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Live weight of beef-cross-dairy calves during the first year of life

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Summary

The use of genetically superior beef sires has the potential to increase the production of high-value meat products from surplus calves born in the dairy industry. The aim of this experiment was to evaluate the 200-day and 400-day live weight of Angus- and Hereford-sired calves born to dairy cows, to calculate the heritability of live weight and to analyse the relationship between progeny live weight and their sires' EBV for live weight at 200 and 400 days of age. Live weight was similar for Angus- and Hereford-sired calves, and steers were heavier than heifers at 200 days and 400 days. Heritability of live weight at 200 days was 0.27 and at 400 days was 0.25, indicating significant potential for increasing live weight of beef-cross-dairy calves through genetic selection. Sires for this system should be selected by their EBV for live weight at 400 days.

Keywords: dairy-beef, crossbreed, live weight, heritability, breeding value

Introduction

Cattle bred in the dairy industry contribute around 62% of the country's beef production, including dairy-beef cattle and bobby calves (Morris, 2013). Rearing surplus calves from the dairy industry for beef has potential to increase the production of high-value meat products. Given that the terminal sire has a considerable direct genetic effect on the growth potential of the progeny in crossbreeding systems, beef sires with improved genetics could be used to generate calves better able to satisfy the requirements of the dairy, grower and finisher farms, through to the meat processor.

Growth and live weight in cattle are moderately (30-62%) heritable (van der Waaij *et al.*, 1997; Beef+Lamb New Zealand, 2017). The dairy-beef system differs from the traditional beef system, in that the calves are typically weaned early (45-90 days compared with 200 days in a beef system). Therefore, the growth trajectory of calves may differ between the two systems.

The aim of this experiment was to evaluate the 200-day and 400-day live weight of Angus- and Hereford-sired calves born to dairy cows when reared in a dairy-beef system, and to calculate the heritability of live weight at 200 and 400 days of age. Further, the relationship between crossbred progeny live weight and their sires' EBV for live weight was analysed.

Materials and Methods

This experiment was conducted at Limestone Downs, near Port Waikato, New Zealand (37°28'S, 174°45'E) with approval from the Massey University Animal Ethics Committee.

Animals and management

The experiment included 214 Angus-sired and 218 Hereford-sired calves born in spring 2016 to mixed-aged (3+ years old) dairy cows (Holstein-Friesian, Jersey and their crosses). Calves were artificially reared on an allowance of 4 litres of milk/head/day, and weaned at a mean live weight of 90 kg and a mean age of 79 days old. Male calves were castrated prior to 4 months of age. At 4 months of age (December 2016), calves were allocated into 6 grazing herds based on live weight (light, medium and heavy) within sex (heifers and steers) and balanced for sire. They remained in those herds throughout the experiment, and were grazed on hill country pasture. Two herds of heifers were supplemented with 1 kg/head/day of calf meal in March 2017 (medium for 37 days and heavy for 28 days). Calves were weighed at monthly intervals from 4 to 12 months of age. The mean birth weight of each grazing herd was used to select the weighing event closest to 200 and 400 days of age for each herd. The mean age at the 200-day weight selected was 196.5 days (s.d. 14.8) for steers and 199.0 days (s.d. 15.5) for heifers, and the mean age at 400 day-weight selected was 401.6 days (s.d. 17.6) for steers and 416.5 days (s.d. 18.4) for heifers.

Estimated breeding values (EBV) for 200-day live weight were 40.0 kg (s.d. 8.09) and 27.7 kg (s.d. 7.0), and for 400-day live weight were 75.8 (s.d. 10.2) and 51.2 (s.d. 13.2), for Angus (n=24) and Hereford (n=24) sires, respectively.

Statistical Analysis

A mixed model (SAS 9.4, SAS Institute Inc., Cary, NC, USA) was used to analyse weight at 200 and 400 days of age, with sire breed and grazing herd as fixed effects, calf age as a covariate and sire as a random effect. Heritability was calculated as $h^2 = \sigma^2_a/(\sigma^2_a+\sigma^2_e)$, where σ^2_a and σ^2_e are the additive genetic and residual variances, respectively. Least squares means for breed and sex were calculated at 200-days and 400-days of age using the regression coefficient for age. Relationships between live weight and EBV for live weight at 200 and 400 days were analysed using a mixed model, with sire breed and grazing herd as fixed effects, and EBV and age as covariates. The effect of EBV did not differ between breeds so EBV was fitted as a covariate, not nested within breed.

