Evolution of mature size, mature production, and the relative maturity and performance during the first two lactations of DHI-registered Holsteins in Canada

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Abstract

Size and milk production of dairy cows have increased over time. However, the magnitude of this increase and its relationship with productivity across lactations has been little studied. The objective of this analysis was to describe the evolution over the last two decades of the mature BW (MBW), mature production and the relative maturity (RMAT) and performance (RPER) during the first two lactations of Holstein cows. Data from first (L1), second (L2) and third and more lactations (L3+) from 2002 to 2021 were extracted from the Quebec DHI data base. Records of age at first calving (AFC, 1,413,772), BW (565,710; 713,668 and 1,152,530) and 305 d-adjusted milk and components yields (1,334,433; 1,0310,24 and 1,538,492) from L1, L2 and L3+ cows, respectively, were averaged per year. The L3+ cows were considered as mature and the reference to evaluate RMAT and RPER of L1 and L2 cows. Data from L3+ cows and AFC were regressed against time while RMAT and RPER were analyzed using a fixed effect model including year, parity and their interaction. The BW and milk (MY), fat (FY) and protein yields (PY) of L3+ cows increased since 2002 (P<0.01) at rates of 3.7±0.1, 109±5, 5.7±0.2 and 4.0±0.2 kg per yr, respectively. In 2021 L3+ cows weighed 738±1.2 kg and produced 11,184±56, 447±2.6 and 364±2.8 kg of milk, fat and protein, respectively. The AFC decreased (P<0.01) at a rate of 0.15±0.01 mo per year, averaging 24.8±0.13 mo in 2021. L1 cows' RMAT decreased (P<0.01) at 0.09±0.01% per year and was 87.4±0.1% of MBW in 2021. Overall, L2 cows' RMAT was 94.46±0.05% of MBW and did not change over time (P=0.61). The RPER decreased over time (P<0.01) but at a faster rate in L1 than in L2 cows (P<0.01) for MY (0.22±0.2 vs 0.06±0.2% per yr), FY (0.17±0.2 vs 0.04±0.02% per yr) and PY (0.24±0.01 vs 0.07±0.02 % per yr). In 2021 MY, FT and PY relative to L3+ cows were 80.3, 81.5 and 81.5% for L1 and 95.0, 95.2 and 96.6 % for L2 cows, respectively. Despite the significant progress in mature lactational performance and AFC, there has been a decline in the RPER of L1 and L2 cows that deserves to be addressed.

Keywords: Maturity, lactation, firts calving, body weight, milk yield.
Presented at the ICAR Anual Conference 2024 in Bled at the Session 6: Evaluation and presentation of new parameters in herd management for dairy farms

Introduction

The average milk production per cow has risen progressively in the past years. In the past 50 years, the average 305-d lactation yield for Holstein cows increased by approximately 5,000 kg (Brito *et al*., 2021). This expressive augment in milk production is driven by intensive genetic selection, along with improvement in nutritional practices,

precision management, reproductive technologies, and improvement in health management (Brito *et al*., 2021).

At the same time, the size of dairy cows has increased over the years. Body weight (BW) is a characteristic that impacts nutrient requirements, feed intake, space needs, and medication dosing, among other factors. However, the magnitude of the increase in body weight and its relationship with productivity across lactations has been little studied. Therefore, the objective of this study was to describe the evolution over the last two decades of the MBW, mature production, and relative maturity (RMAT) and performance (RPER) during the first two lactations of Holstein cows.

Material and methods

Data from Lactation 1 (L1), Lactation 2 (L2), and Lactation 3+ (L3+) cows were extracted from Lactanet database, corresponding to a period of 20 years (from 2002 and 2021). A total of 1,413,772 records of age at first calving (AFC), 2,431,870 records of BW (L1 = 565,710; L2 = 713,668; and L3+ = 1,152,530), and 3,903,949 records of 305-d adjusted milk and component yields (L1 = 1,334,433; L2 = 1,0310,24; and L3+ = 1,538,492) were analysed.

