

ABSTRACT

MERENDA, VICTORIA ROCHA. Timely On-Farm Euthanasia of Dairy Cattle: Exploring Dairy Workers' Attitudes and Training Methods. (Under the direction of Dr. Monique D. Pairis-Garcia).

The first objective for this dissertation was to explore perspectives and attitudes about euthanasia specific to the Brazilian dairy cattle industry using focus groups. The second objective of this dissertation was to develop an interactive training program and investigate its potential to improve dairy workers' perceived euthanasia decision-making skills and awareness of timely euthanasia. The expected outcome was that the training would have an effect on dairy workers' knowledge regarding timely euthanasia. The third objective of this dissertation was to investigate dairy workers' attitudes toward dairy cattle euthanasia and its association to individuals' demographic characteristics and experiences.

For the first objective, three focus groups were conducted in Portuguese and the discussion was transcribed and analyzed by two independent coders. Three major themes were identified: euthanasia training, farm and human components. The discussion revealed that euthanasia is usually misclassified as a procedure that relies exclusively on anesthetics and that the Brazilian dairy industry still relies on euthanasia guidelines from US. It was also revealed that the Brazilian dairy industry provides treatment to cattle with a poor likelihood of recovery and that smaller farms tended to demonstrate greater challenges when implementing euthanasia consistently. Lastly, the decision-making process of euthanasia was largely influenced by the bond between human and animal resulting in an euthanasia avoidance and increased likelihood of unassisted cattle deaths.

For the second objective, an interactive training program was developed. The program's potential to improve dairy workers' perceived euthanasia decision-making skills and awareness

of timely euthanasia was then assessed on farm. Upon completion of the training, respondents were more confident in identifying compromised animals, determining when an animal should be euthanized, and understanding the importance of timely euthanasia. Furthermore, younger, less experienced caretakers demonstrated greater benefit more from the program and should be prioritized for receiving training.

For the third objective, a survey was used to investigate dairy workers' attitudes toward dairy cattle euthanasia and assess their demographic characteristics. Results from this study indicate that workers identifying as white were more comfortable with euthanasia than those identifying as Latin-American. Additionally, individuals who had euthanized before were more comfortable with euthanasia than individuals who had not. Lastly, participants who felt unconfident, lacked knowledge and were detached from cattle primarily worked on farms with 501-1,000 cows, had minimum experience with livestock and no training. These results suggest that future training should focus on unexperienced Latin-Americans, with minimum livestock experience and euthanasia experience given these individuals demonstrate a lack of confidence specific to euthanasia decision-making.

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Timely on-Farm Euthanasia of Dairy Cattle: Exploring Dairy Workers' Attitudes and Training
Methods

by
Victoria Rocha Merenda

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APPROVED BY:

Dr. Monique Pairis-Garcia
Committee chair

Dr. Daniel Poole

Dr. Derek Foster

Dr. Thiago Silva

BIOGRAPHY

Victoria Rocha Merenda was born in São Paulo, a town located in the Southeast Region of Brazil. In 2011, she was accepted to the State University of São Paulo, in Botucatu, where she obtained her degree in Veterinary Medicine. She did not know she would work with dairy cattle until her third year of university when she began an internship at a small dairy farm owned by the university under the supervision of José Luiz Moraes Vasconcelos. Upon graduation of her program, she accepted a one year-externship at North Florida Holsteins to further advance her dairy knowledge and technical skills.

After her externship in Florida, she went to Minnesota, where she was an intern under supervision of Dr. Rafael Bisinotto. During this time, she had her first contact with research and then decided to pursue a Master degree. In 2017, she returned to USA to pursue her Master degree under the supervision of Dr. Ricardo Chebel at the University of Florida. This dissertation was titled “Effects of Metritis Treatment Strategies on Health, Behavior, Reproductive and Productive Parameters of Holstein Cows”.

After earning her Master of Science degree, Victoria then entered the Comparative Biomedical Sciences program at the College of Veterinary Medicine, North Carolina State University to pursue a PhD in the concentration of population health and pathobiology. Under the supervision of Dr. Monique Pairis-Garcia, her research has focused on understanding the attitudes of dairy workers regarding euthanasia and developing training methods with the ultimate goal of improving dairy cattle welfare.

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CHAPTER 1

Introduction

This dissertation is organized with each research project as a separate chapter.

Information in Chapter 1 introduces the dissertation structure, studies objectives and expected results. A literature review focusing on timely euthanasia procedures, barriers for timely euthanasia, euthanasia training and considerations when developing euthanasia training is found in Chapter 2. Chapters 3, 4, and 5 detail individual research projects exploring dairy workers' attitudes towards euthanasia and developing a euthanasia training tool, with more specific introductory and background information included within the research chapters.

The first objective for this dissertation was to explore perspectives and attitudes about euthanasia specific to the Brazilian dairy cattle industry using focus groups. The expected outcome was to understand how euthanasia is viewed within the Brazilian dairy community and identify barriers that prevent timely euthanasia from occurring when needed. This information can be found in chapter 3 and is formatted for the journal *Animals*.

The second objective of this dissertation was to develop an interactive training program and investigate its potential to improve dairy workers' perceived euthanasia decision-making skills and awareness of timely euthanasia. The expected outcome was that the training would have a positive effect in dairy workers' knowledge regarding timely euthanasia. This information can be found in chapter 4 focuses and is formatted following the guidelines of the *Journal of Dairy Science*.

The third objective of this dissertation was to investigate dairy workers' attitudes toward dairy cattle euthanasia and its association to individuals' demographic characteristics. The expected outcome was to identify which dairy workers' characteristics were associated with

being comfortable or uncomfortable towards euthanasia. This information can be found in chapter 5 and is formatted according to the guidelines of the *Journal of Dairy Science*. Chapter 6 is a general discussion of future directions regarding dairy cattle euthanasia.

Chapter 2

Literature Review

2.1 Defining Timely Euthanasia in the Dairy Cattle Industry

The word "euthanasia" has roots in Greek, with "eu" meaning "good" and "thanatos" meaning "death" and is the act of ending the life of an animal to eliminate its pain and distress (AVMA, 2020). The definition of euthanasia is well known and included in every paper on the subject, regardless of the animal industry (Walker et al., 2020). However, whether in the companion or food animal industries, the challenge lies in not defining euthanasia, but determining when to euthanize an animal that is suffering and compromised.

In the dairy industry, despite the acknowledged significance of timely euthanasia, there appears to be a lack of consensus regarding the definition of "timely" when making euthanasia decisions (Walker et al., 2020). Although "timely" is frequently used in the English language to mean prompt, sufficiently early, and opportune, these terms are subjective and open to interpretation (Walker et al., 2020). This issue is not unique to US dairy farms and euthanasia timelines are lacking in the other countries. For example, in the UK, over 90% of farmers survey reported some degree of difficulty when making the decision to euthanize cattle (Neary et al., 2022). As a result, there are significant variations between systems and countries in regard to making euthanasia decision outcomes for cows and calves on dairy farms.

The National Milk Producers' Federation (NMPF) supervises the implementation of dairy cattle care programs through the Farmers Assuring Responsible Management (FARM) program. This handbook recommends timely euthanasia is warranted "when an animal's quality of life has deteriorated or when pain and suffering cannot be alleviated". This handbook also cites different scenarios where euthanasia would be a reasonable choice, such as an animal experiencing severe

pain or distress, poor likelihood of recovery, chronic illness, or recent antibiotic treatment requiring an extended withholding period preventing transport to a slaughter facility. The FARM handbook directs readers to established industry standards, such as those set by the American Veterinary Medical Association (AVMA, 2020) and the American Association of Bovine Practitioners (AABP, 2019) for guidance on decision-making and procedures for euthanasia implementation. Nevertheless, while the FARM handbook provides indicators and guidance materials for making euthanasia decisions, it fails to adequately emphasize the crucial role of timely decision-making in preventing animal suffering (Walker et al., 2020). Specifically, the handbook states that euthanasia should be administered "in a timely manner, if warranted," but does not offer a clear explanation of what this practice entails. Similarly, the AABP's guidance document on humane euthanasia for cattle does not provide timelines specific to the euthanasia decision-making process.

2.2 Euthanasia and Culling on US Dairy farms

The dairy industry has experienced a recent increase in on-farm- mortality rates among dairy cows (Alvåsen et al., 2014a; Reimus et al., 2020). On-farm mortality is defined as an undesirable and unexpected loss of an animal and includes unassisted deaths and euthanasia (Hagner et al., 2023). On-farm mortality does not include culling, which is the practice entailing the removal of cows from farms and sending them to slaughter (Compton et al., 2017).

