A survey of male and female dairy calf care practices and opportunities for change

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ABSTRACT

The primary objective of this study was to compare male and female dairy calf management practices and evaluate risk factors associated with differences in care. Secondary objectives were to understand surplus calf transportation and marketing practices and investigate incentives to motivate calf care improvements. An online survey was distributed to all dairy producers in Ontario (n = 3367) from November 2020 to March 2021 and Atlantic Canada (n = 557) from April to June 2021. Dairy producers were identified through provincial dairy associations and contacted via e-mail and social media. Descriptive statistics were computed, and a logistic regression model was created to evaluate factors associated with using discrepant feeding practices (i.e., fed less colostrum, fed colostrum later, or fed raw, unsalable milk) for male calves compared with females. The survey had a 7.4% response rate (n = 289/3924) and was primarily filled out by farm owners (76%). Although colostrum and milk feeding practices were similar between male and female calves, male calves received less milk while still on the dairy farm of origin compared with females. Male calves were also more likely to be fed a higher proportion of raw, unsalable milk. Female producers and those that kept their male calves beyond 10 d of age had lower odds of using poorer feeding practices for male calves. Male calves were mostly sold between 1 and 10 d (64%), primarily through direct sales to a calf-rearing facility (45%), with auctions being the next most common method (35%). A small but notable proportion of producers (18%) agreed that euthanizing male calves is a reasonable alternative when their sale price is very low; however, few producers (13%) reported that financial costs limited their male calf care. The largest proportion (43%) of producers reported that a price premium for more vigorous calves would motivate them to take better care of their male calves. Conversely, only 28% of producers reported that a price discount for calves in poor condition would be motivating. Producers placed importance on the opinion of their calf buyer, their herd veterinarian, and the Canadian Code of Practice for the Care and Handling of Dairy Cattle when considering their calf care practices, and they highly valued practices that promote calf health. Respondents to this survey reported a lower proportion of tiestall barn use and higher milk productivity compared with typical dairy herds in the region, suggesting selection bias for more progressive dairy producers. Nevertheless, our results suggest that dairy producers provide similar care between male and female calves, but some male calves experience challenges due to milk feeding and marketing practices. Feedback from calf buyers along with continued support and guidance from herd veterinarians and the Code of Practice may motivate dairy producers to improve male calf care.

Key words: surplus calves, producer perspective, colostrum, calf marketing

INTRODUCTION

Surplus calves, frequently males, are those born on dairy farms but not needed to replace lactating cattle or breeding stock. They are often sold to red meat production systems and transported at a young age, which causes concern for their welfare among the lay public (Ritter et al., 2022). Studies have documented surplus calves suffering from poor health on dairy farms before sale (Wilson et al., 2020b), at auction markets (Marquou et al., 2019), and upon arrival at calf-rearing facilities (Pempek et al., 2017; Renaud et al., 2018b). Because calf health challenges can often be prevented through good colostrum management (reviewed by Godden et
al., 2019) and adequate nutrition (Ollivett et al., 2012), investigating these highly influential practices could identify bottlenecks for both replacement females and surplus calves. Although management practices used for surplus and replacement calves are likely correlated, qualitative evidence suggests differences exist in how they are cared for on some Ontario dairy farms (Wilson et al., 2021). Additionally, a mixed-methods study found that 32% of Irish dairy farmers felt that the main purpose of their male calves was merely to induce lactation, and the vast majority of qualitative responses indicated beef prices were an important barrier for their care (Maher et al., 2021). Further, Shivley et al. (2019) found differences in male calf colostrum provision on farms in the United States. It is unclear how frequently care practices differ between male and female calves on Canadian dairy farms.

Along with potentially inadequate care on dairy farms, recent work has highlighted challenges for male dairy calves during marketing, such as comingling with unfamiliar calves and long transport times (Marcato et al., 2020; Creutzinger et al., 2021). Globally, regulations have been established to help protect calf health and welfare, often by imposing limits on the minimum age of calves allowed to be transported, along with limiting their time in transit and at rest stations (Wilson et al., 2020a). Age-based requirements were recently supported by research that suggested older calves mount a better immune response (Marcato et al., 2022a), required fewer supportive medications (i.e., anti-inflammatories, multivitamins, and anticoccidial drugs), and had improved growth (Marcato et al., 2022b). Nevertheless, producers may be unwilling to market older calves due to high rearing costs paired with low or fluctuating calf prices. In addition, many dairy farms have limited capacity to house surplus calves (Creutzinger et al., 2021). Thus, there is a need to understand how Canadian dairy producers are marketing their calves to gauge the impact of new regulations (see Canadian Food Inspection Agency, 2019) on calf welfare and farm profitability.

Although optimal calf management practices have been well described, motivations for dairy producers to implement them remain unclear. Social science is increasingly used for evaluating the adoption of best management practices on dairy farms and developing effective extension efforts (Ritter et al., 2017; Mills et al., 2020). For instance, a recent focus group study described how different barriers and motivations influenced male and female calf care (Wilson et al., 2021), but these findings may not be generalizable to a larger population of dairy producers. Further research is warranted to quantify the perceived barriers to surplus calf care (e.g., economic limitations and adequate labor capacity) to help direct efforts aimed at improving calf welfare. Given these knowledge gaps, the primary objective of this study was to describe calf care practices that differ between male and female calves and explore producer demographics and perspectives associated with discrepant male calf care. Secondary objectives were to describe surplus calf transportation and marketing practices, as well as investigate possible opportunities to motivate change through financial incentives and advisers.

