Heritability of gestation length in beef-cross-dairy calves born to Angus and Hereford bulls.

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Summary

A 365-day calving interval is a major constraint of the pasture-based New Zealand dairy system, and gestation length is a key driver of calving interval. Most New Zealand dairy herds use artificial breeding to generate replacement heifers, with a beef or dairy bull for the remainder of mating. Gestation lengths are 280-282 days for dairy breeds, compared to 280-285 days for beef breeds; with heritabilities ranging from 0.32 to 0.68. The aim of this experiment was to determine the gestation length of the two most common beef breeds in New Zealand when crossed with dairy cows and to estimate the heritability of gestation length in crossbred dairy-beef calves. Data consisted of 462 beef-cross-dairy calves born to Angus or Hereford bulls mated to dairy cows. Mean gestation length was 281 and 284 days for Angus- and Hereford-sired calves respectively, and the heritability estimate was 0.18. This demonstrated that the beef-cross-dairy calf gestation lengths were comparable to the sire breed averages. In conclusion there is scope to improve gestation length, and Angus and Hereford bull breeders should consider shortening gestation length to maximise their appeal in the dairy industry.

Keywords: heritability, gestation length, beef-cross-dairy, angus, hereford

Introduction

The New Zealand dairy industry is a pasture-based system, and one of the major constraints is that cows need to maintain a 365-day calving interval to match feed demand to feed supply (Grosshans et al., 1997; Holmes et al., 2007; Amer et al., 2016). The 365-day calving interval is a key driver of profitability in dairy cattle, and gestation length is an important contributor to calving interval (Winkelman & Spelman, 2001; Donkersloot, 2014). A longer gestation period results in later calving, fewer days in milk and the cow will, on average, calve later in the following season (Donkersloot, 2014).

In most New Zealand dairy herds, approximately 70% of cows, typically the first mated, are artificially bred to superior dairy-breed bulls to produce replacement heifers (Holmes et al., 2007; Back, 2017). The remaining cows are available to mate to beef bulls to generate beef finishing cattle. These are typically the later mated cows as farmers prefer to generate the replacements first.

The average gestation length of New Zealand dairy cattle (Jersey, Holstein Friesian and Holstein-Friesian x Jersey crossbreeds) is 280-282 days (Baker et al., 1990; Grosshans et al., 1997; Donkersloot, 2014; Stachowicz et al., 2015; Amer et al., 2016). Historical data suggests that the approximate gestation length for Angus and Hereford calves is 280-281 days and 284-285 days respectively (Burris & Blunn, 1952; Wheat & Riggs, 1958;
Bourdon & Brinks, 1982; Baker et al., 1990). There are no published estimates for beef-cross-dairy crossbreds. Genetic evaluation of gestation length in beef cattle is limited by the need to use artificial breeding so that the start of gestation is known for calculation for gestation length. Heritability estimates for gestation length in cattle vary between 0.32 to 0.68 (Baker et al., 1990; Winkelman & Spelman, 2001; Maltecca et al., 2011; Stachowicz et al., 2015; Amer et al., 2016). The heritability estimate illustrates the scope to improve gestation length in calves born to the beef bulls used to service the New Zealand dairy industry. Therefore, the aim of this study was to determine the gestation length of the two most common beef breeds in New Zealand when crossed with dairy cows and to estimate the heritability of gestation length in crossbred dairy-beef calves.

Material and methods

This experiment was conducted at the C Alma Baker Trust Limestone Downs dairy farm (coordinates 37.28 S 174.45 E), Port Waikato, New Zealand, with approval from the Massey Animal University Ethics Committee.

Animals

Four hundred and sixty-two singleton calves born to multiparous mixed-aged cows artificially bred to straight bred Angus (n=24) and Hereford (n=24) bulls were included in this analysis. Parentage of the calves was determined by DNA analysis (Zoetis, Dunedin, New Zealand). Only calves with a DNA verified sire and dam were included in the analysis.

Breed of cow was recorded as proportion (out of 16) of Holstein Friesian, Jersey, other and unknown as recorded in MINDA™ (herd recording software, LIC, Hamilton New Zealand) using ancestry records. Breed of bulls was recorded as either Angus or Hereford. Breed of calf was calculated as half the breed proportions of the parents.

The average estimated breeding value (EBV) for gestation length was -5.5 days for Angus bulls, and -1.37 days for Hereford bulls with a mean accuracy of 85% for Angus bulls, and 73% for Hereford bulls.

Ancestry of cows was recorded to one generation, and ancestry of bulls was recorded to two generations to identify relationships between cows and between bulls. The pedigree used included 1868 individual animals, representing 365 sires, and 1024 dams.

Measurements

Artificial breeding was conducted for 9 weeks, and each bull was used throughout the season. Cows were mated to a different bull at each insemination. Parentage results were used to determine the insemination date resulting in pregnancy for cows inseminated multiple times. Birth date and calf sex were recorded for all calves. Dam successful mating date and calving date were used to calculate gestation length.