The decisions surrounding culling and euthanasia are intertwined, both requiring the dairy industry to make more informed and timely decisions. In the United States, approximately one-third of dairy cows are culled on an annual basis, with the majority being sold for slaughter through auction markets or directly to slaughterhouses (USDA, 2014). Many of these cows are in satisfactory condition and are the result of voluntary culling based on productivity rather than

underlying health concerns (USDA, 2014; Walker et al., 2020). However, there is another subpopulation of cows that are culled for involuntary reasons, stemming primarily from health issues such as lameness, mastitis, or injury (Walker et al., 2020). This population is particularly vulnerable, given these cows are often already in a compromised state and may deteriorate rapidly.

Previous studies evaluating the US dairy herd (USDA 2014; Harris et al., 2016; Vogel et al., 2018) have documented cull cow conditions arriving at slaughterhouses, revealing serious welfare and industry reputation concerns regarding the states of these animals. Guidelines are in place to prevent cows that are suffering and/or unfit for transport to be sent to market channels, however recent work suggests these guidelines are not being appropriately followed (Walker et al., 2020). For these cases, the decision to euthanize should be made early on and not as a default if culling is not an option. In addition, euthanasia should be performed on-farm to prevent further suffering and distress to already compromised cows (Walker et al., 2020).

2.3 Euthanasia and Unassisted Deaths of Dairy Cattle

In the current literature to date, data of unassisted deaths and euthanasia are still combined in studies. In the US, there are only a few studies specifying if dead cows include either unassisted dead and euthanized cows or solely unassisted dead cows (McConnel et al., 2009; NAHMS, 2014; Compton et al., 2017). In a 2009 US study conducted by McConnel and colleagues, 55% of cows died unassisted. These trends are also apparent in European countries demonstrating that 30% of cows died unassisted in Sweden (Alvåsen et al., 2014b) and 83% died unassisted in Denmark (Thomsen & Sørensen, 2009). This high incidence of unassisted cow deaths indicates a significant problem with animal welfare, as the animals dying unassisted will likely experience undue suffering prior to their death (Thomsen et al., 2004).

2.3.1 Common causes of dairy cows' mortality

Specific to dairy cows, the National Animal Health Monitoring System report (NAHMS, 2014) estimated that 5.6 percent of cows were euthanized or died without assistance. It is further estimated that only 40 percent of these cow deaths were the result of euthanasia (NAHMS, 2014). To put it more bluntly, more than 300,000 dairy cows die unassisted on an annual basis without the benefit of euthanasia.

In addition to total unassisted deaths, mortality can also be categorized into time of mortality specific to production period. Approximately 48% of cow mortalities occurred during the early lactation stage, which coincides with the period characterized by the highest incidence of disease (NAHMS, 2014). Similarly, 25.6% and 21.0% of cow deaths occurred during mid and late lactation stages, respectively. In contrast, dry cows represented the smallest proportion of cow mortalities, at 5.1%. Lastly, mature cow deaths were identified as or attributed to non-ambulatory, mastitis, injuries and unknown reasons (25, 13.2, 11, and 11.9%, respectively; NAHMS, 2014).

2.3.2 Common causes of dairy calves' mortality

When evaluating dairy calf mortality in the US, NAHMS (2014) estimates that 1.9 percent of weaned heifers, and 6.4 percent of pre-weaned heifers are euthanized or die without assistance on an annual basis. Pre-weaned heifer mortality was primarily attributed to digestive (56%) and respiratory (24%) problems (NAHMS 2014; Compton et al., 2017). It is further estimated that the majority of deaths in these production stages are not due to euthanasia. This percentage means that approximately 500,000 calves and heifers die unassisted on an annual basis. The fact that youngstock have a lower probability of being euthanized compared to animals in the milking herd (NAHMS, 2014; Neary et al., 2022), may be explained by multiple

reasons. For instance, calves may be predisposed to diseases with a more rapid onset and greater severity than cows due to failure of passive transfer and an immature immune system (Neary et al., 2022). This would result in a more rapid deterioration of health compared to a mature cow and potential difficulty in achieving treatment success if not conducted aggressively and early on. In addition, calves and heifers are typically housed at the periphery of the farm or grazing distant pastures and are therefore less visible than cows in the milking herd (Neary et al., 2022). More limited interaction and observation may make it difficult for caretakers to identify subtle deviations in the animal's health.

Calf mortality in modern dairy countries can diminish production efficiency by decreasing the availability of calves as replacements or for sale, as well as incurring welfare costs (Compton et al., 2017). Therefore, clear protocols with guidelines to aid in the euthanasia decision-making of calves and heifers are warranted.

2.4 Timely euthanasia procedures

A euthanasia method is appropriate if it takes into account human/animal safety, causes minimal pain and distress, and results in rapid loss of consciousness and death (Shearer, 2018; AVMA, 2020). The AVMA guidelines classify euthanasia methods into three categories. The following section will briefly define and discuss current euthanasia methods for dairy cattle by category: acceptable, acceptable with conditions or unacceptable.

2.4.1 Acceptable methods

Acceptable methods of euthanasia are defined as methods that consistently result in a humane death when employed as the only means of euthanasia (AVMA, 2020). According to the AVMA recommendations (2020) and AABP guidelines, the only method considered “acceptable” is the use of an overdose of an anesthetic drug, which may be used to euthanize

cattle of all ages and weight groups. Barbiturates and their derivatives are considered the gold standard for euthanasia because they cause a rapid loss of unconsciousness and death, which is a desirable outcome for those performing euthanasia (AVMA, 2020). Administered by intravenous injection, barbiturates result in a quick death via depression of the central nervous system and respiratory centers in the brain leading to cardiac arrest (Shearer, 2018). Although this method achieves the criteria defined in an acceptable method, there are certain drawbacks to their use, such as the need for proper animal restraint during administration and the requirement for personnel to be registered with the Drug Enforcement Administration (DEA, 2000). Moreover, disposal of animal remains is limited due to the possibility of drug residues in the soil and water runoff (Groff et al., 2014).

2.4.2 Acceptable with conditions methods

Firearms and captive bolts are classified as “acceptable with conditions methods” (AVMA, 2020) which are defined as techniques that may need specific scenarios to be met to consistently produce a humane death, may have a higher risk of operator error or safety hazards, have limited scientific literature documentation, or may need an adjunctive method to ensure death (AVMA, 2020).

Firearms are the most frequently used method for on-farm cattle euthanasia in the US (Hoe and Ruegg, 2006). Firearms provide a humane death by physical disruption and complete destruction of the brainstem, immediately rendering the animal unconscious followed by death (Dewell et al., 2016). The main drawback of using a firearm is related to human’s safety risk (AABP, 2019). This is due to the possibility of a projectile ricochet, posing a hazard to operators, and people at a considerable distance from the site (Baker and Scrimgeour, 1995).

The second “acceptable method with conditions” for performing euthanasia is the use of captive bolts. A captive bolt gun is powered by a gunpowder cartridge and is a commonly used method to stun/kill cattle on farms in the US (Shearer, 2018). Captive bolts may be penetrating or non-penetrating and typically cause immediate loss of consciousness, regardless of its type (penetrating versus non penetrating). However, death is not always achieved with these devices.

Penetrating captive bolts can be used for calves or cows, regardless of their weight and size (AVMA, 2020). Penetration of the bolt into the skull and subsequent withdrawal causes structural damage to the brain due to cavitation, which results in marked subarachnoid and intraventricular hemorrhages at the base of the brain (AHAW, 2020). Even though the penetrating captive bolt causes brain damage, there are reports of steers showing signs of returning to consciousness (Grandin, 2002). Therefore, an adjunctive method (e.g., exsanguination, pithing, or potassium chloride IV administration) is always recommended to ensure death when a penetrating captive bolt is used.

Non-penetrating captive bolts can only be used to euthanize calves (AVMA, 2020) and are considered to be only a stunning method (Gillian et al., 2012); therefore, a second step (i.e., adjunctive method) such as exsanguination, brainstem disruption, or overdose with potassium chloride or magnesium sulfate is recommended to ensure death (AVMA, 2020).

2.4.3 Unacceptable methods

The AVMA guidelines (2020) provide an extensive list of unacceptable methods for cattle euthanasia: manually applied blunt trauma to the head, injection of non-anesthetic pharmaceutical agents (e.g., disinfectants, potassium chloride, magnesium sulfate) into conscious animals, administration of xylazine or any other α 2-adrenergic receptor agonist followed by IV

potassium chloride or magnesium sulfate, air embolism, electrocution with 120 V, drowning, and exsanguination in conscious animals.

Although these methods are unacceptable, work by Denis-Robichaud (2023) demonstrated that unacceptable euthanasia methods (i.e., 0.22-caliber long rifle for adult cows, no adjunct method following the use of captive bolt) were used by 25% of the participants for dairy calves, and 58% of the participants for dairy cows. These findings were corroborated by another study in 2020 demonstrating that 7% of participants used blunt force trauma to euthanize animals and half of these participants also indicated blunt force trauma was their primary method of calf euthanasia (Roche et al., 2020).