**MATERIALS AND METHODS**

This study was reported using guidance from the STROBE-Vet statement (O’Connor et al., 2016) along with a survey-specific guideline (Sharma et al., 2021).

**Questionnaire Development**

A cross-sectional study of Ontario dairy producers was conducted to evaluate 5 management areas: cull cows, down cows, male and female dairy calves, antimicrobial use, and disease control and surveillance. This information, along with producer demographics and an evaluation of personal values, was collected using a 50-min online questionnaire (Qualtrics; https://www.qualtrics.com/). Another version of the questionnaire (40 min) was distributed to dairy producers in Atlantic Canada (provinces of Nova Scotia, Prince Edward Island, Newfoundland and Labrador, and New Brunswick) that evaluated 3 management areas: male and female dairy calves (using identical wording to the calf section in the Ontario survey), antimicrobial use, and general perspectives on animal welfare. The questions used for this article, including demographic questions and those related to male and female dairy calves, are available online through the University of Guelph’s data repository (available at https://doi.org/10.5683/SP3/IOEVKM;GeneraCalfSurvey.pdf). The questionnaires were developed collaboratively with researchers investigating the 5 (Ontario) and 3 (Atlantic Canada) different management areas and were pretested with 3 Ontario dairy producers and modified for clarity before final distribution. The questionnaire was available online (Qualtrics) and upon request as a Microsoft Word document (Microsoft Corp.) in Ontario from December 4, 2020, until March 22, 2021, and in Atlantic Canada from April 21, 2021, until July 1, 2021. The final survey delivered in Ontario contained 134 questions (some multipart), with 27 questions related to calf manage-
ment. The final survey in Atlantic Canada contained 76 questions (some multipart), with 28 questions related to calf management. One calf management question was added to the Atlantic Canada survey to further clarify the amount of beef semen being used to improve the profitability of male calves in this region.

The calf management section of the questionnaire evaluated milk and colostrum feeding practices for male and female calves, along with marketing and transportation practices specific to male calves. In addition, producers’ perspectives relevant to calf care were explored by (1) how producers valued their male calves, (2) characteristics of calf care practices that producers prioritized (e.g., whether they are economical to implement; whether they promote calf health), and (3) which dairy industry stakeholder opinions were most influential, with a focus on how producers interacted with calf buyers. The personal values of producers were assessed using a series of questions measuring Schwartz’s 10 basic values (conformity, tradition, security, power, achievement, hedonism, stimulation, self-direction, universalism, and benevolence), which have been validated across cultures for predicting decisions and behaviors (Sandy et al., 2017). Further analysis of producer values is being prepared in another manuscript.

Recruitment of Participants

This study was approved by the Research Ethics Boards at both the University of Guelph (Ontario, Canada) (REB # 20-09-001) and the University of Prince Edward Island (Prince Edward Island, Canada) (REB # 60-08-817). The survey was distributed to all Ontario dairy producers using e-mail and post mail addresses obtained from the provincial milk producers association, Dairy Farmers of Ontario. Participation was promoted using print and online advertisements including (1) postcards delivered in the Dairy Farmers of Ontario weekly newsletter and alongside a local lay publication (Milk Producer; https://new.milk.org/Industry/Milk-Producer-Magazine), (2) a link distributed by the Dairy Farmers of Ontario e-newsletter and the Ontario Association of Bovine Practitioners listserv, and (3) a link distributed through the Twitter accounts of involved researchers who encouraged retweeting by influential Ontario dairy producers. Incentives included (1) a $20 gift card provided to the first 250 respondents, and (2) a drawing of all respondents to win 1 of 2 iPads (Apple Inc.). In Atlantic Canada, recruitment was accomplished electronically by e-mailing a link to the 4 provincial dairy associations (Dairy Farmers of Prince Edward Island, Dairy Farmers of Nova Scotia, Dairy Farmers of Newfoundland and Labrador, and Dairy Farmers of New Brunswick), which was then distributed by the respective association to dairy producers in each province. Participation was promoted online through an e-mail with the survey link sent to members of the Atlantic Association of Bovine Practitioners, who were encouraged to send it to their dairy farm clients, though further follow-up with practitioners was not considered. To encourage participation, respondents were entered in a drawing to win 1 of 3 iPads.

In both surveys, individual participant information was collected to ensure only one survey was completed per producer, but identifiers were kept separate from the research data and could only be accessed by the study administrator. A sample-size calculation was not undertaken given the exploratory nature of the study; however, recruitment efforts were made to reach dairy producers through a variety of platforms to maximize the sample size.

Statistical Analysis

Data were first exported from Qualtrics into Excel (Microsoft Corp.) and checked for errors and completeness. For the calf-specific questions, the maximum number of responses was 227, and the minimum number of responses for stand-alone questions (i.e., those that were not a follow-up question conditional to a previous response) was 212. The discrepancy occurred when questions were unanswered because producers were able to skip questions or end the survey at any time. Methods to deal with potential nonresponse biases (e.g., multiple imputation) were not undertaken, resulting in different data available for each question, which is noted throughout the article.