Statistical Analysis

Variance components and heritability of gestation length were obtained using ASReml version 3 (Gilmour et al., 2009) with a single trait animal model that included the
fixed effects of calf sex, calving month and dam age as class effects, and proportion Jersey, unknown, other, Angus and Hereford breeds, and heterosis of Friesian-Angus, Friesian-Hereford, Jersey-Angus and Jersey-Hereford as covariables, and the random effect of animal. Maternal pedigrees contained 2 generations (dam and grandparents), whilst paternal pedigrees contained 3 generations (sire, grandparents and great grandparents). Age of dam was recorded as 3, 4, 5, 6 or 7+ years of age, and calving month as July, August or September.

Least squares means and standard errors of gestation length for the fixed effects were obtained using the GLM procedure of SAS 9.4 (SAS Institute Inc., Cary NC, North Carolina). The linear model included the fixed effects of calf sex, dam age, calving month, sire breed, and proportion of Jersey, proportion of known breeds other than Friesian or Jersey, and proportion of unknown breed of the dam.

Results

Average gestation length for each sire breed is presented in Table 1. The Angus-sired calves had a significantly shorter gestation length compared with Hereford-sired calves (P<0.0001). There was no difference in the gestation length of heifer and bull calves (Table 1; P>0.05).

Table 1. Least squares means for gestation length for beef-cross dairy calves by sire breed and calf sex.

<table>
<thead>
<tr>
<th>Sire breed</th>
<th>n</th>
<th>Gestation length (days)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angus</td>
<td>223</td>
<td>280.7 ± 0.35 a</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Hereford</td>
<td>239</td>
<td>283.7 ± 0.34 b</td>
<td></td>
</tr>
<tr>
<td>Calf sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>205</td>
<td>282.2 ± 0.36</td>
<td>0.7865</td>
</tr>
<tr>
<td>Male</td>
<td>257</td>
<td>282.3 ± 0.33</td>
<td></td>
</tr>
</tbody>
</table>

a, b Differing superscripts represent significant difference between groups.

The estimate of heritability for gestation length was 0.18 ± 0.12.

Discussion

The difference in gestation length of calves, between sire breeds illustrated in this analysis is in agreement with published literature, that reported that Angus breed calves had a shorter gestation than Hereford breed calves (Burris & Blunn, 1952; Wheat & Riggs, 1958; Bourdon & Brinks, 1982; Baker et al., 1990). The average gestation lengths are similar to published values (Burris & Blunn, 1952; Wheat & Riggs, 1958; Bourdon & Brinks, 1982; Baker et al., 1990), despite the average EBV of the sires being more negative for Angus than for Hereford bulls. The sire breed difference indicates that, based on gestation length alone, Angus bulls would be more useful than Hereford bulls for use over a dairy herd.

The gestation length of beef-cross-dairy calves in this experiment is more than 10 days longer than what would be expected when using a LIC SGL bull (LIC, 2012). However, the progeny resulting from the LIC short gestation breeding programme are not
recommended for retaining as replacement heifers (Donkersloot, 2014), and the resulting calves provide little source of direct income to the dairy farm. In contrast, the progeny resulting from the use of beef bulls are of greater value, but the cows mated to these bulls would have a longer pregnancy and, therefore, potentially fewer days in milk. The relative values of milk and beef fluctuate between seasons, so the relative value of the alternatives would vary.

The similar gestation lengths of bull and heifer calves was not consistent with published research which showed that male calves had longer gestation lengths than female calves (Burris & Blunn, 1952; Bourdon & Brinks, 1982; Norman et al., 2009).

The heritability estimate of 0.18 indicates there is scope to improve gestation length in beef bulls. However, the heritability estimate from this analysis is lower than the range in literature (Baker et al., 1990; Winkelman & Spelman, 2001; Maltecca et al., 2011; Stachowicz et al., 2015; Amer et al., 2016). A possible reason for the lower heritability is the small data set which produced a large SE. In addition, all calves in the study were crossbred and more generations are required to estimate recombination effects. Potential maternal genetic and maternal heterosis could not be accounted for in this data set.

This experiment is part of a larger study comparing Angus and Hereford bulls for use as follow up bulls in a dairy herd, of which one trait of importance is gestation length. Gestation length is a difficult trait to measure in a beef herd as it requires the use of artificial breeding to accurately record the beginning of gestation. The heritability estimate reported here and in published literature indicate a moderate to high rate of genetic gain could be achieved for this trait. Mating date and calving date are routinely recorded on dairy herds, making the dairy industry an ideal source of gestation length records. There is scope to improve gestation length, and both Angus and Hereford breeders should consider shortening gestation length to maximise the value of their bulls to the dairy industry.

Acknowledgements

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