2.4.4 Euthanasia techniques from a global perspective

Even though firearms with free projectile (e.g. shotguns, rifles and humane killers) are the favored euthanasia method for cattle in the US (Dewell et al., 2016), this scenario may be different in other countries since national legislation can limit firearm access and use (AHAM, 2020). In fact, many countries (e.g., Brazil) strictly restrict gun access and require those in possession of firearms to obtain permits (Chavez et al., 2012).

Brazil has the world's third-largest bovine dairy population, with approximately 16.4 million dairy cows (USDA, 2021), yielding an annual milk production of 24.9 million metric tons (USDA, 2021). The Brazilian dairy industry is predominantly comprised of smaller-scale farms, with over 200,000 producers accounting for 82% of the country's milk production (Vilela et al., 2017). As a result of this diverse landscape, there is significant variation in production methods and management strategies employed throughout Brazil (USDA, 2021).

Specific to Brazil, the topic of euthanasia is a contentious issue that is inadequately covered in the veterinary curriculum (Figueiredo and Araujo, 2001). In the absence of national

standards in Brazil that are specific to cattle euthanasia, several veterinarians rely on external sources, such as the AVMA euthanasia guidelines (2020) to develop country/farm specific euthanasia protocols. Despite AVMA guidelines being a comprehensive document, these guidelines were formulated with a specific focus on the US. For instance, the AVMA guidelines propose the use of penetrating captive bolt guns, firearms, and barbiturate overdose as the primary mechanisms for euthanasia in cattle. Nevertheless, in Brazil, the use of captive bolt guns on farms is minimal (Figueiredo and Araujo, 2001). Moreover, firearm ownership is highly restricted and necessitates registration with a federal police database, even after the recent legislation passed to ease gun ownership (Chávez et al., 2012; Casado et al., 2020). Additionally, the country has legal frameworks in place to safeguard pharmacovigilance, which limits access and use of barbiturates for this purpose (Mota et al., 2018). Therefore, developing euthanasia guidelines that take into account barriers from a global perspective is needed to ensure positive dairy cattle welfare by minimizing suffering.

2.5 Barriers impacting timely euthanasia on-farm

The prioritization of animal welfare must be a paramount consideration in the process of decision-making regarding on-farm euthanasia. However, as highlighted by the Farm Animal Welfare Committee's report (2018), several other factors may affect the decision-making process, including the farmer and veterinarian's perception of the animal's severity, the probability of recovery, the level of discomfort and stress experienced by the animal, as well as the farmer's disposition and confidence towards euthanizing.

2.5.1 Euthanasia guidelines

In the US, industry associations have established and enforced animal care standards that include guidelines for euthanasia in all food animal systems. Specific to food animal euthanasia,

mandatory training and protocol implementation on-farm are part of the animal care standards [Pork Quality Assurance (PQA), 2010; Beef Quality Assurance (BQA) 2019; Farmers Assuring Responsible Management (FARM), 2016].

Specific to the dairy industry, the National Milk Producers' Federation (NMPF) supervises the implementation of dairy cattle care programs through the FARM program (2016), which handbook suggests that timely euthanasia is warranted "when an animal's quality of life has deteriorated or when pain and suffering cannot be alleviated." The FARM's handbook also cites several scenarios where euthanasia would be a reasonable choice, such as severe pain or distress, the inability to be saved or relocated properly, chronic illness, or recent antibiotic treatment requiring an extended withholding period.

The type, severity, and duration of disease gathered with the failure to respond to treatment are one of the main variables influencing the farmer's decision to euthanize an animal (Neary et al., 2022). However, relying solely on the producers' judgment of "when is the right time to euthanize an animal" is a questionable strategy given that, most of the times, the disease diagnosis is unknown (McConnel et al., 2009). The 2009 study found that producer's perception of cause of death was seriously flawed (45% incorrect overall), particularly when dealing with animals dying an unassisted death (63% incorrect). Therefore, having clear guidelines of when to euthanize a dairy animal (e.g., 3 days post treatment in case of no improvement) is vital to avoid animal suffering.

2.5.2 Economic influences

Cow mortality is the most expensive type of permanent removal from the herd, serves as an indicator of their welfare, and has increased over time (McConnel et al., 2009). Because of the expenses related to euthanizing an animal on farm, some farmers opt for sending the animal to an

auction or slaughterhouse. Given these economic considerations, dairy cows unfit for transport may still be placed on trucks and transported to facilities for auction or slaughter given there are no significant deterrents for selling or purchasing animals in these conditions (Walker et al., 2020). Despite their compromised condition, there is often a financial benefit (or at least no financial loss) for sending them to market instead of euthanizing (Walker et al., 2020). Therefore, the current system of marketing cull cows does not effectively discourage the transportation of dairy cows that are not fit for transport and candidates for euthanasia (Walker et al., 2020).

While there are potential risks involved in transporting and purchasing compromised dairy cows (e.g., death during transport resulting in a complete loss or regulatory actions), there are still perceived benefits that often outweigh these risks (Edwards-Callaway et al., 2018). Some of these benefits include cost savings associated with carcass disposal, the ability to generate some income from the sale of compromised cows, maintaining business relationships by accepting cows of questionable condition, and the potential profit margin associated with processing lean cows (Edwards-Callaway et al., 2018).

2.5.3 Compassion fatigue

When an animal is in unrelieved pain and has a low likelihood of recovery, euthanasia is the appropriate course of action. Euthanasia is commonly used on US dairy farms as a humane way to alleviate the animal's suffering and achieve the best possible outcome. Despite this, choosing and performing euthanasia can be a challenging decision for both the producer and veterinarian, and can result in moral distress for those involved.

Kemp et al. (2016) noted that caretakers preferred to use euphemisms such as "put to sleep" or "put down" instead of stronger terms like "killing" when referring to euthanasia.

Additionally, caregivers used metaphors such as "doing the right thing" or "the best thing for me and the animal" to help alleviate the experience of human suffering (Kemp et al., 2016).

However, even with the use of metaphors, the grief that followed the loss of an animal was still described as "penetrating anguish" (Bunkers, 2010). In addition, caretakers often associated feelings of shock, hurt, sadness, loss, numbness, and emptiness with the heart using metaphors such as "cracking" or "bleeding" the heart (Bunkers, 2010). Finally, one caregiver, after euthanizing their dog, disclosed that they "didn't stop crying the whole night" (Kwong, 2011). As a result, the process can be emotionally draining and lead to producers avoiding euthanasia entirely over time (Román-Muñiz et al., 2021).

Specifically to dairy farm caretakers, previous studies have shown that although most felt comfortable performing euthanasia, compassion fatigue and emotional stress related to making the decision was evident (Román-Muñiz et al., 2021; Wagner et al., 2020a; Wagner et al., 2020b). The use of training and protocols is a crucial aspect of the decision-making process regarding euthanasia, given that it allows an opportunity to address the emotional distress and bereavement that are not usually outlined in written protocols (Edwards-Callaway et al., 2022).

2.6 Euthanasia training

2.6.1 The need for euthanasia training in the livestock industry

Training farm workers involved in the milk production industry can considerably improve the welfare of the animals, increase milk yields, decrease calf mortality and even enhance job satisfaction among workers (Paranhos da Costa, 2010). The lack of knowledge and suitable training opportunities for people who work daily with animals represents the main problem that affects farm animal welfare (Gallo et al., 2010).

Specific to euthanasia, this problem is even more concerning given that veterinarians, individuals identified as experts in the field of animal welfare, are not routinely trained on the decision making or performance of euthanasia (i.e., captive bolt and firearms use; Turner, 2021). This problem is not only limited to American veterinarians and work conducted in the south of Brazil demonstrated that Brazilian veterinarians also admit to lacking training specific to euthanasia decision-making and performance (Figueiredo and Araujo, 2001).

2.6.2 The need for euthanasia training in the dairy industry

The National Animal Health Emergency Management System (NAHEMS, 2015) guidelines defend that only qualified and trained personnel may perform euthanasia procedures. Training procedures has been demonstrated to enhance animal welfare and audit performance in beef packing plants (Grandin, 2006) as well as employees' capacity to identify and alleviate discomfort in laboratory animals (Hawkins, 2002). Furthermore, according to the Panel on Animal Health and Welfare (AHAW, 2020), one of the main hazards observed during on-farm euthanasia of cattle are associated with lack of staff skills and training. Thus, training of staff is a key preventive measure to avoid hazards and mitigate welfare consequences (AHAW, 2020).

However, National Animal Health Monitoring System (NAHMS, 2014) reports demonstrated only 20% of dairy farms in the US provide euthanasia training. Similarly, recent research conducted in Canada demonstrated only half of workers performing euthanasia have received on-farm training due to the low availability of such training (Denis-Robichaud et al., 2023). This concern is not limited to North America and should be addressed by the global dairy industry.