Statistical analyses, including descriptive statistics for all explanatory variables, were conducted using Stata 16.1 (StataCorp, 2021). The volumes of milk provided to male and female calves in each of the first 3 wk of life were not normally distributed (Shapiro-Wilk test, P > 0.05) and therefore were compared using a nonparametric Wilcoxon signed-rank test. The Pearson’s chi-squared test was used to investigate the association between the source of fed milk [raw unsalable (waste) milk versus other sources (raw salable milk, milk replacer, pasteurized milk, acidified milk, mix of milk and hot water, or variable milk type depending on their milk quota status)] and the calf sex (male versus female). The number of producers in Ontario and Atlantic Canada who believed that complying with new federal transportation regulations would be “not challenging at all” or “minimally challenging” versus those that responded “very challenging,” “challenging,” or “somewhat challenging” were compared using
the Pearson’s chi-squared test. Significant statistical differences were determined by \( P \)-value < 0.05 in all statistical tests.

A multivariable logistic regression model was built to evaluate relationships between the discrepant care of male versus female calves (outcome) and demographic and producer perspectives (explanatory variables). Within each explanatory variable, categories with a small number of responses or no responses were combined with others to avoid complete separation and parameter inflation in regression models. Given that few differences in feeding practices were reported between male and female calves in individual questions related to colostrum and milk feeding, a post hoc decision was made to create a combined dependent variable. Farms were classified as having poorer feeding practices for males if they satisfied at least one of the following characteristics: (1) fed less colostrum to males compared with females, (2) fed colostrum to males later compared with females, or (3) fed raw, unsalable milk to male calves when female calves were fed a higher-quality source, such as salable raw milk from the bulk tank, milk replacer, or pasteurized milk. The volume of milk provided was not included in the aggregated outcome because of a low response rate for male calf milk volume provided in wk 1 (n = 212), wk 2 (n = 164), and wk 3 (n = 129), as male calves are frequently sold during this period.

To direct model building, a causal diagram was created (Figure 1), with an a priori decision to include region as a fixed effect regardless of its statistical significance because of potential confounding effects related to regional differences in farm practices or survey response rate. The linearity assumption was assessed for 2 continuous explanatory variables (herd size and herd productivity) with the log odds of the outcome, and categorized by quartiles if the assumption was not met. Collinearity among explanatory variables was evaluated using Spearman rank coefficients with a cutoff of \( \geq 0.7 \). Given the large number of considered relationships, univariable models were constructed to screen for predictor variables that were associated with the outcome (see Supplemental Table S1: https://doi.org/10.5683/SP3/IOEVKM;SupplementaryTable.pdf). Variables that were associated based on a liberal \( P \)-value cut point of 0.2 were then offered to a multivariable model and eliminated using a manual backward process. Confounding was defined as a nonintervening variable that changed the coefficients of the remaining variables in the model by at least 25%. Two-way interactions between region and all variables that were associated at the univariable level with the outcome were introduced back into the final model and remained in the final models if statistically significant at \( P < 0.05 \). The model fit was assessed using the Pearson’s chi-squared goodness-of-fit, and Pearson’s residuals, delta betas, delta chi-squared, and delta deviance plots were evaluated visually to identify any outliers.

RESULTS

In Ontario, out of the 248 responses, 6 did not consent to participate in the survey, 6 were not dairy farming, and 1 both did not consent and was not dairy farming. Out of the 57 responses from Atlantic Canada, 2 did not consent and 1 response set was removed due to answers suggesting either an extreme outlier herd or a lack of accurate data (e.g., 8,000 Swedish Red cattle producing 30,000 kg of milk per 305-d lactation using a “carry pails” milking system). Given these exclusions, the combined response rate was 7.4% (n = 289/3,924).

Farm and Producer Characteristics

Table 1 displays respondent demographics, showing that the survey was primarily filled out by farm owners or family members, and approximately two-thirds of respondents were male. Respondents were primarily under 50 yr old and had obtained postsecondary education. Table 2 displays the reported farm characteristics, with a median lactating herd size of 86 cows. The typical respondent primarily milked Holstein cows that were housed in a freestall barn, with parlor, pipeline, and robotic milking systems used in similar proportions. Only 7 organic farms (all from Ontario) completed the survey. Approximately 50% of producers had a veterinarian visit their farms weekly or every 2 wk, with most of the rest (~40%) having scheduled herd visits less frequently (every 3 or 4 wk or less than monthly). In Ontario and Atlantic Canada, 7% and 9% of respondents did not have regularly scheduled veterinary visits, respectively.

Male and Female Calf Care Comparison

Calf feeding practices used for the majority of calves were similar between male and female calves, as noted in the descriptive results in Table 3. Male and female calves were generally fed unpasteurized colostrum from their dam, with few producers utilizing pasteurization or colostrum replacer. Bottles were most commonly used to deliver colostrum followed by esophageal tube feeders. Nearly all respondents indicated they fed colostrum within 6 h after birth (93% for male calves and 95% for female calves). However, only 86% and 87% of producers reported feeding at least 3 L of colostrum to female and male calves, respectively, which is the minimum volume recommended by Godden et
Although most producers fed raw, salable milk or milk replacer, 11% and 20% fed unpasteurized, unsalable milk to female and male calves, respectively. Furthermore, compared with all other types of higher-quality milk sources, the proportion of male calves receiving raw, unsalable milk was higher than that of female calves ($\chi^2$ test, $P < 0.001$). A similar amount of milk was offered to female and male calves in the first week of life ($P = 0.07$), with less milk offered to male calves in the second ($P = 0.004$) and third ($P = 0.020$) weeks of life compared with females (Figure 2). In the first week of life, 22% (n = 49/221) and 25% (n = 53/212) of female and male calves were offered < 6 L of milk per day, respectively.