An average per year was calculated for the parameters. For calculating RMAT and RPER, data from L3+ cows were considered as mature and used as reference values for L1 and L2 cows.

Data from L3+ cows and AFC were regressed against time; and data from RMAT and RPER were analyzed using a fixed model including the effects of year, parity, and the interaction between year and parity.

Results

Evolution of body weight and milk yield

According to our records, in the past 20 years, there was an increase in the 305-d milk yield of mature cows, and this increase was accompanied by an increase in mature body weight as well (Figure 1). The BW and milk, fat, and protein yields of L3+ cows increased since 2002 at rates of 3.7, 109, 5.7, and 4.0 kg per year, respectively. In 2021, mature cows weighed 738 ± 1.2 kg, and produced 11,184 ± 56, 447 ± 2.6, and 364 ± 2.8 kg of milk, fat, and protein, respectively.

Evolution of age at first calving

The AFC decreased ($P < 0.01$) at a rate of 0.15 ± 0.01 months per year, averaging 24.8 ± 0.13 months in 2021 (Figure 2).

Evolution of relative maturity, and relative milk, fat, and protein yields for first and second lactation cows

Overall, L1 cows RMAT decreased ($P < 0.01$) over time, by a rate of 0.09 ± 0.01% per year and was 87.4 ± 0.1% of MBW in 2021 (Figure 3, L1). The decrease in maturity of L1 cows does not follow the same pattern as that of the age at first calving. Overall, L2 cows' maturity was 94.46% of MBW and did not change ($P = 0.61$) over time (Figure 3, L2).

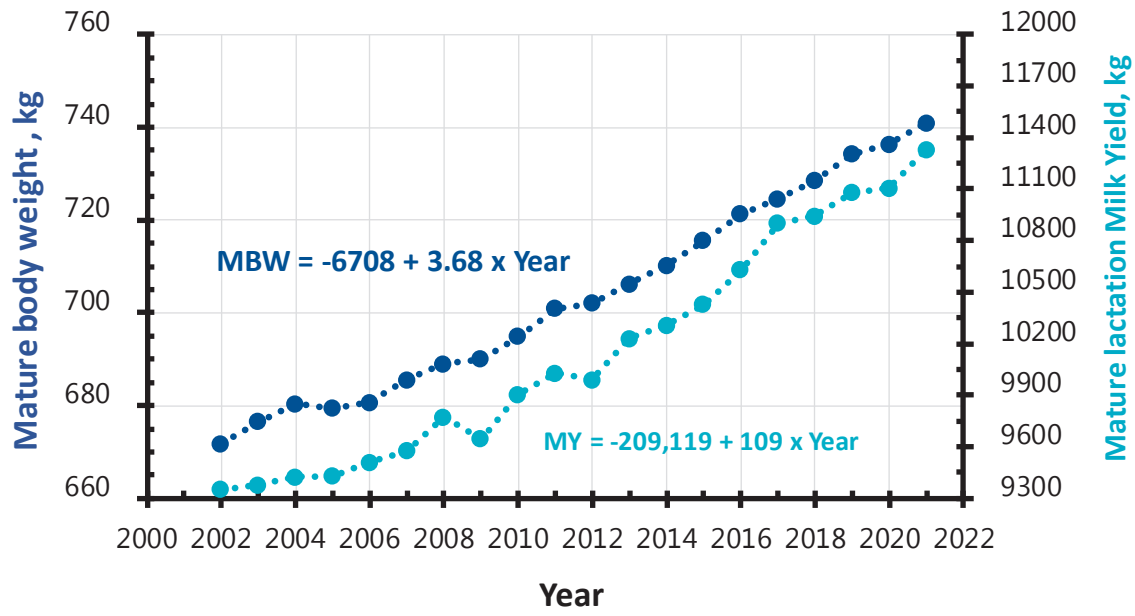

Figure 1. Evolution of body weight and 305-d milk yield of third and more lactation (L3+) cows.