Neary's study (2022) in the UK found that the majority of farms (66%, n = 23 out of 35) did not have anyone who had received training in performing euthanasia. The British study

(Neary et al., 2022) also found a tendency among veterinarians to attempt cows' treatment even in scenarios with poor prognosis. For instance, in cases of non-ambulatory cows with suspected calving injuries, 52% of veterinarians chose to delay euthanasia until 3 to 5 days later, while 24% elected to wait for 6 or more days even though recovery of cows that are non-ambulatory for more than 24 hours is poor (Green et al., 2008). Thus, an evidence-based decision support training tool could aid veterinarians and caretakers in making timely euthanasia decisions, especially in cases where a bias toward treatment may obscure their rational decision-making.

In a recent study conducted by Román-Muñiz and colleagues (2021), interviews were conducted with 38 dairy caretakers, including workers, supervisors, and farm owners, to investigate their concerns about the lack of euthanasia training on dairy farms. Specifically, the study asked participants whether they felt confident in performing euthanasia and whether they believed that there was enough training provided to support them. While managers expressed confidence in the training provided, caretakers did not feel confident and expressed a desire for more comprehensive and specialized euthanasia training. Therefore, to enhance dairy cow welfare on farms and minimize suffering associated with implementing inappropriate euthanasia practices, it is imperative to create euthanasia training resources that are comprehensive, easily understandable, and efficient.

2.6.3 Types of training

Caretaker training programs can take different forms, including formal education with experienced caretakers or managers, farm-specific programs, or external training programs such as workshops organized by FARM. Although on-the-job training may not be considered an official program, employees may still find it satisfactory. In the US, most workers describe the

dairy training provided as a combination of oral guidance, practical demonstration, and supervision.

Neary's study (2022) found that the primary source of training for the respondents was a competent stockperson, with 11 individuals (69%) indicating this as their preferred option. A veterinarian was the next most common source, with 10 respondents (63%) selecting this option. Only a small minority (n = 2, 13%) reported using resources such as books, the internet, or documents for training purposes.

The effectiveness and retention of training can depend on the delivery method. For instance, a study conducted by Matthis (2004) found that swine caretakers who received in-person training were more willing to perform euthanasia on a compromised pig than those who only read company literature. An effective alternative to in-person training is the use of interactive training programs for euthanasia (Mullins et al., 2018). Up to date, the dairy industry does not have any euthanasia training material that is clear, accessible and effective.

2.6.4 Multimedia training

According to Najjar (1996), multimedia refers to the use of various media, such as text, graphics, animation, pictures, video, and sound, to present information. Klupiec et al. (2014) found that multimedia training programs can increase learning flexibility and reduce alienation due to difficulty in understanding the material. Interactive training programs are also helpful in engaging students and keeping them focused during the delivery of the material (Mehrabi et al., 2000).

Multimedia-based training has been found to be highly effective for those with little prior knowledge of the information presented (Najjar, 1996). Furthermore, for applications requiring the recognition of specific situations, picture-based learning is particularly effective (Najjar,

1996). Dairy caretakers often have lower levels of formal education and may feel uncomfortable in a traditional classroom environment (Maloney, 2005). These individuals may be more receptive to training presented in a multimedia format, outside of the traditional classroom.

Research has shown that effective on-farm training programs should include materials translated into the primary language of participants and use multimedia resources to minimize the need for extensive reading (Rodriguez et al., 2018). In the Rodriguez study (2018), researchers used a mobile application to provide a safety training program, in Spanish, for dairy caretakers (Rodriguez et al., 2018). Surveys conducted after the training showed that 89% of trainees learned new ideas and techniques, and 98% of participants took steps to prevent injuries or accidents (Rodriguez et al., 2018). In addition, focus group participants in another study (Menger et al., 2016) expressed a preference for safety training in video format because it provides a clearer understanding. Therefore, these findings highlight the importance of providing training in a multimedia format and using appropriate vocabulary for Spanish-speaking dairy workers that may have limited formal education.

2.7 Considerations when developing the euthanasia training tools

2.7.1 Human-animal bond

When developing a euthanasia training tool, the impact of the human-animal bond in the decision-making process is an aspect that should be taken in consideration. The human-animal bond is defined by the AVMA (2020) as a "dynamic and mutually beneficial relationship between people and animals that is influenced by behaviors essential to the health and wellbeing of both. This includes emotional, psychological, and physical interactions of people, animals, and the environment." The development of strong bonds between dairy producers or caretakers and their cattle may lead to negative welfare outcomes if this relationship delays timely

euthanasia decision-making (Walker et al., 2020). In such situations, individuals who have developed close bonds may not be capable of serving as an unbiased evaluator of the animal's condition, resulting in prolonged treatment and an unassisted death (Shearer, 2018).

2.7.2 Euthanasia-related burden

The psychological burden and feeling of failure linked with ending the lives of one's own animals is another significant factor (Wagner et al., 2020a; Wagner et al., 2020b) that may contribute to a lower frequency of euthanasia. Even when the individuals have extensive training and experience in euthanasia, they may still experience emotional distress when performing the task. Studies have documented euthanasia-related stress in various settings, including shelters (Arluke, 1994), veterinary clinics (Rogelberg et al., 2007), swine operations (Matthis, 2004; Edwards-Callaway et al., 2020; Simpson et al., 2020), and dairy farms (Román-Muñiz et al., 2021; Wagner et al., 2020a; Wagner et al., 2020b). This phenomenon, commonly known as compassion fatigue, affects people in caregiving roles and can interfere with their ability to perform work-related tasks (Figley, 1995).

In UK a similar scenario is observed with the majority of farmers reporting either slight difficulty (37%) or moderate difficulty (29%) experiences when making the decision to euthanize an animal (Neary et al., 2022). In order to find appropriate ways of mitigating the burden associated with euthanasia, the demographic characteristics of the dairy workers must be further explored.

2.7.3 Dairy workers' attitudes towards euthanasia

Another factor that should be considered when developing a euthanasia training tool is the dairy caretaker attitude towards euthanasia and animal welfare. Previous research has identified various factors that can influence human attitudes towards animal welfare (Kellert

1984; Hemsworth 2003; Clark et al., 2016). Clark's study in 2016 showed that demographic characteristics such as gender, pet ownership, religion, age, education, and place of residence (living in a rural or urban area) can have an impact on individuals' attitudes. Specifically, younger, more educated, female individuals were more concerned with animal welfare and held more negative views towards modern farming. Furthermore, individuals of stronger religiosity and on the right of the political spectrum were less likely to be concerned about animal welfare.

These results are corroborated by Kellert's findings (1984) where farmers, males, individuals over 76 years of age, and rural residents were found to be less likely to have a humanistic attitude towards animals, while livestock producers were more likely to have negativistic attitudes (i.e., actively avoid animals due to dislike or fear). Similar results were reported in the dairy industry where farmers with more negative attitudes towards cows had a lower proportion of cows that accepted being touched, while positive attitudes were associated with calmer cows (des Roches et al., 2016).

In terms of attitudes towards livestock euthanasia, research in the swine industry found that caretakers' attitudes towards pigs not only influenced their willingness to perform euthanasia, but also affected the quality and consistency of how it was carried out. Demographic characteristics such as lack of training and knowledge about euthanasia were also found to be moderately correlated with inadequate decision-making and avoidance of euthanasia by swine caretakers. Campler and colleagues (2018) similarly reported that insufficient perceived knowledge about swine euthanasia was correlated with indecisiveness and avoidance to perform the act, leading to feelings of guilt among caretakers.

Regarding attitudes towards dairy cattle euthanasia, a recent Canadian study (Denis-Robichaud et al., 2023) discovered that participants who were uncomfortable with the

responsibility of ending their animals' lives reported negative emotions more frequently than those who felt at ease with the act. In addition, sex and farm size were linked to attitudes toward euthanasia, with women and farmers from small farms more likely to report negative emotions (Denis-Robichaud et al., 2023). Moreover, a study from 2000 found that female caretakers exhibited more positive behavior towards veal calves in contrast to their male counterparts (Lensink et al., 2000). The attitudes of dairy workers in the United States towards dairy cattle euthanasia and how an individual's demographic characteristics can impact appropriate euthanasia performance are currently unknown.

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CHAPTER 3

Dairy Cattle Euthanasia; Focus Groups Exploring Perspectives of Brazilians Working in the Dairy Cattle Industry

Victoria R. Merenda, Eduardo B. de Oliveira, Heather N. Fowler and Monique D. Pairis-Garcia.