For multivariable logistic regression analysis, of the 204 producers with complete data on neonatal male and female calf feeding, 35 were classified as having discrepantly worse male calf feeding practices. Most of these fed raw, unsalable milk to male calves when female calves were fed a higher-quality source, such as salable raw milk from the bulk tank, milk replacer, or pasteurized milk (n = 19). Some also fed colostrum to males compared with females (n = 8). Additionally, 5 responses were excluded from this analysis as they reported better care for male calves, specifically by feeding more colostrum to males than females. Our model indicated female producers and those that kept their male calves on the dairy farm beyond 7 d of age had lower odds of using poorer management practices for male calves (Table 4). Although region was retained in the model based on a priori decision, its effect and interactions with other variables were not statistically significant.

**Transportation and Marketing Practices**

Producers were generally aware of new transport regulations (Canadian Food Inspection Agency, 2019) both in Ontario (n = 155/177, 88%) and in Atlantic Canada (n = 38/41, 93%), but the perceived challenge of complying differed between regions ($P = 0.03$). That is, 37% (n = 14/38) and 15% (n = 23/158) of dairy producers in Atlantic Canada and Ontario, respectively, reported that meeting these new regulations would be either challenging or very challenging.
When asked to list the percentage of male calves marketed in different ways, producers most frequently reported the majority (>50%) of their calves were sold directly to calf-rearing facilities (n = 98/220, 45%) or through livestock auctions (n = 77/220, 35%). Other dairy producers raised the majority of male calves beyond weaning (n = 17/220, 8%) or reported that male calves were picked up by a transporter, but they did not know how they were subsequently marketed (n = 17/220, 8%). The remaining producers euthanized most of their male calves at birth (n = 2/220, 1%) or used a mixture (direct, auction, and euthanasia) of marketing methods (n = 9/220, 4%). Additionally, 10% (n = 23/220) reported euthanizing at least 1% of their male calves. Calves were sold between the ages of 1 and 7 d (n = 61/221, 28%), 7 and 10 d (n = 81/221, 37%), 10 and 14 d (n = 44/221, 20%), or beyond 14 d (n = 35/221, 16%). When marketing to calf buyers, 52% of producers (n = 113/218) had received feedback on calf outcomes from their calf buyers, and of these producers, 39% (n = 44/113) had changed a calf care practice based on this feedback. Most producers (n = 262/221, 73%) reported using beef semen in their dairy herd specifically to increase the profitability of male calves.

Table 1. Number and proportion of different demographic characteristics reported by survey respondents in Ontario (n = 235) and Atlantic Canada (n = 54).1

| Variable                  | Ontario         |                          | Ontario         |                          |
|---------------------------|-----------------|---------------------------|-----------------|---------------------------|
|                           | n   | Proportion (%) | SE | n   | Proportion (%) | SE |
| Role on the farm          |     |                |    |     |                |    |
| Owner                     | 176 | 78             | 2.8 | 35  | 66             | 6.5 |
| Manager                   | 17  | 8              | 1.8 | 5   | 9              | 4.0 |
| Family member of owner    | 29  | 13             | 2.2 | 11  | 21             | 5.6 |
| Employee/other            | 4   | 2              | 0.9 | 2   | 4              | 2.6 |
| Age                       | 226 |                |    | 53  |                |    |
| <30 yr                    | 45  | 20             | 2.7 | 4   | 8              | 3.6 |
| 30 to 39 yr               | 65  | 29             | 3.0 | 18  | 34             | 6.5 |
| 40 to 49 yr               | 47  | 21             | 2.7 | 9   | 17             | 5.2 |
| 50 to 59 yr               | 47  | 21             | 2.7 | 11  | 21             | 5.6 |
| ≥60 yr                    | 22  | 10             | 2.0 | 11  | 21             | 5.6 |
| Education                 | 226 |                |    | 53  |                |    |
| Primary school            | 9   | 4              | 1.3 | 2   | 4              | 2.6 |
| High school               | 46  | 20             | 2.7 | 14  | 26             | 6.1 |
| Apprenticeship training/trades | 3       | 1             | 0.8 | 2   | 4              | 2.6 |
| College                   | 90  | 40             | 3.3 | 10  | 19             | 5.4 |
| University                | 64  | 28             | 3.0 | 13  | 25             | 5.9 |
| Graduate/professional     | 14  | 6              | 1.6 | 12  | 23             | 5.8 |
| Gender pronouns           | 226 |                |    | 53  |                |    |
| He/him                    | 154 | 68             | 3.1 | 33  | 62             | 6.7 |
| She/her                   | 68  | 30             | 3.1 | 17  | 32             | 6.4 |
| They/them or prefer not to say | 4     | 2             | 0.9 | 3   | 6              | 3.2 |

1The survey was distributed to all dairy producers in Ontario (n = 3,367) and evaluated 5 management areas (cull cows, down cows, male and female dairy calves, antimicrobial use, and disease control and surveillance). Another version was distributed to all dairy producers in Atlantic Canada (n = 557) that evaluated 3 management areas (male and female dairy calves, antimicrobial use, and general perspectives on animal welfare).