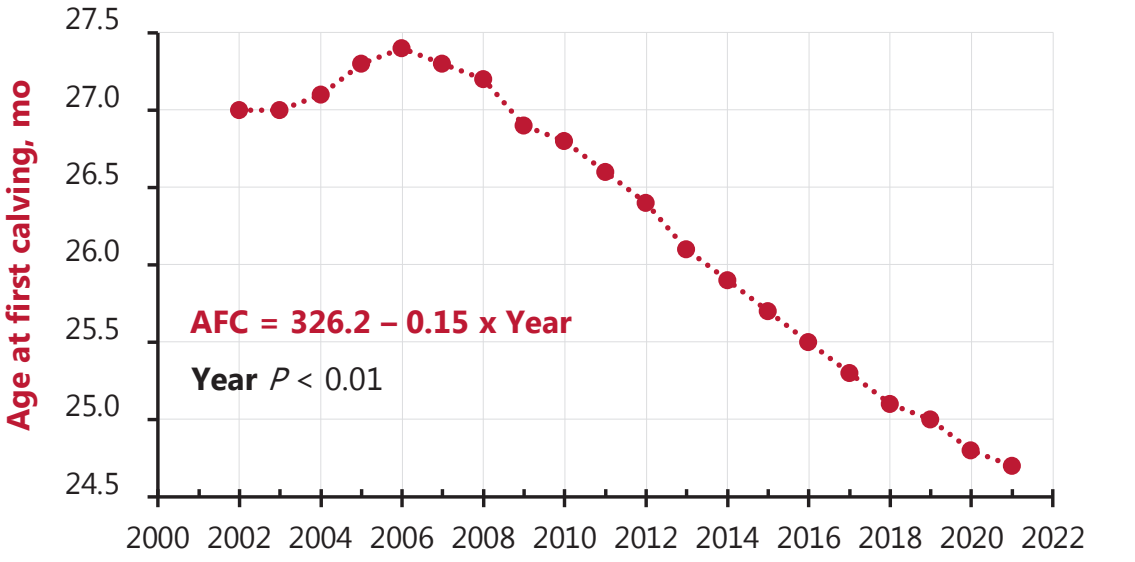

Figure 2. Evolution of age at first calving (AFC).

