately 140 kg was gained by both herds from yearling stage until the start of the next winter (i.e. this was actual gain in practice), when the selected and control herds were assumed to weigh 362 and 326 kg. Weights were then assumed to be maintained over the second winter in both herds. In practice, the 2 herds would probably have to be grazed separately to achieve this. By the start of 2 year old mating, the selected and control herds were assumed to be 379 and 356 kg (i.e. the same as previously calved 2 year old heifers). Subsequent live weights were assumed to be unaffected by age at first mating.

### Estimated feed requirements

Winter feed requirements were calculated from winter live weight profiles and mean calf birth weights as discussed previously (McMillan and McCall, 1991). Briefly, energy requirements for body weight change over the winter followed mature live weight scaling procedures outlined by Taylor (1982). This meant that feed conversion efficiency for live weight change in each of the 2 lines of cattle was the same *at the same degree of maturity*. Maintenance requirements were assumed to be a function of metabolic body weight only. To test the sensitivity of our analyses to this assumption we carried out an analysis where energy requirements followed mature live weight scaling procedures for body weight maintenance and live weight change requirements, but this made little difference to our herd comparisons (although absolute efficiency values did differ).

## RESULTS

### Selection and Control herds

#### Herd structure and performance

Herd size including replacements, and age structure at the start of the winter, adjusted to the same winter feed requirement, are shown in Table 1. The selected herd has fewer total animals than the control herd (88 vs 100). Almost half of the difference (5/12) in numbers of animals in the 2 herds was associated with fewer replacement heifers wintered. The higher per head performance of the selected herd for cow live weight, calf weaning weight and to a lesser extent reproductive performance is highlighted (Table 2).

#### Efficiency

The selected herd was similar in efficiency to the control herd (99.8 vs 100).

**TABLE 1** Number of cows and replacement heifers in Selected and Control Angus herds, at the same winter feed requirement.

	Selected Herd	Control Herd Cow age
Rising 1 year	17	22
Rising 2 years	14	16
Rising 3 years	11	13
Rising 4-10 years	46	49
Total	88	100

**TABLE 2** Performance data for selected and control Angus herds

	Selected Herd	Control Herd
Mid-winter weight (kg)		
.....Rising 1 year	229	198
.....Rising 2 years *	377	337
.....Rising 3 years *	394	379
.....Rising 4-10 years *	486	447
Calves weaned/100 cows to bull	75	72
Mean calf weaning weight (kg)	174	158

\* Conceptus-free

**TABLE 3** Effect of age at first mating on herd size (including replacement heifers), weaning performance and efficiency.

	Two-year First Mating	Yearling First Mating
Herd size	100	97
Number of calves weaned	100	112
Mean calf wean weight (kg)	171	166
Efficiency	100	108

### Age at first mating

Results were similar for each of the selected and control herds so combined means are presented. Yearling heifer mating reduced the number of animals that could be wintered (97 vs 100, Table 3). In spite of this, more calves were born (115 vs 100) and weaned (112 vs 100) under a policy of yearling heifer mating. Mean calf weaning weight was slightly lower with yearling heifer mating (166 vs 171 kg, Table 3). Overall, efficiency was higher under a policy of yearling heifer mating (108 vs 100).

## DISCUSSION

These results demonstrate that the Angus herd selected for 13-month weight is no more efficient than the control in terms of its winter feed requirements per unit of calf weaning weight produced. This result was consistent for an analysis which either included or excluded mature live weight scaling principles for maintenance (Taylor, 1982). The heavier cow weights and calf birth weights in the selected herd resulted in a higher estimated mean daily feed requirement during winter (4.61 vs 4.06 kg DM/head/d). As a consequence, proportionally fewer animals could be wintered in the selected herd (88 vs 100). Although calf weaning weight was higher by 10%, and weaning rate was higher by 3 percentage points in the selected herd, the net effect was a similar output of total calf weaning weight from this herd, *when considered at the same winter feed requirement*. Other studies are underway (by C.A.M) to estimate the feed intakes of cows from the 2 herds.