Barriers for Providing Optimal Calf Care

Approximately half (n = 114/220, 51%) of dairy producers reported using employee labor (nonfamily) for calf care. Of these 114 respondents, 49% considered training these employees “very challenging” (n = 12), “challenging” (n = 18), or “somewhat challenging” (n = 26), whereas the remainder considered training employees “minimally challenging” (n = 41) or “not challenging at all” (n = 17). Producers’ workload was infrequently a barrier to male calf care, as only 6% (n = 13/219) agreed with the statement about male calves, “I cannot provide the level of care I wish to provide to calves because of the workload of the rest of the dairy herd.” When questions specifically about the financial aspect of male calf care were posed, 13% (29/220) agreed with the statement, “I cannot provide the level of care I wish to provide to male calves due to the financial cost.” In a related question, when asked whether “euthanizing male calves is a reasonable alternative when their selling price is very low,” 18% (n = 39/219) agreed with this statement. However, 43% (n = 94/220) of producers agreed that a financial incentive would be motivating compared with only 28% (n = 61/220) who agreed that a disincentive would
be motivating (Figure 3). Finally, 47% (n = 103/221) agreed male dairy calves are a valuable part of the dairy industry, 29% (n = 64/221) were neutral, and 24% (n = 54/221) disagreed.

**Important Influencers of Calf Care Practices**

To investigate potential avenues for addressing calf care barriers, producers were asked about the importance of different stakeholder opinions on their calf care practices. Overall, other dairy producers, the public, and the provincial milk associations were considered least important, whereas the Code of Practice for the Care and Handling of Dairy Cattle (National Farm Animal Care Council, 2009; hereafter referred to as the Code of Practice) and producers’ herd veterinarians were considered the most important (Figure 4). Characteristics of calf care that were most important to respondents were those that promoted calf health and welfare, with high importance also placed on practices that are simple and economical to implement, and less importance placed on practices that mimic what would occur in nature (Figure 5).

**DISCUSSION**

This study aimed to describe and compare male and female calf care practices used on dairy farms in Ontario and Atlantic Canada. We found that a small proportion of farms continued to feed low volumes of milk and colostrum, and that raw, unsalable milk was fed more frequently to male calves compared with females. Female producers and those keeping male calves at least 7 d were more likely to treat female and male calves the same. In addition, this study explored barriers that producers face with improving calf care and possible avenues to influence change. Most producers continue to market male calves at a young age, with approximately half of respondents perceiving male calves to have low value to the dairy industry. Respondents indicated they valued the guidance of their herd veterinarian and the Code of Practice, and more producers felt that a price premium for more vigorous male calves would motivate better care compared with a price discount for poorer calves.

When evaluating colostrum feeding practices, although most producers provided at least 3 L of colos-
trum within the first 6 h after birth, 13% and 14% of respondents reported feeding <3 L to male and female calves, respectively. Calves receiving a low volume of colostrum are at risk for increased morbidity and mortality, as adequate colostrum volume and IgG concentration are 2 critical factors to ensure transfer of passive immunity (Godden et al., 2019). Interestingly, few respondents reported differences in colostrum feeding practices between male and female calves, which is comparable to the discovery of Shivley et al. (2019) of only a small difference between sexes in the method of colostrum delivery. Given few and subtle differences in colostrum feeding practices, it is unsurprising that a recent cross-sectional study found a comparable prevalence (24%) of failure of passive immune transfer between male and female calves (Renaud et al., 2020). Despite years of research, there clearly remains a need for improvement in colostrum management for both male and female calves on select farms that may require targeted extension efforts.

With respect to milk feeding practices, our study found that dairy producers fed raw waste milk more frequently to male calves. Studies indicate that feeding raw waste milk, which frequently contains antibiotic residues, can result in disruption of the fecal microbiota and diarrhea (Penati et al., 2021), along with fecal shedding of antimicrobial resistant bacteria (Aust et al., 2013). Feeding waste milk preferentially to male calves has been previously reported (Duse et al., 2013) and could contribute to high levels of diarrhea in surplus calves during the first weeks after arrival to calf-rearing facilities (Schinwald et al., 2022). Although pasteurization of waste milk reduces pathogen prevalence, practical improvements in weight gain and morbidity are

### Table 3. Colostrum and milk feeding practices for female and male calves reported by survey respondents from dairy farms in Ontario (n = 235) and Atlantic Canada (n = 54)

