ABSTRACT

On-farm euthanasia is complicated in that farmers have to make the decision to end the life of an animal they are caring for. Studies have shown that some culling decisions are made too late, which results in animal welfare issues. However, information about on-farm euthanasia methods and the decision process leading to the euthanasia of an animal is limited. Additionally, emotions and feelings are involved in the decision and the act of euthanasia. The objectives of this study were to describe current practices related to on-farm euthanasia performed by Canadian dairy farmers and to assess the emotions and complex feelings surrounding the act. A cross-sectional study design was used to gather this information through an online questionnaire completed exclusively by Canadian dairy farmers. Data were analyzed descriptively using frequencies, and associations between the participants’ characteristics and their practices and emotions regarding on-farm euthanasia were assessed using logistic regression models. A total of 479 dairy farmers from 5 provinces answered the survey. The most commonly used primary method of on-farm euthanasia was a firearm (>70%). Unacceptable euthanasia methods, such as standard 0.22-caliber long rifle for adult cows or no adjunct method following the use of captive bolt, were used by 25%, 18%, and 58% of the participants for calves, replacement animals, and dairy cows, respectively. Ninety-four percent of the participants reported that the farm owner was the person who always or often made the euthanasia decisions. Additionally, 32% of the participants reported that the veterinarian always examined the animal before performing euthanasia, 51% reported at least one person received training to perform euthanasia, and 16% reported having a decision tree for euthanasia. Some participants (17%) were troubled with the responsibility for ending the life of their animals, and 19% perceived other people on the farm to be uncomfortable with performing euthanasia. Half of the participants reported that people performing euthanasia on the farm felt at least one related painful emotion or complex feeling, and half reported they had at least one reason to feel anxiety or unease concerning euthanasia. The results of this study showed gaps such as the limited use of acceptable euthanasia methods and decision trees by Canadian dairy farmers, low availability of on-farm training for euthanasia, and variable involvement of veterinarians.

Key words: dairy farm, euthanasia method, emotion, feeling, end-of-life responsibility

INTRODUCTION

Euthanasia is the act of ending the life of an animal to relieve its pain and suffering. The end-of-life management of dairy cows presents several challenges. Timely culling decisions are of the utmost importance, and on-farm euthanasia is sometimes the only humane option (Stojkov et al., 2018). For example, in a study of culled dairy cows arriving at slaughterhouses in Alberta, Canada, almost half (n = 78/172) were considered compromised or unfit for transport upon arrival (Heuston, 2017). Such findings emphasize the need for better end-of-life decisions for culled dairy cows. Following similar observations in the United States (Vogel et al., 2018), recommendations were made for euthanizing animals in a timely manner, which implies on-farm euthanasia (Walker et al., 2019). Despite recommendations to make euthanasia plans with specific criteria to support decision-making (Turner and Doonan, 2010), studies report that work remains to be done to understand the constraints surrounding the full scope of euthanasia (Heuston, 2017; Walker et al., 2019; Edwards-Callaway et al., 2022). The National Farm Animal Care Council (NFACC) developed the Canadian Code of Practice for the Care and Handling of Dairy Cattle (NFACC, 2009), which
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offers guidelines for the care of farm animals, including the use of acceptable euthanasia methods. These recommended practices are also incorporated into the Dairy Farmers of Canada’s dairy quality assurance program, the proAction Initiative (Dairy Farmers of Canada, 2017). Such standards are similar to the American Veterinary Medical Association guidelines (Leary et al., 2020). In brief, they outline that the chosen euthanasia method should cause the animal the least possible pain and stress and that death must be confirmed (NFACC, 2009). The acceptable methods for on-farm euthanasia of cattle are gunshot (free bullet); a penetrating captive bolt (PCB) followed by pithing, exsanguination, or cardiac puncture; or fatal injection with barbiturates, which must be performed by a licensed veterinarian. A nonpenetrating captive bolt (NPCB) followed by exsanguination was also considered an acceptable method but only for bovines under 181 kg (NFACC, 2013, 2017).

Firearms, most commonly 0.22-caliber rifles, were reported to be the principal euthanasia method used in the United States (86% in 2005; Fulwider et al., 2008). In Australia, regulations restrict the ownership and use of firearms, but more than two-thirds of farmers reported using them to euthanize their cattle. In the same study, the use of PCB guns was uncommon (3%), and blunt-force trauma for euthanasia of young calves (<24 h old) was still used in 9 to 31% of herds, with a greater percentage in larger herds (Beggs et al., 2015). In a 2015 survey, Canadian dairy farmers reported that the euthanasia method most commonly used was firearms (>50%), while 7% of the participants still used blunt-force trauma (Roche et al., 2020). Other management information around on-farm euthanasia, such as the use of adjunct methods, confirmation of unconsciousness and death, the decision-making process, and related training, were not assessed. Moreover, factors influencing euthanasia management and decisions have not been identified, although they could help the dairy industry and its stakeholders develop targeted training and support.

Animal caretakers have been suggested to be particularly at risk of suicide (Bayingana et al., 2006), and the stress related to animal caretakers’ work, coupled with the lack of control over several elements of their daily lives, has been shown to lead to psychological distress (reviewed by Scotney et al., 2015). The impact of euthanasia on animal caretakers has also been observed for multiple animal species and in multiple professions. For example, it has been associated with a bereavement process, compassion fatigue, burnout, and suicide of veterinarians (Lamothe, 2005; Bartram et al., 2009; Shugart, 2021). Similar results were found for biomedica
cal research staff (Scotney et al., 2015), livestock owners (Román-Muñiz et al., 2021), and shelter workers (Anderson et al., 2013; Hoy-Gerlach et al., 2021).