Dairy Cattle Euthanasia; Focus Groups Exploring Perspectives of Brazilians Working in the Dairy Cattle Industry. *Animals* **2022**, *12*, 409. <https://doi.org/10.3390/ani12040409>

3.1 Abstract

The objective of this study was to explore perspectives and attitudes about euthanasia specific to the Brazilian dairy cattle industry. Twenty-five Brazilian citizens (13 veterinarians, 4 animal scientists, 3 professors, 3 researchers, 1 dairy owner and 1 caretaker) participated in one of three focus groups conducted and recorded online (10, 8 and 7 participants per group). Questions regarding euthanasia were posed by a moderator and the focus group discussions were then transcribed verbatim for analysis. After the initial data analysis, themes were evaluated and collapsed into three major categories: Euthanasia Training, Farm and Human Components. A complex interconnection between the three main themes and multiple subthemes specific to dairy cattle euthanasia was also revealed. The lack of nationally recognized euthanasia guidelines for dairy cattle paired with ineffective and inaccessible euthanasia tools makes it difficult for dairy veterinarians to implement humane protocols for on-farm euthanasia. In addition, logistical factors, particularly the financial cost of euthanasia and human-animal bond both play a role in the failure to perform euthanasia when warranted. Future studies should focus on the development of science-based standards and producer training to improve the consistency of on-farm euthanasia in Brazilian dairy operations.

3.2 Introduction

Euthanasia is the practice of ending the life of a patient or animal who has no prospect of improvement [1]. Euthanasia minimizes suffering and pain experienced by the individual and is the ethical responsibility for caretakers designated to this role [2]. Thus, animal caretakers must not only have the proper training to identify compromised animals, but the decision-making skills and confidence to perform euthanasia when necessary. Nonetheless, even with extensive euthanasia training and experience, individuals performing this task can be affected emotionally. Euthanasia-related stress has been documented in those working in shelters [3], veterinary clinics [4], swine operations [5-7] and dairy farms [8-10]. This condition, more commonly referred to as compassion fatigue, affects people in caretaking jobs and may interfere with an individual's ability to perform work related tasks [11].

In recent years, animal welfare scientists have begun to explore perceptions and attitudes towards euthanasia with a particular focus on emotional barriers associated with performing this act. This work, specific to dairy cattle operations, has highlighted perspectives from both dairy farm caretakers [8,9] and veterinarians [10] and has shown that although most felt comfortable performing euthanasia, compassion fatigue and emotional stress related to making the decision was evident.

This issue is not unique to the United States (US), and concerns regarding animal welfare and suffering are an international priority given euthanasia standard requirements have the potential to impact global trade for animal products [12,13].

Brazil has the third largest dairy herd in the world, with 16.4 million dairy cows [14] and an annual milk production of 24.9 million metric tons [15]. The Brazilian dairy industry is composed primarily of smaller farms with over 200,000 producers responsible for 82% of

national milk production [16]. Given this, production practices and management strategies vary widely [15] and to date, there are no national standards outlining best management practices, such as timely euthanasia decision-making for dairy herds.

Given the structure of the Brazilian dairy industry and lack of specific management standards and guidelines, ensuring humane and timely euthanasia of compromised cattle is critical. This not only pertains to individual cows requiring euthanasia on farms, but for zoonotic outbreak events in which large populations of cattle require euthanasia [17, 18].

In order to ensure positive dairy cattle welfare by minimizing suffering via euthanasia, we must first understand how euthanasia is viewed within the Brazilian dairy community and identify barriers that prevent timely euthanasia from occurring when needed. Therefore, the objective of this study was to explore perspectives and attitudes about euthanasia specific to the Brazilian dairy cattle industry using focus groups.

3.3 Materials and Methods

All research was reviewed and approved by the North Carolina State University IRB Committee for Human Subjects Research (protocol #19243).

3.3.1 Participant recruitment

Brazilian citizens associated with the dairy cattle industry (i.e. veterinarians, academia, producers, caretakers) were recruited using an electronic mailing list to participate in this study using a convenience sampling methodology. The electronic mailing list was initially created by an academic professor whom invited Brazilian colleagues with dairy cattle experience to join. This mailing list has been and continues to be used as a form of communication for this group including but not limited to research collaboration, projects of interest and research advice. Specifically for this study, a private message was sent to each individual in the group and asked a series of questions to determine if groups members were 1) familiar with dairy cattle; 2) familiar with euthanasia in dairy cattle; 3) willing to participate in a focus group discussion. In order to participate, individuals were required to be Brazilian citizens, native Portuguese speakers and have experience with dairy cattle euthanasia. Following recruitment, twenty-seven individuals agreed to participate in one of three focus groups. The distribution of individuals among the focus groups was according to the participants' schedule availability.

3.3.2. Web-based Focus Group

Focus groups were conducted using the online platform Zoom (Zoom Video Communications Inc., San Jose, California, US, 2016). Two weeks prior to the focus group, each participant received an individual email to access the electronic consent form (Qualtrics International Inc., Seattle, WA), demographic survey and zoom link. A reminder text message was sent the day prior to the focus group to ensure participants arrived on time. All participants

were made aware that the focus group would be recorded and were reminded that participation was voluntary and individuals could remove themselves from the zoom meeting at any time. An incentive (\$25 gift card) was provided to all participants that completed the study.

Focus groups were conducted in Portuguese and audio recorded to support future transcription (total duration per group: 90 minutes). One moderator and one assistant were present in all three focus groups to coordinate the discussions (both native Portuguese speakers). The moderator was a PhD student with experience in the dairy industry and expertise in cattle euthanasia, and the assistant was a DVM resident with an expertise in cattle health. The moderator and assistant also served as coders for the analysis of this study.

Discussion was prompted using the same eight questions previously utilized in work conducted by Wagner and colleagues [9,10]. All questions were translated into Portuguese and included: 1) What comes to mind when you think about euthanizing animals on-farm? 2) What, if any, are the benefits of euthanizing animals on-farm? 3) What, if any, are the drawbacks to euthanizing animals on-farm? 4) When do you know it is the right time to euthanize an animal? 5) When do you know it is not the right time to euthanize an animal? 6) What are the main reasons why you would delay euthanasia? 7) What are the main reasons why you would not perform euthanasia? 8) What other factors might you consider when making the decision to euthanize animals on-farm? Follow-up questions were asked when necessary by the moderator to further encourage discussion.

Focus groups were transcribed and analyzed by two independent coders (moderator and assistant) using the thematic analysis described by Braun and Clarke [19]. The overall agreement between the coders was 94% before consensus was reached. The misinterpretations of the codes were discussed between coders until final agreement was reached.

3.4 Results and Discussion

Twenty-five Brazilian citizens associated with the dairy cattle industry participated in one of three focus groups (10, 8, and 7 participants/group, respectively). Two participants originally recruited did not participate due to undisclosed personal reasons. The majority of participants identified themselves as veterinarians (52%) followed by animal scientists (16%), professors (12%), researchers (12%), dairy owners (4%) or caretakers but not owners (4%). Eighty-four percent of the participants responded with “yes” when asked if any cow has been euthanized during the last 12 months where they worked, reflecting that the majority of the individuals participating in the focus groups were familiar with euthanasia on-farm.

3.4.1. Thematic Analysis

Initial analysis of the data revealed a complex and interconnection of multiple themes and subthemes specific to dairy cattle euthanasia (Figure 3.1). After the initial data analysis, themes were evaluated and collapsed into three major categories: Euthanasia Training, Farm and Human Components.

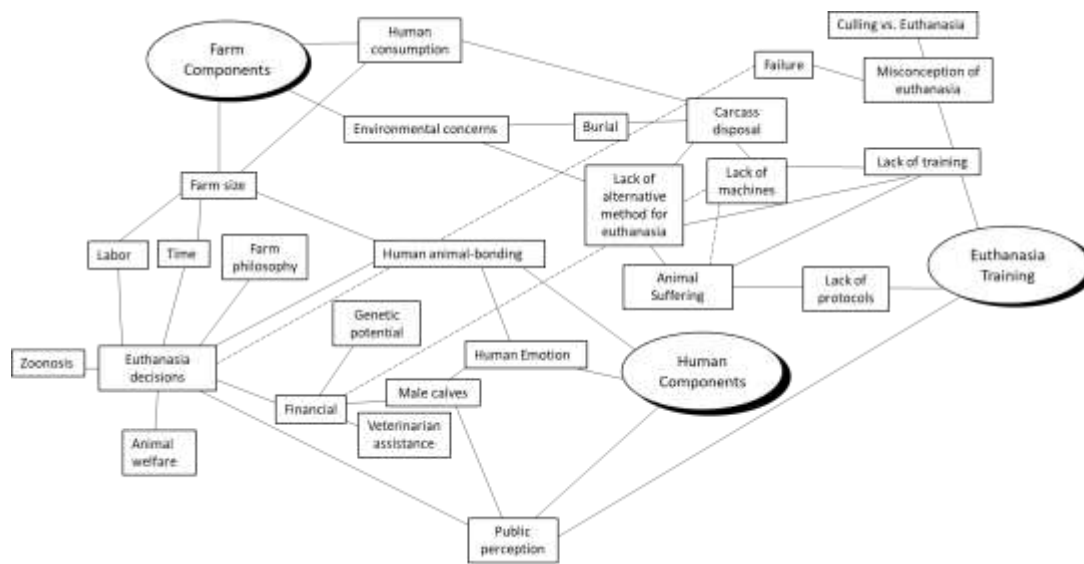


Figure 3.1. Initial thematic map.