Results and Discussion

Progeny from Angus and Hereford sires had similar live weight at both 200 and 400 days ($P>0.05$, Table 1), whilst heifer calves were 13.2 kg and 5.4 kg lighter ($P<0.05$) compared with their steer siblings at 200 and 400 days respectively. Steers are typically heavier than heifers of the same age (Garrick *et al.*, 1989). However, it should be noted that sex and grazing herd were confounded in the present experiment. The regression coefficients for age were 0.597 kg/day for 200-day live weight and 0.493 kg/day for 400-day live weight, reflective of the moderate growth rates of the calves.

The calculated heritabilities of live weight (Table 1) were similar to those reported for beef breeds (0.18 for 200-day live weight and 0.25 for 400-day live weight, Beef+Lamb New Zealand, 2017), but slightly lower than heritabilities reported for dairy heifers (0.39 for 270-day live weight and 0.52 for 450-day live weight; van der Waaij *et al.*, 1997) in New Zealand. It is not surprising that the heritability calculated for 200- and 400-day weight were similar in this experiment, as both reflect primarily post-weaning gain. Additionally, this likely explains why the heritabilities calculated are more comparable to the beef industry values for heritability of 400-day live weight than for 200-day live weight. The calculated heritabilities indicated that there is a significant potential for increasing live weight of beef-cross-dairy calves through genetic selection.

Table 1. Live weight of Hereford- and Angus-cross-dairy calves (LSM ± s.e.) by sire breed and sex of calf, and heritability of live weight at 200 and 400 days of age.

	200-day live weight (kg)	400-day live weight (kg)
Sire breed		
Angus	156.5 ± 1.26	287.9 ± 2.08
Hereford	157.4 ± 1.25	289.9 ± 2.04
P-value	0.59	0.48
Sex		
Heifers	150.3 ± 1.14^{a}	286.2 ± 2.20^{a}
Steers	163.5 ± 1.07^{b}	291.6 ± 1.68^{b}
P-value	<0.001	0.03
Heritability	0.27	0.25

^{ab} Values within column for each category with different superscripts differ at the P<0.05 level.

Figure 1. Regression of progeny live weight on sire EBV for live weight at 200 and 400 days, for Angus-sired (solid line) and Hereford-sired (dotted line) calves. Calf live weights are represented by the progeny group means for Angus (circles) and Hereford (squares) sires. Regression coefficients were: -0.07±0.094 at 200 days (P>0.05) and 0.19±0.095 at 400 days (P<0.05).

Sire EBV for 200-day live weights had no effect (P>0.05, Figure 1) on the progeny live weights. This contradicts results from a beef progeny test (Beef+Lamb New Zealand Genetics, 2017) that used some sires in common with this experiment, where 1 kg extra in the bull EBVs could predict 0.41 kg increase in live weights of the calves at weaning (200 days). Angus and Hereford sires' EBV for live weight at 200 days are derived from straightbred beef calves weighed between 81 and 300 days old, typically measure pre-weaning growth, and are influenced by the calf's growth potential, dam's milk production and the performance of all known relatives (Beef+Lamb New Zealand, 2017). Calf growth rates pre-weaning in beef cattle are closely related to milk feeding intensity, and suckling calves may drink more than calves reared artificially (Asheim *et al.*, 2016). The animals in this experiment were removed from their dams within 24 hours of birth, and group fed on an allowance of 4 litres of milk/head/day until 90 kg live weight, which occurred at a mean age of 79 days. Thus, there was no maternal influence through milk production on calf growth and much of the 200-day live weight was post-weaning liveweight gain. As a result, the genetic differences in growth at 200 days were not able to be expressed in this study.

At 400 days, sire EBV had an effect on the progeny live weights (0.19 kg per extra kg of sire EBV, P<0.05). This was approximately half of the value (0.45 kg increase in live weights of the calves per extra kg in the sire EBV) that was explained in the beef progeny test at yearling age (Beef+Lamb New Zealand Genetics, 2017). It is likely that the non-effect of sire EBV on calves' live weights at 200 days carried through to 400 days. Consequently, these crossbred animals will be followed to 600 days to compare their growth with the expected values in the beef industry.

Conclusions

Live weight was similar between Angus- and Hereford-sired calves at both 200 and 400 days of age. The heritabilities of live weight at 200 and 400 days of age were consistent with previous reports for post-weaning live weight for beef cattle. Therefore, genetic selection could be made within either breed to identify sires whose beef-cross-dairy calves perform well in a dairy-beef system. Sires for this system should be selected by their EBV for live weight at 400 days, as this is a better estimation of the animal's own ability to grow. Further work is underway to determine if the relationship of progeny live weight and sire EBV at 600 days (finishing weight) and its heritability, are as strong in a dairy-beef system compared to a beef system.

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