In Canada, even though mental health support and resources are in place in multiple provinces (Fairles et al., 2020), 90% of farmers included in a cross-sectional survey were classified as possibly or probably having anxiety, while 49% possibly or probably experienced depression (Jones-Bitton et al., 2020). Although the mental health issues that farmers are facing are increasingly being studied and addressed, limited information exists on how performing on-farm euthanasia or making the decision to end the life of one of their animals affects farmers. Recently, euthanasia of dairy cattle cared for by dairy workers in the United States has emerged as one of the factors responsible for the deterioration of the workers’ mental health (Edwards-Callaway et al., 2022).

This impact on mental health can have important repercussions because the decision to euthanize an animal on a dairy operation has been shown to be influenced by animal factors (e.g., animal welfare and prognosis), human factors (e.g., individual feelings and morality), and operation factors (e.g., costs and carcass disposal). Moreover, the human factors, especially the emotional well-being of the animal caretakers, were particularly important in the process of decision-making for euthanasia (Wagner et al., 2020).

Basic emotions, including fear, anger, sadness, joy, surprise, and disgust (Ekman, 1992), are physically felt through vagal reactivity as a response to external stimuli when universal human needs are being met or left unmet (Porges, 2009). This response can result, for example, in increased heart rate, stomachache, trembling, crying, or anxiety. Emotions are considered to be universal because they are triggered by specific neural networks (Panksepp, 2010). Complex feelings, such as guilt, mourning, depression, and isolation, have been defined as emotions mixed with interpretation (Ekman, 1992). The bereavement process has been described in depth (Bowlby, 1982) and has been investigated with regard to the loss of a companion animal (Gerwolls and Labott, 1994; Lavergne, 2003). Veterinarians practicing with companion animals experience the same bereavement process, as well as complex feelings (Lamothe, 2005). It is unclear, however, how deciding on or performing euthanasia affects dairy farmers emotionally.

The objectives of the current study were to describe the current on-farm euthanasia methods used on Canadian dairy farms, to identify factors associated with the adoption of different practices, and to assess the painful emotions and complex feelings connected with euthanasia performed by dairy farmers.
MATERIALS AND METHODS

Study Design and Questionnaire Development

A cross-sectional study of the Canadian dairy-farming industry is reported following the STROBE guidelines (O’Connor et al., 2016). The study was conducted between March and May 2019, using an online questionnaire developed collaboratively by the research team. The objective was to collect information about the farm and participant characteristics; on-farm euthanasia decisions, management, and methods; and painful emotions and complex feelings related to euthanasia. The questionnaire consisted of 46 questions formatted as follows: 26 multiple-choice questions with single-answer options (9 had an open-ended text-entry option), 7 multiple-choice questions with multiple-answer options (all had an open-ended text entry option), 9 matrix tables (7 had an open-ended text-entry option), and 4 open-ended text entry questions.

The questions addressing the emotions related to performing euthanasia were developed based on previous work carried out among companion animal veterinarians (Lamothe, 2005). These questions were intended to evaluate the presence of painful emotions and complex feelings (Ekman, 1992) before, during, and after euthanasia by assessing the physical and physiological phenomena underlying these emotions when farmers had to euthanize cattle in their care.

Questions were written in French and translated into English by a registered translator and validated by bilingual research team members (n = 2). Questions were then tested by a group of 15 dairy farmers and then finalized. A replacement animal was defined as a postweaning heifer, pregnant or not, that has not yet calved, and calf was defined as an animal from birth to weaning. Both versions of the questionnaire are available online (English, http://hdl.handle.net/1866/26726; French, http://hdl.handle.net/1866/26725). Ethics approval for using human participants was obtained from the Comité d’éthique de la recherche en santé from the Université de Montréal (CERSES 19-022D), and the questionnaire was formatted for online use (SurveyMonkey).

Study Population and Sampling Strategy

All Canadian dairy farmers were invited twice to participate in the survey on the Dairy Farmers of Canada web application (DairyExpress+/ExpressLaitier+) on March 29 and April 29, 2019. Dairy farmers from Québec were also invited through the newsletter of Les Producteurs de Lait du Québec and on the website of their DHIA on March 29 and April 12, 2019. The invitation specified that the survey was available to be completed online until May 14, 2019, and completing the full survey would take approximately 25 min. No sample size was calculated, as this was an exploratory study and having as many participants as possible was ideal, but 3 to 5% of Canadian dairy owners (n = 311–518) were expected to answer based on similar surveys administered to dairy farmers in recent years (Denis-Robichaud et al., 2016; Watters, 2019; Roche et al., 2020).