3.4.2. Theme 1: Euthanasia Training

This theme included any discussion revealing euthanasia misconceptions, lack of euthanasia equipment and science-based guidelines to support the development of euthanasia protocols.

Based on the focus groups, the term ‘euthanasia’ is not used frequently in the Brazilian dairy industry and was consistently incorrectly defined as a procedure that relies exclusively on the use of anesthetics. One of the veterinarians stated:

“We commonly do not use the term euthanasia in milk production. We say culling. When we talk about registering in an online system (...), we write culling, but it's actually death... Euthanasia is a term that not even the producers know very well what it is (...) So when we say that the cow was culled, it does not always mean that it went to the slaughterhouse, death is considered culling. Euthanasia is unknown to producers. For veterinarians... Look, I haven't done a ‘properly said’ euthanasia since the residency period. (...) In Brazil, it is practically impossible to perform euthanasia like we used to do in the hospital.”

According to work conducted by Figueiredo and Araujo [20], euthanasia is a controversial subject that is poorly addressed in Brazilian veterinary curriculum. Given Brazil has no national standards specific to cattle euthanasia, many veterinarians rely on external resources to develop euthanasia protocols including the American Veterinary Medical Association euthanasia guidelines (AVMA; Schaumburg, IL, USA). Although a comprehensive document, these guidelines were developed with a US specific focus. For example, AVMA guidelines identify penetrating captive bolt guns, firearms and barbiturate overdose as primary mechanisms for euthanasia in cattle. However, in Brazil, captive bolts gun use on-farm is minimal [20], firearm ownership is extremely restricted and must be conducted through a federal

police registration database (regardless of the recent law approval for easing gun ownership) [21,22] and legal frameworks safeguarding pharmacovigilance in the country limits barbiturate access and use [23].

It was also identified that the tools needed to perform euthanasia were not always available. One participant expressed frustration over this fact stating

“I use xylazine with potassium chloride. I don’t know if this is the right protocol, but this is what I use here.”

Another participant complemented the discussion and expressed concern about the accessibility to the drugs

“The potassium chloride is not easy to find, it is not easy to buy. The situation is very complicated.”

Deficiencies in euthanasia guidelines and equipment specific to the Brazilian dairy industry has limited Brazilian veterinarians in developing and implementing euthanasia protocols that can be used on-farm. As nicely summarized by one participant:

“The disadvantage is that we do not have protocols. Because we don’t have protocols, we end up doing a handful of things that we do not agree with, (...) We must be realistic about things. Anyone who works in the field knows. We use (...) products that ends up causing animal suffering...”

Future work is needed in developing science-based guidelines specific to the Brazilian dairy industry that can support the development of realistic protocols as well as the identification of effective and humane euthanasia methods. Previous work conducted by Dalla Costa and colleagues [24] may be used as a template to move the Brazilian dairy industry forward. Dalla Costa and colleagues [24] evaluated on-farm euthanasia methods and attitudes towards

euthanasia in the Brazilian swine industry using survey methodologies. This work identified current euthanasia methods used on pig farms and identified potential barriers for implementing euthanasia successfully. This work was later used to develop national guidelines for swine euthanasia and identified key conditions in swine, which warrant immediate euthanasia [25]. Given the challenges that Brazilian swine and dairy producers face are similar, collecting information on dairy farm euthanasia may assist in identifying knowledge gaps that can be filled through education and research and developing national standards on cattle euthanasia.

3.4.3. Theme 2: Farm Components

The second theme centered around logistical factors impacting euthanasia including cost (labor, time, equipment) and farm size. Logistical concerns specific to financial impact were consistently brought up in each focus group. Balancing the cost-benefit of treating a cow was evident with many participants acknowledging that dairy producers do not have the financial resources to support long-term or aggressive treatment. For example, one participant stated:

“Maybe you would have a solution in the case of a fracture, for example, but in a production system this [the treatment] is not economically viable.”

Not only does treating a cow have significant financial impact to the operation, but many participants also posed concerns specific to the success of such treatment interventions. As mentioned by one participant:

“I prefer my employee to check on 50 calves per hour preventing something than losing one hour treating an animal that will not bring any result.”

This suggests that either the treatment protocols available to Brazilian dairy producers are not effective or the condition of the animal is beyond recovery and any treatment is unlikely to be successful.

This issue is not unique to the Brazilian dairy industry and has received much attention in the last 5 years in the US [26]. A good case example of this is the management of non-ambulatory cows on US dairy farms. It is estimated that approximately 19% of cows down for at least 24 hours are involuntarily culled and sold for slaughter in the US [27] and it can be assumed that this number may be even higher if counting non-ambulatory cattle that die on-farm. Work assessing treatment interventions suggests that cows that are non-ambulatory for more than 24 hours are unlikely to recover, particularly when the cause is not associated with hypocalcemia [28]. Even with this information, 46.3–54.9% of US producers surveyed would treat and monitor non-ambulatory cattle [9] regardless of the high likelihood for poor welfare outcomes for these individual cows. The sentiment to administer and treat cattle that are unlikely to recover was also shared by one Brazilian citizen in the focus group stating,

“You either treat, treat, treat and it [cow] dies or you treat it and she doesn’t die.”

Providing treatment to cattle with a poor likelihood of recovery has both negative welfare and economic implications to the industry. Ensuring appropriate training of veterinarians and effective communication to producers is imperative when treatment decisions are being made. Animals whose conditions are refractory in nature must be euthanized given treatment will not change the end outcome for the cow and failure to provide any intervention will result in prolonged suffering and duress [2].

Euthanasia implementation was also directly influenced by farm size. The Brazilian dairy industry is diverse and composed of large (>101 cows, 10% of farms), medium (11-100 cows; 57% of farms) and small operations (1-10 cows; 33% of farms) [29,15]. Based upon responses from focus group participants, smaller farms tended to demonstrate greater challenges when implementing euthanasia consistently. For instance, one participant said:

"The smaller the farm, the larger is the amount of time this animal will be treated. They do not want to lose this animal because this animal has a huge value for him [farmer]."

And another stated:

"When the animal is sick, it [euthanasia] depends on the size of the property, on the financial condition of the owner, on the attachment to the animal (whether the owner is attached to the animal or not), and if he has time and employees for that."

The USDA -NAHMS [26] reported a similar phenomenon in the US dairy industry highlighting that a higher percentage of non-ambulatory cows died unassisted on smaller farms (30 to 99 cows; 23.6%) than on operations with more than 500 cows (14.8%). Furthermore, larger farms seem to make euthanasia decisions in shorter time-periods than smaller farms [26] and suggests that external factors are likely to play a larger role in the euthanasia decision-making process than cow condition alone. Given these variations, future educational programming must take into account farm demographics and ensure all producers, regardless of farm size, can implement euthanasia effectively and consistently.

3.4.4. Theme 3: Human Components

The last theme of the focus groups included the impact of the participant's emotional response on the decision-making process and public perception on conducting euthanasia.

Euthanasia on livestock operations is not easy to discuss and euthanasia decisions are not easy to make. Making the decision to euthanize depends on a multitude of factors including the emotional response and acceptance of the act. When participants were asked the question *"When is the right time for euthanasia?"* the majority of responses were not based on clinical signs or conditions of the animal, but more so on how the person performing euthanasia perceived the act, as one participant stated:

“I think... the right time for euthanasia has more to do with the people than to the animal condition”.

Another individual stated:

“I choose euthanasia when I am confident that this was the best decision I could have made for that animal and that I will lay my head on the pillow and think ‘I’ve tried everything I could.’”

The emotional impact on the decision to euthanize may be impacted by Brazilian’s religious affiliation and human-animal bond. In Brazil, it is estimated that 93% of citizens have a religious affiliation with the majority of citizens belonging to Christianity [30] and the majority of citizens entering the field of veterinary medicine (i.e. veterinary students) believe that animals have a soul [31]. In addition, over 90% of Brazilian dairy farmers surveyed in Southern Brazil could recognize all their individual dairy cows, and over half of those cows had a name [32]. As defined by the AVMA [33], the human-animal bond is “a mutually beneficial and dynamic relationship between people and animals that is influenced by behaviors essential to the health and wellbeing of both. This includes, among other things, emotional, psychological, and physical interactions of people, animals, and the environment.” Dairy producers and caretakers that develop strong bonds with their cattle may result in poor welfare outcomes for these cattle if that relationship prevents that individual from making timely euthanasia decisions [26]. In situations such as these, those individuals that have developed strong bonds may not be able to serve as an objective proxy for the animal, thus resulting in prolonged treatment and an unassisted death [2]. Future work is needed in better understanding the complex and dynamic relationships between farm animals and their caretakers.

