J. Dairy Sci. 99:1–9
http://dx.doi.org/10.3168/jds.2015-9934

Phenotypic associations between gestation length and production, fertility, survival, and calf traits

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ABSTRACT

Gestation length may be a useful selection criterion in the genetic evaluation of fertility for New Zealand's predominantly seasonally calving dairy herd. However, it is unknown if calves born following shorter gestation lengths have lower survival or are compromised in their subsequent performance as a milking cow. In this study, data from a large number (~38,000) of cows were first analyzed to determine if those animals born following a short (shortest 5%) or a long (longest 5%) gestation length differed in their subsequent fertility, milk production, and survival compared with intermediate-gestation-length animals. To determine the effect of gestation length on calving difficulty and perinatal mortality, the gestation records of the calves born to these cows (from their heifer and subsequent 6 parities) were also analyzed. Animals born following short gestation lengths had improved fertility (specifically, their probability of being presented for mating in the first 21 d of the mating season was increased by 4 to 5 percentage points and the day of the calving season at which they calved was 2 to 5 d earlier), whereas those born following long gestation lengths had decreased fertility (3 to 4% less likely to be presented for mating in the first 21 d of the calving season and calved 3 to 5 d later) compared with animals with average gestation lengths. Both short- and long-gestation-length animals produced significantly less milk and solids (e.g., 1.3 to 1.4 kg of protein over a standardized 270-d lactation) relative to intermediate-gestation-length cows, after adjusting for the day of the year they were born. However, for short-gestation-length cows, this effect disappeared when the earlier birth advantage was retained. Short-gestation-length cows did not exhibit a significant reduction in survival compared with intermediate-gestation-length cows. Short gestation length did not affect calving difficulty but long gestation length was negatively associated with this trait (i.e., about 2% higher incidence). Calves gestated for shorter or longer periods were more likely to die in the perinatal period than other calves (3 and 7% higher incidence of mortality, respectively). Overall, the net effects of shortened gestation lengths are likely to be economically positive.
Key words: gestation length, survival, production, fertility

INTRODUCTION

Gestation length (**GL**) is a highly heritable trait (Winkelman and Spelman, 2001; Hansen et al., 2004) and can be easily calculated using mating and calving data in the New Zealand dairy industry. Estimated breeding values currently exist for gestation length direct (**GLd**, the effect of the calf's own genes on its gestation length), although it is not included in the fertility genetic evaluation model and no direct economic weighting is applied to the trait within the national breeding objective (breeding worth, BW). The benefits of including GL as a correlated predictor trait in the fertility genetic evaluation model and breeding objective is that it is highly heritable and has a high genetic correlation with the trait calving season day (**CSD**), which defines the day of the calving season on which the cow calved (K. Stachowicz, unpublished data). A strong correlation between gestation length and calving season day is not unexpected because of the part–whole relationship of these traits. In the seasonal calving dairy production systems of New Zealand, cows that have poorer fertility typically have a lower chance of being presented for mating within the first 21 d of the mating season and calve later in the calving season. This means that GL has the potential to increase the accuracy of the fertility EBV predictions, particularly for bulls whose daughters have been born or calved themselves but have not yet expressed fertility traits. In addition, because of the seasonal nature of mating and calving in the New Zealand dairy industry, service sires with EBV for shorter GLd improve the mating and conception opportunities for the cows they are mated

Received June 9, 2015.
Accepted September 15, 2015.
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to, a benefit that is independent of the increase in accuracy of the fertility EBV due to the use of GL as a correlated trait. Therefore, potential economic benefits can be realized by including GL in the fertility genetic evaluation analysis as a correlated trait (indirect selection) and in the breeding objective (direct selection).