Statistical Analysis

Data were extracted from the online survey platform and stored in Excel (Microsoft). Statistical analyses were performed using R (version 4.0.0; R Core Team, 2015). The answers from all participants were used, and the descriptive statistics were calculated for each question with the exclusion of missing values. The geographical location of the farms was categorized as Western provinces (British Columbia, Saskatchewan, and Manitoba), Ontario, and Québec. The farms’ quota (daily butterfat production in kilograms) was used as a proxy for farm size and was categorized using the median category as small (≤75 kg) or large (>75 kg). The methods of euthanasia used on-farm were reported as primary and adjunct methods in the questionnaire and then categorized as acceptable or not, following the NFACC guidelines (NFACC, 2009). For this study, acceptable methods of euthanasia for calves and replacement animals, regardless of their weight, were gunshot (no adjunct method required); PCB followed by pithing, exsanguination, or cardiac puncture; and NPCB followed by exsanguination. Acceptable methods for adult dairy cows were gunshot (excluding the use of a standard 0.22-caliber long rifle) and PCB followed by pithing, exsanguination, or cardiac puncture (NFACC, 2009). Although the intravenous administration of saturated solutions of potassium or magnesium is considered an appropriate adjunct method following PCB in beef cattle and veal (NFACC, 2013, 2017), it was not stated as acceptable for dairy cattle when the analyses were conducted and was thus considered unacceptable (NFACC, 2009). Given that the survey was carried out with dairy farmers, injectable barbiturates or other approved euthanizing agents were not included in the acceptable methods because they are only acceptable if administered by a licensed veterinarian. Any other methods were considered unacceptable.

As a first step, the frequency for each variable was calculated, as this was an exploratory study and having as many participants as possible was ideal, but 3 to 5% of Canadian dairy owners (n = 311–518) were expected to answer based on similar surveys administered to dairy farmers in recent years (Denis-Robichaud et al., 2016; Watters, 2019; Roche et al., 2020).
and their practices and perceptions regarding on-farm euthanasia, 12 outcomes of interest were selected by the research team. These outcomes were all categorical variables but were coded as binary variables (logical grouping) for assessment in logistic regression models (Table 1).

For each of the outcome variables, univariate models were first built to assess the association with each of the 7 independent variables tested. These variables were farm characteristics (geographical region, type of housing, and daily milk production), participant characteristics (gender and age), emotions and feelings about the responsibility for ending an animal’s life, and perceived comfort of other people with the responsibility to euthanize animals on the farm. The participants’ feelings about the responsibility for ending an animal’s life were categorized as comfortable with the responsibility, having no problem with the responsibility, being troubled (including troubled and very troubled) with the responsibility, and preferring not to answer. The perceived comfort of other people with the responsibility to euthanize animals on the farm was categorized as comfortable (perceived the other people were not or almost never bothered by it), uncomfortable (perceived the other people were quite often bothered by it), did not know how the other people felt about it, or did not delegate to other people on the farm.

Multivariable logistic regression models based on complete cases were then created with a regressive elimination approach, using a causal diagram developed by the research team and a P-value < 0.16 (Sauerbrei and Royston, 1999). The fit of the logistic regression models was assessed using the Hosmer and Lemeshow goodness-of-fit test (ResourceSelection package), and comparisons between categories of variables included in the final models were performed using the multiple comparison test (Tukey contrasts; multcomp package). As multiple models were assessed, the final P-values were adjusted using the Benjamini and Hochberg approach (stats package; Jafari and Ansari-Pour, 2019) to minimize type-I errors.

For open-ended questions, a thematic analysis was carried out (O’Cathain and Thomas, 2004). Briefly, the answers provided by the respondents were read, and themes describing the content were formulated. Responses were then coded manually, and the number of the participants who mentioned each theme was extracted. When a theme was not considered self-explanatory, an example citation was used to illustrate it.

**RESULTS**

A total of 479 dairy farmers, representing 4.6% of the 10,371 dairy farms in 2019 (Agriculture and Agri-Food...
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Table 2. Demographic characteristics of participants and their farm characteristics in an online questionnaire on euthanasia management and practices on Canadian dairy farms and their distribution by geographical region

| Characteristic                  | Global | Western provinces | Ontario | Québec | P-value |
|--------------------------------|--------|-------------------|---------|--------|---------|
| Farm Geographical region       |        |                   |         |        |         |
| Québec                         | 242    | 50.8              | 125     | 65.1   | 85      | 35.7   | <0.01 |
| Ontario                        | 192    | 40.3              | 85      | 43.1   | 76      | 31.7   |       |
| Western provinces              | 42     | 8.9               | 15      | 7.8    | 6       | 4.3    |       |
| Type of housing                |        |                   |         |        |         |
| Freestall                      | 252    | 53.2              | 125     | 65.1   | 85      | 35.7   | <0.01 |
| Tie stall                      | 222    | 46.8              | 77      | 34.9   | 68      | 24.3   |       |
| Number of employees            |        |                   |         |        |         |
| 0                              | 54     | 11.4              | 7       | 17.5   | 26      | 13.7   | 20     | 8.3   | <0.01 |
| 1                              | 159    | 33.7              | 1       | 2.5    | 82      | 43.1   | 76     | 31.7  |       |
| 2                              | 132    | 28.0              | 13      | 32.5   | 41      | 21.6   | 78     | 32.5  |       |
| ≥3                             | 127    | 26.9              | 19      | 47.5   | 41      | 21.6   | 66     | 27.5  |       |
| Daily production (quota)       |        |                   |         |        |         |
| Small (≤75 kg/d)               | 212    | 44.9              | 8       | 19.5   | 72      | 38.5   | 131    | 54.1  | <0.01 |
| Large (>75 kg/d)               | 260    | 55.1              | 33      | 80.5   | 115     | 61.5   | 111    | 45.9  |       |
| Participant Gender             |        |                   |         |        |         |
| Men                            | 365    | 80.4              | 30      | 78.9   | 159     | 86.9   | 176    | 75.9  | <0.01 |
| Women                          | 89     | 19.6              | 8       | 21.1   | 24      | 13.1   | 56     | 24.1  |       |
| Age, yr                        |        |                   |         |        |         |
| ≤35                            | 125    | 27.1              | 6       | 15.8   | 50      | 26.7   | 69     | 29.4  | <0.01 |
| 36-45                          | 112    | 24.3              | 10      | 26.3   | 38      | 20.3   | 64     | 27.2  |       |
| 46-55                          | 140    | 30.4              | 6       | 15.8   | 63      | 33.7   | 71     | 30.2  |       |
| >55                            | 84     | 18.2              | 16      | 42.1   | 36      | 19.3   | 31     | 13.2  |       |

1Western provinces included British Columbia, Saskatchewan, and Manitoba.