Modelling what would happen to the selected herd if only mean calf weaning weights, and not cow reproductive performance were increased, suggests that a 5 or 10% increase in mean calf weaning weight would increase efficiency by 5 or 10%, respectively. In contrast, improving only in-calf rates by 5 or 10 percentage points would increase efficiency by only 3 and 6% respectively (since calf losses would need to be taken into account). These sensitivity analyses strongly suggest 2 reasons why efficiency in the selected Angus herd is unlikely to improve beyond that in the control herd. Firstly, it is unlikely that weaning weight will further improve without any correlated improvements in later weights. Other results in cattle (Carter *et al.*, 1990) substantiate this point. Secondly, the selection history in this herd to date is one of minimal association of reproduction with live weight. Accordingly, even if the reproductive rates were to improve another 5 percentage units in selected animals, overall efficiency improvements would only be small.

The outcomes from our biological efficiency modelling provide some of the physical parameters necessary for an economic appraisal of the selection herd. Since herd size is lower in the selected herd, it is likely that total herd financial costs will be lower (e.g. animal health, transport, interest, etc). If a premium exists for heavier calves over lighter calves (i.e. they are worth more dollars per kg live weight), this is likely to favour calves from the selected herd. Collectively, these results suggest that the economic efficiency of the selected herd is likely to be favoured over the control herd.

The results from modelling age at first mating are in contrast to our previous results with Angus cattle, where the efficiency increase was only 2% (McMillan and McCall, 1991). However, they are consistent with our previous results in Hereford x Friesian herds where the advantage was 6% (McMillan and McCall, 1991). In the Angus herd in this previous publication, the difference in pregnancy rate between yearling heifers and that

achieved 1 year later was large (i.e. 72 vs 85%). In the 2 Angus herds under consideration in this analysis, yearling heifer reproductive performance was not too dissimilar to that achieved one year later (e.g. in-calf rates of 78 vs 82% in selected herd and 74 vs 79% in control herd). This higher *relative* performance of the yearling heifers accounts for the difference in results between the 2 studies. Increased yearling reproductive performance has been shown to be associated with increasing efficiency (McMillan and McCall, 1991).

In summary, this modelling exercise shows that selection for high early growth in beef cattle may not be associated with any change in efficiency of winter feed use by the breeding cow herd. High correlated responses in cow size, and lesser correlated responses in reproductive performance form the basis of this outcome. Yearling heifer mating may be a more efficient option than 2 year old first mating in these Angus cattle, since high yearling in-calf rates were achieved. Feed intake studies are required to test the validity of our intake assumptions.

## REFERENCES

- Baker, R.L.; Morris, C.A.; Johnson, D.L.; Hunter, J.C. Hickey, S.M. 1991 Results of selection for yearling or 18-month weight in Angus and Hereford cattle. *Livestock Production Science* **29**: 277-296.
- Carter, A.H.; Morris, C.A.; Baker, R.L.; Bennett, G.L.; Johnson, D.L.; Hunter, J.C.; Hickey, S.M. 1990 Long-term selection for yearling weight or post-weaning gain in Angus cattle. *New Zealand Journal of Agricultural Research* **33**: 49-61.
- McMillan, W.H.; McCall, D.G. 1991 Are yearling heifer mating and more productive beef cow breeds a worthwhile use of winter feed? *Proceedings of the New Zealand Society of Animal Production* **51**: 265-269.
- Morris, C.A.; Baker, R.L.; Hunter, J.C. 1992. Correlated responses to selection for yearling or 18-month weight in Angus and Hereford cattle. *Livestock Production Science*.**30**: 33-51.
- Taylor, C.S. 1982. Theory of growth and feed efficiency in relation to maturity in body weight. *Proceedings of the 2nd World Congress of Genetics Applied to Livestock Production*., Madrid, p 218-230.