Confidence around making and performing euthanasia varied greatly within these focus groups. Although some participants felt confident with making the decision, others, such as one dairy owner responded:

“I always delay euthanasia. There is a calf here that it has been a month that we’ve been trying to fix her lesion and she doesn’t get better. But at some point you reach the conclusion that there is no other way.”

Ensuring producers and veterinarians are confident in the decision-making process is key to guaranteeing timely euthanasia is implemented consistently on farm. Work conducted by Campler and colleagues [34] demonstrated that trained and confident swine caretakers were more comfortable conducting complex decision-making on euthanasia and performing euthanasia than caretakers who did not feel confident. Even though individuals participating in the focus groups have extensive experience within the dairy industry, gaining confidence through educational training programs would likely result in more consistent and reliable euthanasia decision-making.

In addition to the emotional response and concerns related to performing euthanasia by those directly involved with the dairy industry, many participants noted the effect of public perception on performing dairy cattle euthanasia. More recently, the Brazilian dairy industry has received much scrutiny regarding animal management, specifically regarding the euthanasia of healthy bull calves on-farm. In work conducted by Cardoso and colleagues [35], 79% of participants surveyed were unaware that the Brazilian dairy industry “kills” bull calves immediately after birth and 90% of those participants rejected the practice as acceptable [35].

Bull calf management was frequently mentioned in the focus groups with one participant noting

“Every week there is a new video on Instagram about male calves in the dairy production. We need to solve this problem.”

Focus group participants felt that this scrutiny has limited their ability to perform euthanasia, as stated

“When you have an audience that you don’t know a lot, you may have to wait a little, change the environment, think of your surroundings before [performing euthanasia].”

Euthanizing healthy calves is not just a concern for the general public [2,36], but a contentious issue amongst those participating in the focus group as well. Participants in the focus group both supported and condemned the practice while a few individuals removed themselves from the conversation. One participant in particular confessed that she would leave the farm whenever bull calf euthanasia was performed to avoid the moral distress.

As the public in Brazil becomes more further removed from livestock practices, the Brazilian dairy industry must address how euthanasia is perceived and accepted in the country as well as how management practices must change and evolve to fulfill public demands specific to dairy cattle welfare.

3.5 Conclusions

In our assessment of perspectives surrounding euthanasia in the Brazilian dairy industry, our focus groups revealed euthanasia training, farm and human components as primary factors influencing the euthanasia decision-making process on the farm. The lack of nationally recognized euthanasia guidelines for dairy cattle coupled with ineffective and inaccessible euthanasia tools makes it difficult for dairy veterinarians to implement humane protocols for on-farm euthanasia. Lastly, logistical factors, particular the financial cost of euthanasia and human-animal bond both play a role in the failure to perform euthanasia when warranted. Future

research must focus on the development of science-based standards and producer training to improve the consistency of on-farm euthanasia for Brazilian dairy operations.

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CHAPTER 4

Interactive euthanasia training program for the dairy industry; implementation and perceived respondent knowledge change

Victoria R. Merenda, Eduardo B. de Oliveira, Magdiel Lopez-Soriano, Andréia G. Arruda, Ashley Robbins, and Monique D. Pairis-Garcia.

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4.1 Abstract

This study described the development of an interactive euthanasia training program and its potential to improve dairy workers' perceived euthanasia decision-making skills and awareness of timely euthanasia by using a survey instrument before and after the program. Training material encompassed euthanasia information over two production stages (calves and cows/heifers) and material was delivered on-farm in a case scenario format (14 cases). During a three-month period, 30 different dairy farms were visited and 81 participants were enrolled in this study. Each participant was required to complete a survey pre-training, to complete the case studies from the production stage in which their job responsibility was more closely aligned with (estimated completion time of one hour), and to complete a survey post-training. Surveys contained eight statements regarding participants' perceived knowledge of euthanasia practices. The questions were answered on a 5-point scale: 1) strongly disagree, 2) disagree, 3) neither agree nor disagree, 4) agree, or 5) strongly agree. Multivariable mixed-effects logistic regression models were created for each question to investigate the effect of age, sex, dairy experience, farm size, role at the farm, race, previous experience with euthanasia, veterinarian degree and production stage in the score change, defined by the presence or absence of an increase in the 5-point scale score. Upon completion of the training, respondents were more confident in identifying compromised animals (score change = 0.35), determining when an animal should be euthanized (score change = 0.64), and understanding the importance of timely euthanasia (score change = 0.26). Age and euthanasia experience were significantly associated with the respondents' perceived knowledge; suggesting that younger, less experienced caretakers on-farm should be prioritized to receive training. The proposed interactive case-based euthanasia training

program has proven to be valuable to dairy participants and veterinarians as it provides a means to improve dairy welfare.

4.2 Introduction

Euthanasia is always the right decision to make when an animal is experiencing unmitigated pain and suffering; and the likelihood of recovery is poor. Euthanasia is a common practice implemented on dairy farms in the United States (US) and is recognized as a humane act that serves to bring about the best possible outcome for the animal (AVMA, 2020). However, euthanasia remains a difficult decision to make on-farm and it is estimated that, on an annual basis, more than 300,000 dairy cows and 500,000 calves and heifers die unassisted without the benefit of euthanasia (NAHMS, 2014). Another concern fact is that many caretakers (those responsible for the day-to-day care and management of those animals) view euthanasia as a failure in their ability to provide adequate and appropriate care (Merenda et al., 2022).

Euthanasia challenges are not unique to dairy farms and recent work in the swine industry has reported that euthanasia decision-making adversely affects caretaker well-being and those caretakers that lack knowledge and confidence in euthanasia decision-making are more likely to make poor-decisions or avoid conducting euthanasia all-together (Rault et al., 2017; Campler et al., 2020; Edwards-Callaway et al., 2022).

It is worth noting that National Dairy FARM Program Animal Care Version 4.0 does have requirements for continuing education on euthanasia for caretakers that have that responsibility on the dairy [Farmers Assuring Responsible Management (FARM), 2020]. Furthermore, American Association of Bovine Practitioners (AABP) guidelines state that individuals responsible for euthanasia should have annual training and certification on recognizing animals need of euthanasia, proper euthanasia technique, proper confirmation of death, safe use of euthanasia methods, and equipment maintenance (AABP, 2019). However, to date, the US has no nationally recognized euthanasia training program for dairy producers and

current programs are limited and often deficient in providing caretakers with adequate information on the decision-making process itself. In fact, according to a National Animal Health Monitoring System report (NAHMS, 2014), only 20% of dairy operations provide training in euthanasia. This concern is not limited to the US as a recent study in Canada revealed that, as a consequence of the low availability of on-farm training for euthanasia, only half of the workers performing euthanasia were trained for it (Denis-Robichaud et al., 2023).

Recent social science research working directly with dairy caretakers mirrored similar concerns specific to the lack of euthanasia training on farm. Román-Muñiz and colleagues (2021) interviewed 38 dairy caretakers (workers, supervisors and farm owners) and asked the question “Do workers think there is enough training to feel confident performing euthanasia?”. While managers in the focus groups felt confident in the euthanasia training provided, caretakers did not feel confident and expressed a desire for more euthanasia-specific training.

Thus, in order to improve dairy welfare on-farm by eliminating pain and suffering associated with untimely euthanasia, the development of euthanasia training materials that are clear, accessible and effective is needed. Therefore, the objectives of this study were to develop an interactive training program and investigate its potential to improve dairy workers’ perceived euthanasia decision-making skills and awareness of timely euthanasia. The main hypothesis was that training would have an effect in dairy workers’ knowledge regarding timely euthanasia.

4.3 Materials and Methods

The study protocol was approved by the Institutional Animal Care and Use Committee of North Carolina State University (protocol No. 19-601). Animals were cared for and handled in accordance with the Guide for the Care and Use of Agricultural Animals in Research and Teaching (FASS, 2010).

4.3.1 Training Tool Development

A 14-case study multimedia training tool was developed over the course of nine months (October 2020 to July 2021). This tool was developed using a similar educational template created by Mullins and colleagues (2018) to train swine caretakers on euthanasia (Campler et al., 2020). Training materials encompassed euthanasia information over two production stages (calves and cows/heifers) and materials were primarily delivered in a case scenario format. In order to ensure the relevance of the content and its applicability, an external advisory group was formed consisting of veterinarians, dairy scientists, extension specialists and producers (n = 11). This advisory group was responsible for supporting design, delivery, and scientific quality of the tool. All components of the training program were made available to all members of the advisory group for three rounds of reviews (e.g., pictures, videos, scripts, SOPs) over a four-month period utilizing the online platform 360.articulate.com.