More than half of the farms were freestall barns, produced more than 75 kg of daily butterfat (quota), and had 2 or more hired employees (Table 2). Ninety-three percent of the farms (446 of 478 farms) had Holstein cows as their primary breed. On average, the farms in the study had 101 lactating cows (median = 72, range = 1–750), 64 replacement animals (median = 45, range = 0–700), and 22 calves (median = 14, range = 0–300).

Participant and farm characteristics differed by geographical region (Table 2).

Eighty percent of the participants were men, and the ages of the farmers varied (Table 2). Sixty-nine percent of the participants were comfortable (n = 151/335; 45.0%) or had no problem (n = 80/335; 23.9%) with the responsibility for ending the life of their animals, and 24% of the participants were not comfortable with this responsibility (n = 79/335); the remaining participants preferred not answering (n = 25/335; 7.5%). Of the participants who delegated the act of euthanasia (n = 212/335; 63.3%), 68.4% (n = 145/212) perceived other people performing euthanasia on their farm to be comfortable, 18.9% (n = 40/212) perceived them being uncomfortable with the task, and 12.7% (n = 27/212) did not know how comfortable other people were regarding the matter.

The number of calves, replacement animals, and dairy cows that died on farm without being euthanized in the year preceding the study averaged 6 (median = 4, range = 0–56), 1 (median = 0, range = 0–12), and 3 (median = 2, range = 0–50), respectively. Overall, the proportion of participants reporting that more calves died than were euthanized in the last year (n = 289/401; 72.1%) was greater (P < 0.01) than the proportion of participants reporting this difference for replacement animals (n = 113/379; 29.8%) and cows (n = 64/392; 16.3%).

The most commonly used primary method of on-farm euthanasia was firearm for calves (73.0%), heifers (80.7%), and cows (82.8%; Table 3). Only the daily production (quota) was associated with the odds of using a firearm as the primary method to euthanize dairy cows. Indeed, farms with large daily production (>75 kg/d) were more likely to use a firearm as the primary method to euthanize dairy cows (P < 0.01).
kg/d) had lower odds of using a firearm than farms with small daily production (≤75 kg/d; odds ratio = 0.42, 95% CI = 0.20–0.84; P-value = 0.04). The proportion of farmers using an acceptable method for calves, replacement animals, and adult dairy cows was 74.8% (n = 166/222), 82.5% (n = 179/217), and 41.8% (n = 112/268), respectively. The participants classified as using an unacceptable method were using a 0.22 rifle to euthanize adult cows (n = 114), a PCB without an accepted adjunct method (calves: n = 21; replacement animals: n = 19; cows: n = 19), an NPCB in adult cows (n = 4) or without an accepted adjunct method (calves: n = 4; replacement animals: n = 3), or another primary method (calves: n = 31; replacement animals: n = 16; cows: n = 19). The most common other primary method mentioned by the participants was a hammer (various types; n = 19).

Almost all participants who reported performing euthanasia on farm also reported always confirming the animal was unconscious and not responsive after applying the primary method of euthanasia (n = 280/289; 96.9%) and confirming the animal’s death (n = 278/287; 96.9%). In both cases, participants from Québec confirmed unconsciousness and death less often (94.0% and 94.7%, respectively) than participants from Ontario (99.2% and 98.5%, respectively) and Western provinces (100% in both cases; P < 0.01).

Most participants identified the farm owners as the person who almost always or often made the final decision to euthanize an animal on the farm (n = 382/408; 93.6%). In some cases, a veterinarian (n = 9/408; 2.2%) or an employee (n = 5/408; 1.2%) made the decision, and 2.9% (n = 12/408) of the participants reported no one person almost always or often made the euthanasia decisions on the farm. The farm owner was identified as the person almost always or often performing the euthanasia by 63.0% (n = 255/405) of the participants; other responses included veterinarian (n = 86/405, 21.2%), employee (n = 24/405, 2.0%), and no one person (n = 56/405, 13.8%). Participants from Québec were less likely than participants from Ontario to report that the owner often or always had the task of euthanizing animals on the farm (Québec: n = 111/218, 50.9%; Ontario: n = 125/162, 77.2%; odds ratio = 2.8 [1.7–4.8]; P < 0.01; Figure 1).