| Variable                                      | Female calves |          | Male calves |          |
|-----------------------------------------------|---------------|----------|-------------|----------|
|                                               | n             | Proportion (%) | SE | n       | Proportion (%) | SE |
| Colostrum type                                | 217           |          | 219         |          |
| From the dam                                  |               |          |             |          |
| Unpasteurized                                 | 194           | 89       | 2.1         | 195      | 89           | 2.1 |
| Pasteurized                                   | 1             | 0.5      | 0.0         | 0        | 0            | 0.0 |
| Pooled among herd                             | 2             | 1        | 0.6         | 4        | 2            | 0.9 |
| Unpasteurized                                 | 5             | 2        | 1.0         | 4        | 2            | 0.9 |
| Pasteurized                                   | 3             | 1        | 0.8         | 1        | 0            | 0.5 |
| Colostrum replacer                            | 12            | 6        | 1.6         | 15       | 7            | 1.7 |
| Mixed methods                                 | 217           |          | 219         |          |
| Bottle                                        | 160           | 74       | 3.0         | 161      | 74           | 3.0 |
| Tube                                          | 29            | 13       | 2.3         | 27       | 12           | 2.2 |
| Udder                                         | 5             | 2        | 1.0         | 6        | 3            | 1.1 |
| Pail                                          | 7             | 3        | 1.2         | 6        | 3            | 1.1 |
| Bottle/udder equally                          | 16            | 7        | 1.8         | 19       | 9            | 1.9 |
| Colostrum delivery method                     | 219           |          | 218         |          |
| 1 to 2 h                                      | 115           | 53       | 3.4         | 107      | 49           | 3.4 |
| 2 to 6 h                                      | 93            | 42       | 3.3         | 95       | 44           | 3.4 |
| 6 to 12 h                                     | 10            | 5        | 1.4         | 15       | 7            | 1.7 |
| 12 to 24 h                                    | 1             | 0        | 0.5         | 1        | 0            | 0.5 |
| Colostrum amount offered                      | 212           |          | 212         |          |
| 2 to 2.9 L                                    | 29            | 14       | 2.4         | 28       | 13           | 2.3 |
| 3 to 3.9 L                                    | 78            | 37       | 3.3         | 80       | 38           | 3.3 |
| 4 L                                           | 95            | 45       | 3.4         | 93       | 44           | 3.4 |
| More than 4 L                                 | 10            | 5        | 1.5         | 11       | 5            | 1.5 |
| Milk type offered                             | 224           |          | 222         |          |
| Milk replacer                                 | 105           | 47       | 3.3         | 81       | 36           | 3.2 |
| Raw, salable milk                             | 75            | 33       | 3.2         | 78       | 35           | 3.2 |
| Raw, unsalable milk                           | 25            | 11       | 2.1         | 44       | 20           | 2.7 |
| Pasteurized milk                              | 11            | 5        | 1.4         | 10       | 5            | 1.4 |
| Other2                                        | 8             | 4        | 1.2         | 9        | 4            | 1.3 |

1The survey was distributed to all dairy producers in Ontario (n = 3,367) and evaluated 5 management areas (cull cows, down cows, male and female dairy calves, antimicrobial use, and disease control and surveillance). Another version was distributed to all dairy producers in Atlantic Canada (n = 557) that evaluated 3 management areas: male and female dairy calves, antimicrobial use, and general perspectives on animal welfare. The data presented represent the feeding practices producers used for the majority of their calves.

2Including acidified milk, a mixture of milk and hot water, and variable milk types depending on producers’ herd supply as related to their quota status.
not always observed (Vieira et al., 2021), which may explain low producer uptake of pasteurization observed in this study (5%).

Beyond feeding waste milk, approximately one-quarter of producers reported feeding less than 6 L of milk to female and male calves in the first week of life and fed a lower total volume of milk to male calves in the second and third weeks of life. The results of our study suggest higher milk provision compared with older research from Québec, Canada, that reported a median of 4 L of milk was given to calves during the first week (Vasseur et al., 2010). However, some farms still fall short of feeding calves the recommended 20% of their BW in milk (approximately 8 L for newborn calves), representing a persistent welfare problem (reviewed by Khan et al., 2011). As reviewed by Devant and Marti (2020), providing adequate nutrition to surplus dairy calves before they are marketed is especially protective for their health and welfare.

When evaluating risk factors associated with poorer feeding practices for males (i.e., males that were fed less colostrum, fed colostrum later, or fed raw, unsalable

Table 4. Final multivariable analysis of dairy producer characteristics associated with substandard male calf feeding practices (n = 198)¹

| Variable               | Description            | Odds ratio | 95% CI    | P-value |
|------------------------|------------------------|------------|-----------|---------|
| Region                 | Ontario                | Referent   |           |         |
|                        | Atlantic Canada²       | 1.84       | 0.74 to 4.61 | 0.19    |
| Farmer gender          | Male                   | Referent   |           |         |
|                        | Female                 | 0.31       | 0.11 to 0.86 | 0.02    |
| Age of male calf sale  | 1 to 7 d               | Referent   |           |         |
|                        | 7 to 10 d              | 0.30       | 0.12 to 0.81 | 0.02    |
|                        | 10 d or later          | 0.46       | 0.19 to 1.12 | 0.09    |

¹Substandard male calf feeding practices were defined based on an aggregate of 3 variables: (1) providing male calves with a lower quantity of colostrum compared with female calves; (2) providing male calves colostrum within a longer time frame after birth compared with female calves; and (3) providing male calves raw, unsalable (waste) milk while female calves are fed a higher-quality (milk replacer, salable milk, or pasteurized milk) milk source.

²Atlantic Canada includes the provinces of New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island.
milk) compared with females, we found that female producers were less likely to use differential treatment between male and female calves. This finding adds to previous evidence that female workers provide better calf care compared with male workers, resulting in less diarrhea (Al Mawly et al., 2015) and higher serum total protein levels (Trotz-Williams et al., 2008). This may relate to gendered differences in perspectives on animal care, as evidenced by a study of workers on veal farms that found female workers more frequently interacted positively with calves and viewed their interactions positively (Lensink et al., 2000). Together, these findings suggest efforts to improve male calf feeding practices should accommodate gendered perspectives on calf care. Though changing the behavior of stockpeople is challenging (Hemsworth, 2003), in a review of human resource management on dairy farms, Mills et al. (2021) suggest a role for farm advisers who understand the context of the farm, including conflicts based on gendered roles. Further research is warranted to investigate how to overcome barriers male farmers face in providing better care to male calves, but developing standard procedures and setting clear expectations regarding implementation with the same diligence for male and female calves could be beneficial for all calf care providers.