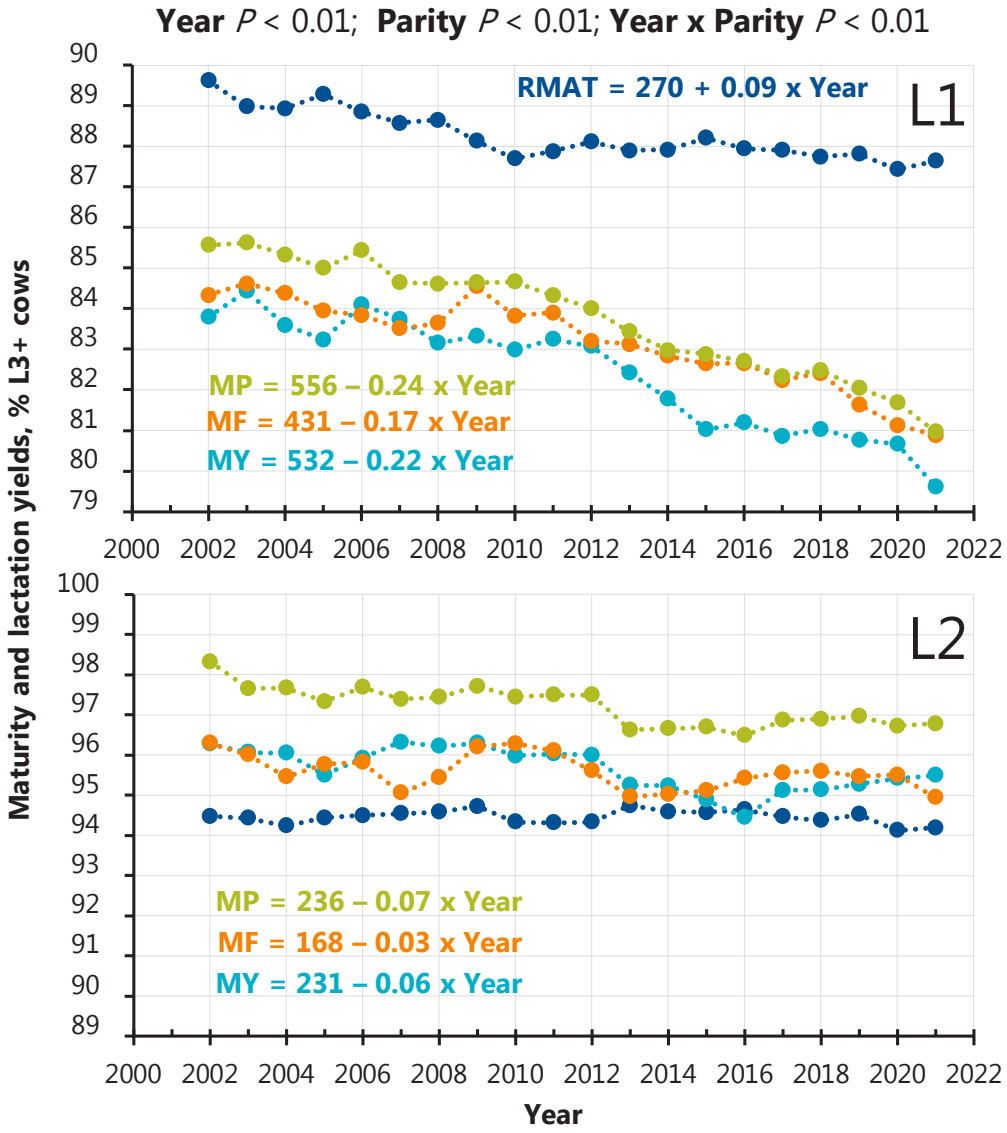

Figure 3. Evolution of the maturity and relative milk (MY), fat (MF), and protein yields (MP) for 1st (L1) and 2nd lactation (L2) Holstein cows.

The relative performance decreased over time but at a faster rate in L1 than in L2 cows and the greatest decline was observed in the protein and milk relative yields. In 2021 milk, fat, and protein yields relative to L3+ cows were 80.3, 81.5, and 81.5% for L1 and 95.0, 95.2, and 96.6 % for L2 cows, respectively. The decline in relative performance of L1 and L2 cows does not correspond to the evolution of their maturity.

Conclusion and implications

In conclusion, significant advancements have been achieved in AFC and the mature lactation performance. The increase in mature performance coincides with an increase

in MBW. However, a decline in the relative performance over time has been observed for first and second-lactation cows, particularly for protein and milk yield. Interestingly, this decline in RPER of L1 and L2 cows does not correspond to the evolution of RMAT. Moreover, the decline in RMAT of L1 cows does not follow the same trend as the one observed for AFC. It is imperative to further explore and address the decline in RPER and explore potential management and nutritional factors that could be limiting the performance of L1 and L2 cows.

Acknowledgements

Lactanet would like to acknowledge and thank the dairy producers in the province of Quebec registered to its DHI service for allowing the use of their records for this analysis and the advancement of dairy science.

List of references

Brito, L. F., N. Bedere, F. Douhard, H. R. Oliveira, M. Arnal, F. Penagaricano, A. P. Schinckel, C. F. Baes, and F. Miglior, 2021. Review: Genetic selection of high-yielding dairy cattle toward sustainability farming systems in a rapidly changing world. Animal. 15:100292.