Thirty-one percent (n = 128/411) of the participants reported animals were almost always examined by a veterinarian before being euthanized. Participants from Québec were more likely to almost always have a veterinarian examine an animal before euthanization than

### Table 3. Primary and adjunct method of euthanasia used on Canadian dairy farms for calves, replacement animals, and dairy cows, as reported in an online questionnaire on euthanasia management and practices

| Primary method | Adjunct method | Calves (n = 222) | Replacement animals (n = 217) | Dairy cows (n = 268) |
|----------------|----------------|-----------------|-------------------------------|---------------------|
|                | n               | %               | n                             | %                  |
| Gunshot        | 162             | 73.0            | 175                           | 80.7               | 222               | 82.8 |
| 0.22 rifle     | 130             | 93              | 111                           | 54.9               | 21                | 35   |
| 0.22 magnum rifle | 21              | 28              | 35                            |                    |                   |      |
| 12-caliber shotgun | 6               | 10              | 15                            |                    |                   |      |
| Other          | 13              | 28              | 44                            |                    |                   |      |
| Not specified  | 12              | 16              | 14                            |                    |                   |      |
| Penetrating captive bolt | 24              | 10.8            | 22                            | 10.1               | 23                | 8.6  |
| Exsanguination | 1               | 1               | 1                             | 1                  | 1                 | 1    |
| Pithing        | 2               | 2               | 2                             |                    |                   |      |
| Intravenous potassium | 17              | 15              | 17                            |                    |                   |      |
| Second captive bolt | 1              | 1               | 1                             | 1                  | 1                 | 1    |
| None           | 3               | 2               | 2                             |                    |                   |      |
| Not specified  | 3               | 2               | 2                             |                    |                   |      |
| Nonpenetrating captive bolt | 5              | 2.2             | 4                             | 1.8                | 4                 | 1.5  |
| Exsanguination | 1               | 1               | 1                             |                    | 1                 | 1    |
| Pithing        | 1               | 1               | 1                             |                    |                   |      |
| Intravenous potassium | 3              | 2               | 2                             |                    |                   |      |
| Second captive bolt | 1              | 1               | 1                             |                    |                   |      |
| None           | 3               | 2               | 2                             |                    |                   |      |
| Not specified  | 3               | 2               | 2                             |                    |                   |      |
| Other          | 31              | 14.0            | 16                            | 7.4                | 19                | 7.1  |

1Calves were defined as bovine from birth to weaning.
2Replacement animals were defined as postweaning heifers, pregnant or not, that have not yet calved.
3Adjunct methods reported by these participants were not detailed, as the Canadian Code of Practice for the Care and Handling of Dairy Cattle (NFACC, 2009) does not require one.
4Methods considered unacceptable (calves: 25.2%, n = 56/222; replacement animals: 17.5%, n = 38/217; dairy cows: 58.2%, n = 156/268).
participants from the Western provinces. Moreover, women were more likely than men to almost always have their veterinarian examine the animal before euthanasia, and participants that felt troubled about the responsibility for ending the life of their animals were also more likely to almost always consult their veterinarian compared with those who were comfortable with this responsibility (Table 4). However, 24% (n = 96) of the participants reported animals were never or rarely examined before being euthanized. Their reasons were mainly that they were qualified to make the decision themselves or that the decision was obvious (n = 42; e.g., “I am experienced enough to recognize when an animal is not going to survive or is suffering”). Other reasons included not wanting to pay to be told an animal needed to be euthanized (n = 17; e.g., “The value of the animals is too low and the cost of the veterinarian too expensive to kill them anyway”), most of their euthanized animals were male calves (n = 2), and their veterinarian was too far or unavailable (n = 6).

The majority of participants reported they would move animals outside barns before euthanizing them whether they were lame (n = 141/251; 56.2%) or not (n = 165/244; 67.6%). However, 68% of them would not move downer cows to euthanize them (n = 225/333).

Eighty-four percent of the participants reported they did not use (n = 246/358; 68.7%) or were uncertain they used (n = 56/358; 15.6%) a decision tree or diagram to guide their decision concerning euthanizing animals. Two-thirds reported that their farm had a written document describing the method of euthanasia it used (n = 239/360) and that at least one person on the farm other than the veterinarian or deadstock service provider was trained to perform euthanasia (n = 147/290; 50.7%).

Training to perform euthanasia was mainly given by the farm’s veterinarian (n = 85/147; 57.8%) or another person on the farm (n = 27/147; 18.4%). Notably, some participants considered a firearm-handling course as training to perform euthanasia (n = 7). The training received by on-farm personnel was theoretical only (n = 50/147; 37.3%), practical only (n = 55/147; 41.0%), or both theoretical and practical (n = 29/147; 21.7%).

Almost half the participants (n = 147/362; 48.3%) were interested in receiving training on diverse topics related to euthanasia. Participants could choose more than one topic, and the greatest interest was shown for the presentation of acceptable euthanasia methods and protocol (n = 71/362; 19.6%); the laws, regulations, and requirements governing animal well-being (n = 47/362; 13.0%); and specific training on the use of a captive bolt (n = 40/362; 11.0%). Participants from Québec were more likely than participants from the other geographical regions to have interest in at least one topic of training; participants ≤35 yr old were more likely than participants between 46 and 55 yr
old to express such interest; and participants who felt troubled regarding the responsibility for ending the life of their animals were more likely to have that interest than those who were comfortable with this responsibility (Table 5).