Another factor associated with poorer feeding practices for male calves was length of stay on the dairy farm; producers who kept calves for 7 to 10 d were less likely to differ in their feeding practices between males and females compared with male calves before 7 d old. Those producers keeping male calves beyond 10 d were also numerically less likely to use differential feeding practices between males and females, but the relationship was not statistically significant ($P = 0.09$). Producers keeping calves longer are likely motivated to prevent male calf morbidity, as evidenced by a recent focus group study, where a producer suggested good neonatal care of male calves was “a big benefit. Because we don’t want to have to deal with sick calves” (Wilson et al., 2021). In a series of papers evaluating the effect of age (14 vs. 28 d) at transport on hematological and production parameters, Marcato et al. (2022a,b) concluded that older calves benefited from improved immune responses, health, and growth. One way of encouraging producers to keep calves longer is by regulating the minimum age of transport, for example, as has been done in the European Union, which requires calves to be a minimum of 14 d (European Union, 2005). New amendments to Canadian requirements will also encourage producers to keep calves longer, as unweaned calves cannot be transported longer than 12 h, and calves 8 d of age or less cannot be marketed via auctions (Canadian Food Inspection Agency, 2019). Producers in our study were generally aware of these amendments, and some producers expressed it would be challenging to comply with the new requirements, especially in Atlantic Canada.

In our survey, 45% of producers sold most of their male calves directly to calf-rearing facilities, but auctions were also commonly used. This was similar to results from Ireland, where direct sales and auctions were both used by approximately 50% of dairy producers (Maher et al., 2021). Selling dairy calves through auction is associated with several welfare concerns, as recently reviewed by Creutzinger et al. (2021), who recommended moving toward more direct sale of calves from the dairy farm to calf-rearing facilities. Along with welfare benefits, direct sale of surplus calves affords the opportunity for communication between dairy producers and calf buyers. Of the 52% respondents who had received feedback from their calf buyers, 39% had used the information to change a management practice. Producers have previously reported that feedback from calf buyers encouraged them to provide healthy calves to retain their business relationship (Wilson et al., 2021). In our current study, most producers (63%) indicated they valued the opinion of calf buyers and raisers when deciding on new calf care practices. Future research is warranted to evaluate communication strategies between calf buyers and dairy producers to optimize nutritional, genetic, and health management strategies to improve calf welfare and productivity.
A low but notable proportion of respondents in our survey (13%) indicated that financial cost limited their ability to care for their male calves. This result is seemingly in contrast to recent findings suggesting that, regardless of marketing strategy, the high cost of rearing male dairy calves compared with their low selling price was frustrating for producers (Wilson et al., 2021). When producers in our survey were specifically asked about how financial incentives, disincentives, or baseline pricing would influence their male calf care, the response pattern suggested a financial incentive would be motivating. However, for all 3 pricing strategies, a similar proportion of producers agreed, were neutral, or disagreed about whether the strategy would motivate improved care. Studies evaluating economic incentives and disincentives in the dairy industry have found similar variation in producer preferences (Valeeva et al., 2007; Belage et al., 2019), suggesting that the success of using financial strategies to motivate better animal care depends on contextual differences and requires a tailored approach. Our results also suggest that, depending on the question, producers reported seemingly different perspectives on how economics related to male calf care. This could be influenced by how the question was asked, as few producers may have felt their care was “limited,” but that incentives could motivate them to provide “improved” care such as additional vaccines. Given that economics and male calf care may be sensitive topics for discussion, and farmers may not have wanted the results of this study to influence calf pricing, the responses may have also been affected by social desirability bias.

For the producers who suggested finances limit their care, improving the economic return on rearing male dairy calves could be beneficial. Research has shown crossbreeding with beef semen in dairy herds increases the market value of calves (Dal Zotto et al., 2009; Buczinski et al., 2021), so it was unsurprising that most dairy producers (73%) in our survey reported using beef semen to increase male calf profitability. Despite this opportunity, 18% of producers agreed with euthanizing male calves when selling prices are low and 10% of respondents euthanized at least 1% of male calves. Within this 10% of producers, some may have been reporting the euthanasia of unhealthy calves. Furthermore, euthanasia of healthy male calves after birth does not inherently reduce their welfare, so this finding does not necessarily represent poor male calf care. Regardless, euthanasia of young calves is not readily accepted by the public or other industry stakeholders (Bolton and von Keyserlingk, 2021), and a qualitative evaluation of dairy farmers in Ireland found few support this practice (Maher et al., 2021). Together, these results suggest that producers perceive and act on the economic limitations of rearing male dairy calves differently but that improvement in profitability could motivate improved neonatal care and be a disincentive to euthanize male calves.

