J. Dairy Sci. 98:1–11
http://dx.doi.org/10.3168/jds.2014-8279

Weight, height, and relative-reliability indicators as a management tool for reducing age at first breeding and calving of dairy heifers

M. Duplessis,*[1] R. I. Cue,†[2] D. E. Santschi,‡ D. M. Lefebvre,‡ and R. Lacroix‡
*Département des Sciences Animales, Université Laval, Québec, G1V 0A6, Canada
†Department of Animal Science, McGill University, Ste-Anne-de-Bellevue, Québec, H9X 3V9, Canada
‡Valacta, Ste-Anne-de-Bellevue, Québec, H9X 3R4, Canada

ABSTRACT

In Québec first calving occurs on average at 27 mo, whereas the target is 23 to 24.5 mo to maximize herd profitability. The aim of this study was to quantify current and future heifer growth using individual heifer random regressions and to generate indicators (such as heifer weight and height at 15 and 24 mo, average daily gain before and after 15 mo, age at which optimal weight for breeding is attained, i.e., 55% of mature weight, and reliability of the 15- and 24-mo weight predictions) that could be used as a practical on-farm tool. Dairy heifer weight estimated by heart girth circumference and height measured at the withers (from 0 to 27 mo) were obtained from the Valacta database (DHI agency, Ste-Anne-de-Bellevue, QC, Canada) from 1995 to 2012. Indicators were calculated based on the current situation of Holstein (HO), Ayrshire (AY), Jersey (JE), and Brown Swiss (BS) heifer growth in Québec. Heifers with less than 2 records were excluded from the analysis. Mature weights were determined by weight at calving of cows from third or greater lactation for a given breed and were 710 kg for HO, 625 kg for AY, 470 kg for JE, and 670 kg for BS. Estimated weights at 15 and 24 mo were 425 and 627, 334 and 482, 297 and 429, and 379 and 560 kg for HO, AY, JE, and BS, respectively, which are heavy enough for breeding and calving, except for AY. Relative reliabilities of the 15- and 24-mo weight predictions were on average 89 and 60%, respectively, based on measurements up to 15 mo. For HO, AY, JE, and BS, wither heights at 15 and 24 mo were 134 and 143, 125 and 134, 122 and 131, and 130 and 140 cm, respectively. Age at optimal breeding weight was 13.6, 15.5, 12.6, and 14.5 mo for HO, AY, JE, and BS, respectively. These data suggest that it is realistic to expect a first calving at 24 mo for HO, JE, and BS. A growth delay was observed for AY; average daily gain was 655 and 538 g/d before and after 15 mo, respectively. The average daily gain before and after 15 mo was 848 and 747 g/d for HO, 603 and 486 g/d for JE, and 775 and 662 g/d for BS, respectively. These indicators could be calculated for an individual heifer and on a herd-level basis and used on farm as a management tool for reducing age at first breeding and at first calving.

Key words: heifer growth, age at first breeding, age at first calving

INTRODUCTION

Moore et al. (1991) reported that, on average, age at first calving for Holstein (**HO**) heifers in Québec was 28.2 mo, whereas 26.5 mo was reported 15 yr later by Pietersma et al. (2006). Despite the slight decrease in the 1990s, age at first calving has not declined over the past 10 yr in Québec, Canada, and is still higher than the recommendation of 23 to 24.5 mo to maximize farm profitability (Ettema and Santos, 2004; Pellerin and Gilbert, 2008). A similar trend in the United States was observed; average age at first calving for HO heifers was 26.9 mo between 1980 and 2004 (Hare et al., 2006), which represents a decrease of 1.3 mo compared with results reported by Nieuwhof et al. (1989) between 1966 and 1986. Using field data from Québec, Pietersma et al. (2006) showed that, at 14 mo, HO and Ayrshire (**AY**) heifers were large enough to be bred because 59 and 56% of mature BW were already attained at this age, respectively. According to the NRC (2001), the first breeding can occur when 55% of mature BW is reached. These data suggest that it is possible to achieve a first calving at 24 mo. However, in 2013 average age at first calving was still higher than the recommendation and was 27 mo in Québec for HO heifers (Valacta, 2013). Three assumptions can be proposed to explain the delay at which age at first calving occurs: (1) suboptimal ADG; (2) delayed breedings; and (3) underestimation of heifer weight at which first breeding should occur, and hence projected weight at calving.