Half of the participants (n = 103/201; 51.2%) reported that people performing euthanasia on the farm had at least one related painful emotion or complex feeling (Table 6). The participants who felt troubled about the responsibility for ending the life of their animals reported painful emotions or complex feelings more often than those who felt comfortable with this responsibility (Table 7). Women were more likely than men to report at least one painful emotion or complex feeling, as were participants from smaller farms (75 kg of quota or less) compared with participants from larger ones (more than 75 kg; Table 7). Similarly, 51.9% (n = 168/324) of the participants reported they had at least one reason to feel anxiety or unease concerning euthanasia, as a greater proportion of participants feeling troubled by

Table 4. Odds ratio obtained from a logistic regression model assessing factors associated with almost always having a veterinarian examining an animal before euthanasia by participants in an online questionnaire on euthanasia management and practices on Canadian dairy farms (n = 319)

| Variable                                      | No. included | Unadjusted proportion veterinary examination, % | Odds ratio (95% CI) | P-value2 |
|-----------------------------------------------|--------------|-------------------------------------------------|---------------------|----------|
| Geographical region                           |              |                                                 |                     |          |
| Québec                                        | 163          | 35.0                                            | Referent            |          |
| Ontario                                       | 133          | 25.6                                            | 0.74 (0.42–1.29)    | 0.30     |
| Western provinces                             | 23           | 13.0                                            | 0.27 (0.06–0.89)    | 0.05     |
| Gender                                        |              |                                                 |                     |          |
| Men                                           | 252          | 23.8                                            | Referent            |          |
| Women                                         | 67           | 50.7                                            | 3.03 (1.67–5.54)    | 0.01     |
| Daily production (quota)                      |              |                                                 |                     |          |
| Small (≤75 kg/d)                              | 150          | 34.7                                            | Referent            |          |
| Large (>75 kg/d)                              | 169          | 24.9                                            | 0.64 (0.38–1.08)    | 0.11     |
| Feelings about the responsibility for ending the life of their animals | |                                                 |                     |          |
| Troubled                                      | 76           | 39.6                                            | Referent            |          |
| No problem                                    | 77           | 29.9                                            | 0.87 (0.42–1.80)    | 0.71     |
| Comfortable                                   | 145          | 20.7                                            | 0.24 (0.23–0.86)    | 0.03     |
| Preferred not to answer                       | 21           | 57.1                                            | 2.39 (0.86–6.87)    | 0.11     |

1The numbers include only participants who answered all questions in the model (complete case).

2Adjusted P-value for multiple comparisons with Tukey contrasts within the model and the Benjamini and Hochberg approach among all tested models.

Table 5. Odds ratio obtained from a logistic regression model assessing factors associated with interest for at least one training topic related to euthanasia for participants in an online questionnaire on euthanasia management and practices on Canadian dairy farms (n = 335)

| Variable                                      | No. included | Unadjusted proportion interest in training, % | Odds ratio (95% CI) | P-value2 |
|-----------------------------------------------|--------------|------------------------------------------------|---------------------|----------|
| Geographical region                           |              |                                                 |                     |          |
| Québec                                        | 171          | 56.7                                            | Referent            |          |
| Ontario                                       | 139          | 31.7                                            | 0.37 (0.22–0.61)    | <0.01    |
| Western provinces                             | 25           | 32.0                                            | 0.35 (0.12–0.88)    | 0.05     |
| Age, yr                                       |              |                                                 |                     |          |
| ≤35                                           | 97           | 56.7                                            | Referent            |          |
| 36–45                                         | 81           | 45.7                                            | 0.58 (0.30–1.10)    | 0.23     |
| 46–55                                         | 98           | 35.7                                            | 0.42 (0.22–0.77)    | 0.01     |
| >55                                           | 59           | 37.3                                            | 0.52 (0.25–1.05)    | 0.15     |
| Feeling about the responsibility for ending the life of their animals | |                                                 |                     |          |
| Troubled                                      | 79           | 63.3                                            | Referent            |          |
| No problem                                    | 80           | 38.8                                            | 0.40 (0.20–0.80)    | 0.07     |
| Comfortable                                   | 151          | 39.1                                            | 0.37 (0.20–0.67)    | 0.03     |
| Preferred not to answer                       | 25           | 36.0                                            | 0.32 (0.12–0.84)    | 0.22     |

1The numbers include only participants who answered all questions in the model (complete case).

2Adjusted P-value for multiple comparisons with Tukey contrasts within the model and the Benjamini and Hochberg approach among all tested models.
the responsibility for ending the life of their animals reported anxiety or unease than participants comfortable with this decision (Table 8). Very few farmers (n = 7) were reluctant to consider euthanasia as a priority topic.

**DISCUSSION**

The results from the present study describe the management practices related to on-farm euthanasia and the dairy farmers’ emotions and complex feelings when performing euthanasia or deciding to perform euthanasia. The participants were not fully representative of the country, as the Western provinces were underrepresented and the Maritimes were not represented at all (Agriculture and Agri-Food Canada, 2019). This lack of representation was likely due to the province-specific advertisements and should be addressed in future research projects. The participants were also proportionally from larger farms and farms with more freestall barns than the Canadian dairy industry averages in 2019 (Agriculture and Agri-Food Canada, 2019). For these reasons, interpretation of the study results should be done with caution. However, some of our findings were similar to a previous nationally representative study (Roche et al., 2020). Interpretation of the present results needs to account for euthanasia being a sensitive topic as well as a socially controversial issue. Discomfort related to the topics covered in the survey might explain why many respondents skipped questions. Such discomfort