To evaluate strategies for influencing calf care improvements, we asked about how respondents viewed different stakeholder opinions, and we found the Code of Practice was highly valued by respondents. It is unclear whether producers value the advice of the Code of Practice for calf health, welfare, and productivity or see

![Figure 4. The importance respondents attributed to the opinions of different industry stakeholders regarding calf care practices, based on the question, “When deciding what calf care practices to use, how important do you consider the opinions of the following dairy industry stakeholders?” Respondents chose from a 5-level scale of importance, where “unimportant” and “of little importance” are collapsed into “unimportant,” and “important” and “very important” are collapsed into “important.”]
it as important from a regulatory and ethical perspective. Regardless, familiarity with the Code of Practice has been previously associated with improved calf care (Renaud et al., 2017), suggesting it is a fruitful avenue to promote adoption of best management practices for calves. Stakeholder opinions that were less valued were those of other dairy producers and the public, which could reflect a lack of direct relationship between these stakeholders and the day-to-day practice of calf rearing. The benefit of other dairy producer opinions may be underestimated by respondents, as peer learning with other dairy producers has been beneficial for improving antimicrobial use (Morgans et al., 2021) and biosecurity practices for Johne’s disease (Roche et al., 2015). The importance of public opinion regarding farm practices is debated, but it is clear that the public is concerned about calf-rearing practices, especially for surplus calves (Weary and von Keyserlingk, 2017). Ignoring public opinion on calf care practices puts the dairy industry at risk for losing societal trust (Renaud and Pardon, 2022).

Respondents highly valued the opinion of their herd veterinarian when considering their calf care practices, and most respondents indicated they would emphasize new calf care practices that promoted calf health and welfare. Other studies have noted an important role for herd veterinarians as trusted advisers on calf health (Sumner et al., 2020), so these findings were unsurprising. Our survey also identified a need for support in employee training, as half of producers who used employee labor for calves found the training process challenging. Recent studies have emphasized the need for improved and ongoing training and enhanced communication between employees and managers (Durst et al., 2018) and suggest an opportunity for veterinarians to take a more expanded role in the initial and ongoing training programs for calf care personnel (Sischo et al., 2019). A recent literature review also argued that external advisers (e.g., veterinarians) could play an important role in helping manage human resources on dairy farms, and emphasized a need for development of training materials and improvements in employer training and communication skills (Mills et al., 2021). Despite these findings, other evidence suggests that most (63%) dairy herd veterinarians do not routinely discuss calf health and performance with their clients (Renaud et al., 2018a). More research is warranted to identify ways to further engage veterinarians in expanding their health management services for male and female dairy calves.

Some limitations exist in generalizing these results due to a low response rate and potential for selection bias. Although recommended practices were used to increase response rate, including survey piloting, using a clear and simple design, and offering incentives, response rate remained low (Boynton, 2004). The length of the survey was likely an important limitation and may have resulted in response drop-off, as approxi-

![Figure 5. The importance respondents attributed to different characteristics of calf care practices, based on the question, “If you were considering adopting a new calf care practice, how important would you consider the following characteristics of the new practice?” Respondents chose from a 5-level scale of importance, where “unimportant” and “of little importance” are collapsed into “unimportant,” and “important” and “very important” are collapsed into “important.”](image-url)
mately 80 respondents (depending on the question) did not answer the calf-specific questions after starting the survey. Despite this, the response rate was comparable to that for a previous Canadian survey on calf management, which found similar volumes of milk fed in the neonatal period and a similar proportion of herds using waste milk (Medrano-Galarza et al., 2018). Our sample likely overrepresented freestall barns, as approximately 27% of respondent herds used tiestall barns. This is a lower proportion compared with Canadian farms, where approximately 58% and 45% of farms in Ontario and Atlantic Canada use tiestalls, respectively (Agriculture and Agri-Food Canada, 2020). Furthermore, respondents reported a median (interquartile range) milk production of 10,638 kg per 305-d lactation (9,657 to 11,500 kg), which is higher than other estimates of Canadian freestall and tiestall herds that report means of approximately 9,200 to 9,500 kg (Villetta Robichaud et al., 2019a,b). Despite these differences, the age, farm role, and education level of respondents was similar to those in a recent survey of Canadian dairy producers (Van Schyndel et al., 2019). Taken together, these data suggest a selection bias for survey respondents who adopt a progressive style of dairy farming, use more modern barn designs, and have increased productivity. The effect of this selection on calf treatment practices is unclear because farmers implement calf care practices based on complex factors beyond productivity and herd size, including previous experiences, social pressures, and practical farm considerations (Wilson et al., 2021). Larger farms may have more dedicated staff for calf care, which could improve general calf care (Sischo et al., 2019) and may carry over to the male calves. Survey responses may also have been influenced by social desirability bias to report good care of male calves, especially given the recent focus in Canada on surplus calves and calf transport due to changing regulations. To attempt to deliver the survey to all potential respondents, it was advertised via post and e-mail and through social media, and anonymity of the results was emphasized. Further, external validity of the results is supported by a recent Irish survey evaluating dairy producer perspectives on male dairy calves, which found similarities in how dairy producers market their surplus calves and value calf welfare (Maher et al., 2021).

CONCLUSIONS

This survey provides descriptive and comparative information on male and female dairy calf feeding practices, information about male calf transport and marketing, and producer perspectives on male calves and possible opportunities for influencing calf care improvements. Although most practices were similar between male and female calves, males were fed lower volumes of milk in the first 3 wk of life and were more likely to be fed raw, unsalable milk. Female producers and those who kept male calves on their farm beyond 7 d of age were less likely to use discrepant care practices for male and female calves. Most producers sold their male calves before 10 d of age, and 1% euthanized the majority of male calves. Economic limitations were infrequently reported as a barrier to male calf care, and producers most frequently thought a financial incentive (rather than baseline pricing or a disincentive) would motivate improved care. Furthermore, producers may be motivated to improve calf care practices by their calf buyer, the Code of Practice, and the guidance of their herd veterinarian. This information suggests dairy producers generally value male calves and can be influenced by various industry stakeholders and pricing strategies to improve their calf care.

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