However, these steps first require careful consideration of the link between calf GL and perinatal mortality, and the link between GL of the cow herself and her future milk production, fertility, and survival. Many studies have reported a link between GL and perinatal mortality and calving difficulty. Some have reported associations between short GL (e.g., <272 d) and increased perinatal mortality (Bleul, 2011). Others have reported associations between long GL and perinatal mortality often as a result of dystocia (McGuirk et al., 1998; Chassagne et al., 1999) and yet other studies have reported associations between extreme GL and perinatal mortality (Johanson and Berger, 2003; Hansen et al., 2004; Norman et al., 2011). These studies have typically focused on how service sire GL affects calf traits (mortality/calving difficulty) or the subsequent performance of the cow that carried the calf. Norman et al. (2011) found a positive linear relationship between days open (a fertility trait) and GL: cows gestated for shorter periods tended to have improved fertility during their first lactation. Norman et al. (2011) also found that the cows that performed best for milk production and had the most favorable productive life and culling records tended to have been born following intermediate GL (approximately 274–279 d). In the same study, those cows gestated for shorter than optimum periods were less affected in terms of milk production and productive life than were those cows gestated for longer periods.

Few other studies have focused on the effects of GL of the cow before her birth and on her subsequent performance. Furthermore, the majority of gestation length studies have focused on the Holstein breed and all-year calving systems. The objective of this study was to ascertain the risks associated with a genetic reduction in GL, due to either direct or indirect selection, in terms of future fertility, production, BCS, and survival in cows and survival and perinatal mortality in calves in the New Zealand seasonal calving system.

MATERIALS AND METHODS

Data

Records for over 40,000 cows and their calves from Livestock Improvement Corporation (LIC, Hamilton, New Zealand) sire proving scheme (SPS) herds born from 1997 to 2013 inclusive were analyzed. A detailed list of variables studied is presented in Table 1. The data set included contemporary group (herd-year-age category of the dam where age differentiates first vs. subsequent lactation), mating dates during the first 3 lactations and the first 4 calving dates; GL; 270-d milk, fat, and protein yields, protein and fat percentages, and fat to protein ratio (**FPR**) based on yields from 270-d milk data, all from lactation 1; the age at which each cow exited the herd (CullAge); BCS recorded during first lactation; as well as calf fate and calving difficulty (Cdiff) of the cows' calves. Minimum eligibility for a cow's records to be considered was that the cow must have both a first calving and a first mating data record.

Only seasonal mating and calving events were used; that is, mating events between September and January and calvings between June and November, inclusive. Age of the cow at calving was edited to include only cows within a specified age group, according to DairyNZ contemporary group age classes (DairyNZ, 2007). The calving age ranges were 548–913, 914–1,278, and 1,279–1,643 d for first, second, and third calvings, respectively. Mating interval was calculated as the difference in days between first and last recorded mating. Last mating date, within season, was set to missing when the mating interval was greater than 110 d (~5 estrus cycles). Calving interval was calculated as the difference in days between consecutive calvings. Data were filtered to exclude records with calving intervals <300 or >550 d in length. Gestation length was calculated as the difference in days between last recorded mating and the subsequent calving. Data were filtered to exclude GL <265 and >295 d (±3 SD). Any cows with an unknown sire or dam were excluded. Data were also edited to exclude records from cows with breed composition other than Holstein-Friesian and Jersey. Mating and calving records with recorded synchronizations (controlled internal drug release, CIDR; 6%), inductions (<3%), and abortions (0.3%) were set to missing in the data set. This did not necessarily lead to missing fertility phenotypes in the final data set, as cows that were mated but did not calve as a result of this mating (i.e., had a missing calving record) were penalized according to Donoghue et al. (2004) by having a penalty record assigned as 21 d added to the longest CSD record within their contemporary group. Mating dates were converted to binary scores (**PM21b1**, **PM21b2**, and **PM21b3** for mating during the first 3 lactations, respectively) with a score of 1 assigned when the cow was mated within 21 d of the planned start of mating for the contemporary group defined specifically for each herd and year cohort, and 0 otherwise. Calving dates were converted to CSD, defined as the number of days from the planned start of calving to the caving date. Planned start of calving was defined for each