**Table 6.** Painful emotions and complex feelings identified by respondents as symptoms related to euthanasia, experienced by the people carrying out euthanasia on Canadian dairy farms who reported being comfortable or had no problem with the responsibility for ending the life of their animals (comfortable) versus those who reported being troubled or very troubled (troubled) by this responsibility in an online questionnaire on euthanasia management and practices

| Item                                                                 | Comfortable | Troubled |
|----------------------------------------------------------------------|-------------|----------|
| At least one symptom²                                               | 54 (38.3)   | 43 (87.8)|
| Difficulty seeing an animal die                                      | 20 (23)     |           |
| Stress or anxiety before euthanizing an animal                       | 18 (17)     |           |
| Anxiety or fear of not being successful on the first attempt         | 15 (18)     |           |
| Feelings of guilt                                                   | 14 (14)     |           |
| Irritability before or after euthanizing an animal                   | 13 (9)      |           |
| Crying or sadness                                                   | 10 (12)     |           |
| Stress or anxiety after euthanizing an animal                        | 6 (5)       |           |
| Feelings of disgust                                                 | 3 (9)       |           |
| Anxiety or fear about the animal’s reaction                         | 1 (5)       |           |
| Insomnia, nightmares, or sleep-related problems                     | 2 (0)       |           |
| Physical symptoms                                                   | 0 (2)       |           |
| No symptoms                                                         | 87 (61.7)   | 6 (12.2) |

²The numbers include only participants who answered both questions (complete case).

²Participants could choose more than one symptom.

**Table 7.** Odds ratio obtained from a logistic regression model assessing factors associated with experiencing at least one painful emotion and complex feeling related to performing euthanasia for participants on Canadian dairy farms (n = 326)

| Variable                                           | Unadjusted proportion experiencing symptoms, % | Odds ratio (95% CI) | P-value² |
|----------------------------------------------------|-----------------------------------------------|---------------------|----------|
| Gender                                             |                                              |                     |          |
| Men                                                | 257 (38.9)                                   | Referent            |          |
| Women                                              | 69 (72.5)                                    | 4.09 (2.31–7.49)    | <0.01    |
| Daily production (quota)                           |                                              |                     |          |
| Small (≤75 kg/d)                                   | 156 (53.8)                                   | Referent            |          |
| Large (>75 kg/d)                                   | 170 (38.8)                                   | 0.48 (0.08–0.80)    | 0.02     |
| Feeling about the responsibility for ending the life of their animals | |                     |          |
| Troubled                                           | 78 (83.3)                                    | Referent            |          |
| No problem                                         | 78 (38.5)                                    | 0.13 (0.06–0.27)    | <0.01    |
| Comfortable                                        | 146 (28.8)                                   | 0.08 (0.04–0.16)    | <0.01    |
| Preferred not to answer                            | 24 (54.2)                                    | 0.21 (0.07–0.60)    | 0.02     |

²The numbers include only participants who answered all questions in the model (complete case).

²Adjusted P-value for multiple comparisons with Tukey contrasts within the model and the Benjamini and Hochberg approach among all tested models.

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could also have resulted in participants not answering truthfully in some cases, thus introducing information bias. Previous studies have indicated that farmers are sensitive to criticism from society (Daghagh Yazd et al., 2019; Hagen et al., 2019; Jones-Bitton, 2020), and further research is needed to explore in greater depth why dairy farmers are reluctant to discuss this topic.

In the present study, 72% of the participants reported that more calves died without intervention than were euthanized on their farms; 30% and 16% participants respectively reported that more replacement heifers and adult cows died without intervention than were euthanized. This finding could be an indicator of suboptimal welfare, as animals that died without assistance were likely to have suffered (Walker et al., 2019). Many participants who rarely or never had their animal examined by a veterinarian before euthanasia mentioned they euthanized animals with obvious outcomes, which also suggests delayed euthanasia and potentially unnecessary suffering of animals with less obvious outcomes. Furthermore, some participants appeared to have eluded the theme of euthanasia by not answering some questions. They might have had difficulties reporting the real number of euthanasia they performed over a certain period of time, and it might have been easier for them to answer the exact number of animals that died.

Denial of death (Becker, 1997), a normal and healthy defense mechanism protecting humans from being too anxious about death, could at least partly explain this gap. Briefly, when a person is confronted with death, even death by euthanasia of an animal under their care, this denial stops operating momentarily, leaving the person in a state of increased anxiety (Lamothe, 2005). It is plausible that the participating farmers’ anxiety level increased when they were faced with questions about euthanasia, causing them to avoid certain questions and to have difficulty recalling the number of euthanasia cases that occurred on the farm.

In the present study, the main primary method of euthanasia used on farm by dairy farmers was firearms, which was similar to previous Canadian research (Roche et al., 2020). Only milk production (a proxy for farm size) was associated with the odds of using a firearm as the primary method of euthanasia, with small farms being more likely than large ones to use firearms. The use of firearms, however, remained the most common primary method for small and large farms, with more than 75% of the participants using firearms as their primary method in both groups. This finding could suggest that smaller farms have less access to or are less likely to seek alternative tools or training.

Of the participants performing on-farm euthanasia, more than half used a method of euthanasia for dairy cows that was unacceptable according to NFACC (2009) recommendations, while 25% and 18% of them used unacceptable methods for calves and replacement heifers, respectively. Similarly to farmers in the United States (Fulwider et al., 2008), 51% of the participants using firearms to euthanize adult dairy cows used 0.22-caliber rifles, despite this method being unacceptable. These rifles are not recommended because of poor penetration, deflection, and fragmentation of the bullet, as shown by tests done on a limited number of heads from a distance of 25 m (Baker and Scrimgeour, 1995; Leary et al., 2020). Communicating the limitation of this method to farmers is lacking and should be addressed by the industry.