Using mixed-model methodologies and random regressions, Cue et al. (2012) have developed a model

Received April 24, 2014.
Accepted November 26, 2014.
[1]Current address: Valacta, Ste-Anne-de-Bellevue, Québec, H9X 3R4, Canada.
[2]Corresponding author: Roger.Cue@McGill.ca

allowing prediction of future growth curves of each individual heifer based upon the weight and height measurements of each heifer, which are updated thereafter as new measurements are available. These authors concluded that age at first calving in Québec above the recommended value could be explained by dairy producers not having accurate tools to predict individual heifer weight at first calving and then preferring to wait 2 or 3 mo for first breeding to ensure that heifers would be large enough at calving (Cue et al., 2012).

This study was undertaken to create an on-farm practical tool to quantify current and future growth of HO, AY, Jersey (**JE**), and Brown Swiss (**BS**) heifers using a predicting model based on random regressions as developed by Cue et al. (2012). To do so, the work of Cue et al. (2012) was extended to report on the current situation of heifer growth in Québec. From the model, indicators were generated, based on observations of the heifer (such as heifer weight and height at 15 and 24 mo, ADG before and after 15 mo, age at which optimal weight for breeding is attained, and relative reliabilities of the 15- and 24-mo weight predictions) that dairy producers could use to aid management decisions about heifer reproduction. Moreover, this study provides a portrait of the current state of heifer growth in Québec for the most popular breeds (i.e., HO, AY, JE, and BS). It is expected that the adoption of this on-farm tool by dairy producers and specialists in Québec would increase the number of dairy-heifer growth measurements, allow better prediction of individual heifer growth, reduce age at first calving, and thereby improve farm profitability.

MATERIALS AND METHODS

Data Collection

Weight, estimated by heart girth circumference, and wither-height data of dairy heifers (from 0 to 27 mo) were obtained from the Valacta database (DHI agency, Ste-Anne-de-Bellevue, QC, Canada) from 1995 to 2012. The same data set used by Pietersma et al. (2006) and Cue et al. (2012) formed part of this study and was updated to take into account measurements from 2006 to 2012. A complete description of data recording and extraction from the Valacta database was given previously (Pietersma et al., 2006; Cue et al., 2012). Briefly, estimated BW and height records were measured by Valacta technicians in dairy farms participating in the heifer recording option. Body weight was estimated using calibrated weight tapes measuring heart girth circumference. Because electronic scales are not commonly available on Québec dairy farms, estimated BW using a tape is a practical and reliable technique (Heinrichs et al., 1992). For HO, AY, JE, and BS heifers, a total of 401,474, 20,668, 3,226, and 3,563 estimated BW records and 359,650, 18,066, 2,796, and 3,416 wither-height records were collected, respectively.

Mature BW was estimated from Valacta BW records of multiparous cows from the 4 studied breeds (i.e., HO, AY, BS, and JE) from 2007 to 2012. Random regressions were used with a linear model based on a Wilmink function on DIM to estimate average BW at calving (Wilmink, 1987). Mature BW represents the average estimated weight at calving for multiparous cows from third, fourth, and fifth lactations within each breed.

Data Verification

This study was carried out in 2 steps: step one was an update of estimates of equation parameters for HO, AY, and BS breeds of the study of Cue et al. (2012) and an initial estimation of the same parameters (for weight and height) for JE heifers. The second step was an examination of the population growth curves and various indicators that might be used to monitor and assist in improving heifer growth and achieving recommended age at first calving.

Table 1. Numbers of animals and records, before and after editing, for weight (step one)

Item	Holstein	Ayrshire	Jersey	Brown Swiss
Number of animals, before	147,024	7,475	1,788	1,464
Records, initially	401,474	20,668	3,226	3,563
After removing records more than 4 SD from the respective breed-age mean				
Number of animals	145,828	7,439	1,766	1,457
Records	399,437	20,589	3,188	3,555
After imposing the requirement of age at first observation <5 and >19 mo for the last observation				
Number of animals	12,695	572	165	317
Records	91,665	4,746	892	1,497
After imposing the requirement of 4+ records per heifer				
Number of animals	11,269	515	165	317
Records	87,844	4,592	892	1,497