The definition of calves in the present study included animals from birth to weaning. With weaning usually being around 7 wk of age in dairy heifers (Vasseur et
Moreover, fewer participants in Québec than in Ontario examined by a veterinarian before performing euthanasia. The provinces to almost always have their animals examined by a veterinarian in on-farm euthanasia. Participants from Québec and the other provinces was the involvement of veterinarians in the decision and act of on-farm euthanasia. An opportunity exists for veterinarians or other stakeholders to support the development of an on-farm decision tree to guide euthanasia decisions, as at least 69% of the participants did not use one. Such guidance could also help farmers make decisions early to minimize suffering.

Additionally, although two-thirds of the participants reported having a written document describing the method of euthanasia, almost half reported that none of the people euthanizing animals on the farm received prior training, and only a few participants showed interest in additional training on methods of euthanasia (n = 50/288; results not presented). Moreover, some of the participants who reported being trained said their training consisted of a firearm-handling course. The course information would need to be clarified, but it is unlikely a firearms course would address euthanasia methods.

Studies have identified psychological distress and mental health concerns in Canada and around the world (Lafleur and Allard, 2006; Hagen et al., 2019, 2022; Dolbec, 2021). For example, the higher level of suicide among farmers compared with the general population illustrates the level of suffering some agricultural workers experience (Lafluer and Allard, 2006). Painful emotions and psychological distress have been displayed by farm workers and other animal caretakers related to their responsibilities regarding the end of animals’ lives (Scotney et al., 2015; Hoy-Gerlach et al., 2021; Román-Muñiz et al., 2021), which is in line with the findings of the present study.

However, the assessment of emotions and complex feelings in this study was carried out differently than in previous research. Indeed, the present questionnaire was developed to discover the emotions and feelings around the farmer’s experience when deciding on or performing euthanasia. Our findings shed light on the painful emotions related to on-farm euthanasia, but additional research is necessary to understand how to mitigate them. For example, the impact of on-farm euthanasia training on the adoption of acceptable methods, on animal welfare, and on the farmers’ experience of painful emotion could be assessed. Additional research on the type of training is indeed necessary because, despite the training and explanatory documents provided to
farmers, compliance remained partial when assessed for other topics (Ritter et al., 2017; Farrell et al., 2021).

Canadian dairy farmers are increasingly exposed to animal welfare criteria through the Animal Care section of proAction, an on-farm excellence program coordinated by the Dairy Farmers of Canada (2017). It is not clear how this increased awareness of the possible suffering of their animals affects farmers’ empathy toward them and possibly their discomfort around euthanizing their animals. Determining the impact would require additional research. Such research could be combined with an assessment of the impact of an increased awareness without an accompanying improvement of knowledge and technical skills, which could, for example, lead to exacerbate discomfort and reluctance to perform euthanasia.

Offering support related to euthanasia and animal suffering to dairy farmers through veterinary service and industry initiatives could help decrease or alleviate painful emotions and complex feelings related to euthanasia. For example, a farmer may have difficulty deciding to euthanize a cow because of a difficult personal situation with relatives. In such a case, the farmer needs support to improve his or her mental health and to be able to make euthanasia decisions in a timely manner. Similarly, increased financial needs in a dairy farm may cause a farmer to send a cow to slaughter instead of euthanizing it. These painful emotions or complex feelings could be related to the failure of making a timely decision of euthanasia, as found by Walker et al. (2019), but also to a lack of confidence in the tools or the ability to perform the euthanasia adequately.

Support via online and hands-on training has been shown to be beneficial to farmers (Winder et al., 2017). No studies have been published related to euthanasia, but the benefits of training for this topic should be present too, especially for farmers who are troubled by the responsibility of ending the life of their animals, including women and farmers from small farms, who were more likely to report painful emotions and complex feelings in the current study. Moreover, farmers troubled by the responsibility of ending the life of their animals were more likely to be interested in training. Future research could address the positive impact that industry training on euthanasia and pain management, in partnership with veterinarians, could have on dairy farmers (Ritter et al., 2017; Bard et al., 2019; Farrell et al., 2021).

Additional research would also present an opportunity to investigate if psychological factors such as attachment toward livestock or gender differences in patterns of communication, expression of emotions, or sensitivity could explain some of the painful emotions and complex feelings reported in our study. The painful emotions related to euthanasia could also point to some unmet needs (Ekman, 1992), which have the potential to be alleviated if they are identified and subsequently met. For some farmers, developing more acceptable and less stressful euthanasia methods could achieve this, but additional research is needed.

CONCLUSIONS

This study described the management practices related to on-farm euthanasia performed by dairy farmers. We found that a gap in training existed for farmers performing on-farm euthanasia and that the use of a decision tree to guide euthanasia decisions and the involvement of a veterinarian before performing euthanasia were limited. It is still unclear if these gaps are associated with the use of unacceptable methods of euthanasia, the number of animals that died on a farm being greater than the number of euthanized animals, or painful emotions and complex feelings related to euthanasia reported by the participants. Veterinary services and industry initiatives in partnership with veterinarians could address those gaps, and future studies should evaluate the impact of such actions.

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ORCIDS

J. Denis-Robichaud https://orcid.org/0000-0002-7742-0631
M. Rousseau https://orcid.org/0000-0002-2702-434X
M. Villettaz-Robichaud https://orcid.org/0000-0001-9685-1827
L. DesCôteaux https://orcid.org/0000-0002-3153-2160