4.3.2 Case Scenario Criteria and Development

Case scenarios were developed utilizing photographs and video recordings as the primary source of information. A voice over narrative with easy-to-understand language and limited text were prioritized in order to ensure all participants, including those with poor literacy, could retain information.

Case scenario content was chosen to simulate the most common euthanasia scenarios reported on farm utilizing mortality data collected by National Animal Health Monitoring System (NAHMS; 2014). Case scenario description for calves and cows/heifers are depicted in Figures 4.1 and 4.2, respectively.

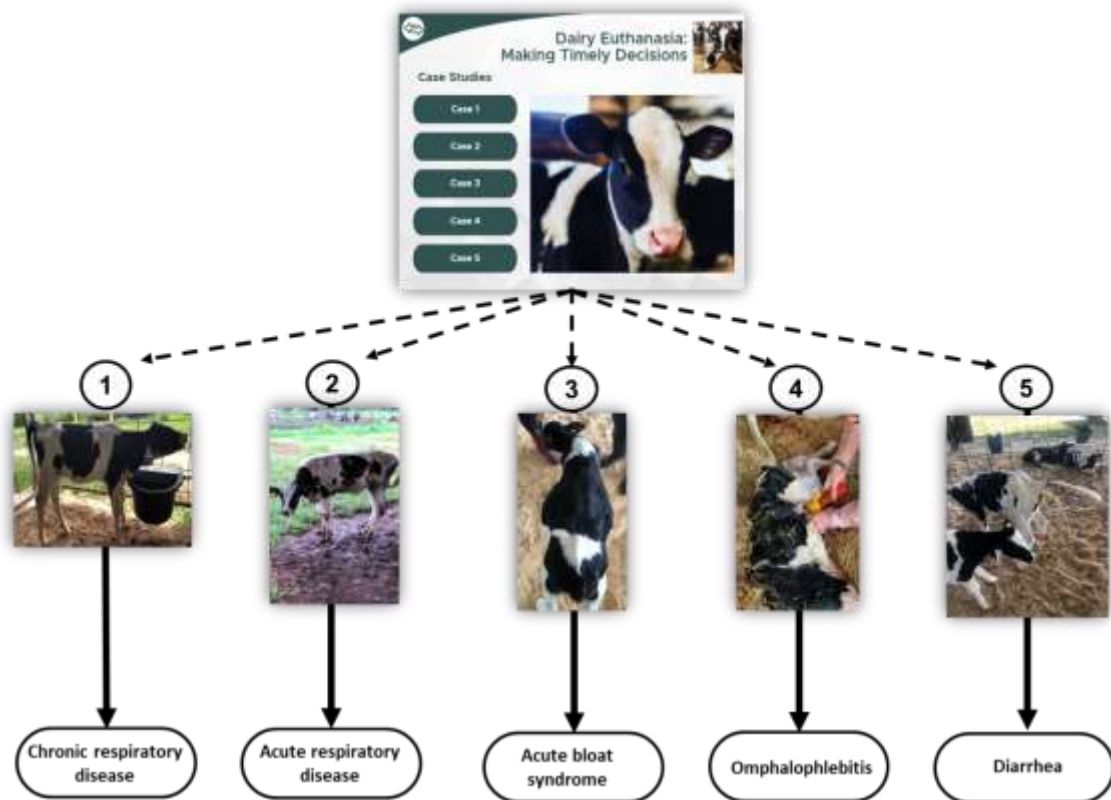


Figure 4.1. Calf case scenarios included in the interactive computer-based training program

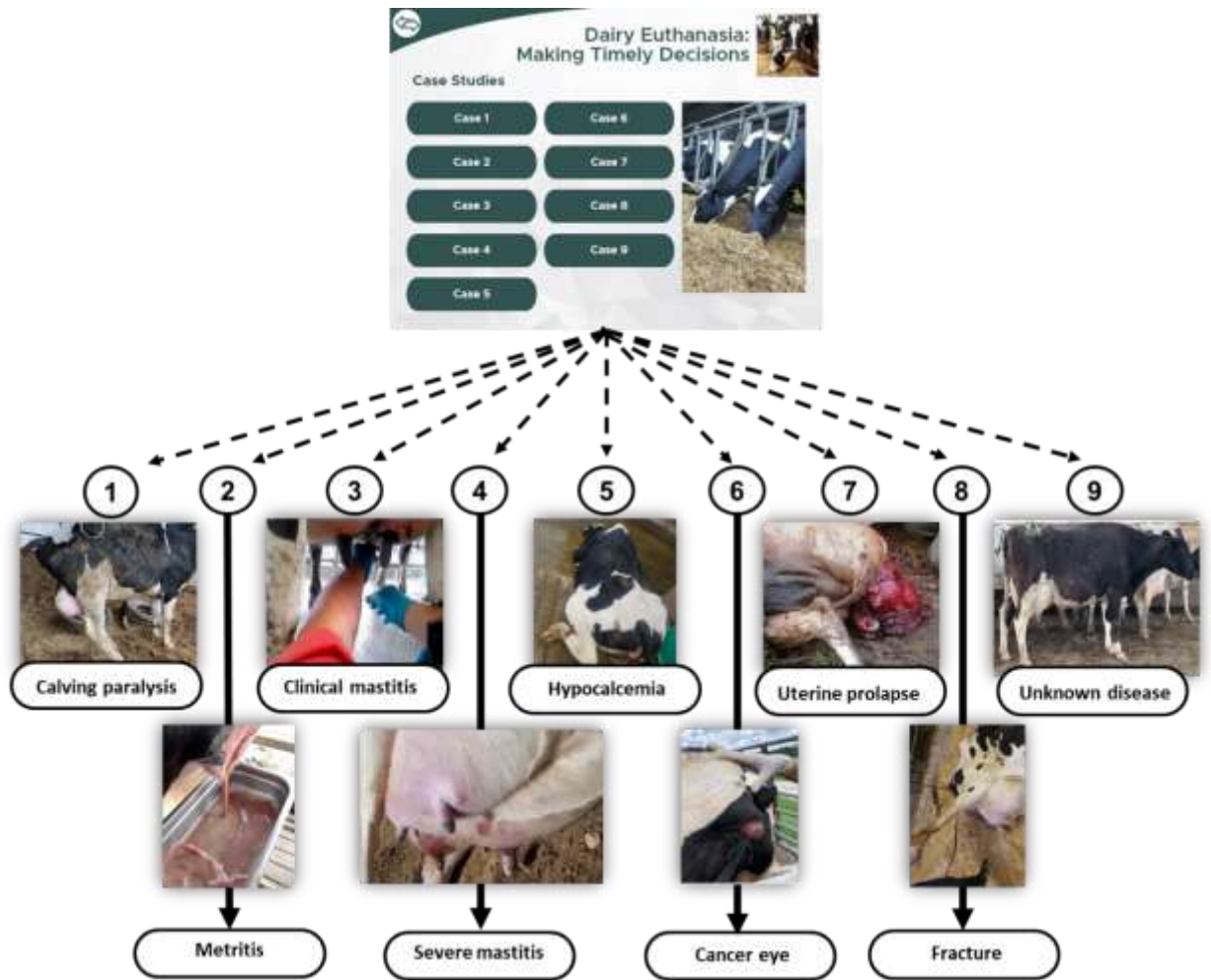


Figure 4.2. Cow case scenarios included interactive computer-based training program

Multimedia content used for the training tool was collected from veterinarians and dairy farmers interested in actively supporting the development of the tool. Individuals were recruited using a convenience sampling methodology in which a private message was sent to individuals belonging to an online dairy cattle group. All multimedia content used in the training tool had explicit permission to be used for teaching purposes. Multimedia content (i.e., videos and images) selected to be used for the program was primarily chosen for its relevance in the dairy industry and the ability for the image/video to mirror the caretaker’s viewpoint.

All case scenarios began by providing the user with a patient signalment, including age, sex, production stage, treatment history, clinical signs and condition. Most case scenarios presented the information to the participant and asked the question “What do you want to do next?”, in which participants were asked to make a decision from one of the following selections: (1) do not intervene and continue to monitor the calf/cow, (2) euthanize the calf/cow within a particular timeframe, or (3) provide treatment or make management changes (e.g., moving the animal into a hospital pen, cleaning the environment, etc.).

Feedback was provided after each question and, if applicable, alternative treatment options were also included. Case scenarios included multiple-choice questions that required an active choice to be made by participants to move forward through the program. In addition, supplemental information was provided to participants on a scenario-by-scenario basis. The finalized version of the program is now publicly available in Spanish or English (<https://nationaldairyfarm.com/index.php/animal-care-training-resources/#euthanasia>), and has an estimated completion time for each production stage of one hour.

4.3.3 On-farm Testing of the Tool

This study was reviewed and approved by North Carolina State University Institutional Review Board (IRB:24324) for The Use of Human Subjects in Research.

Dairy farms from North Carolina, California, and Connecticut were recruited to participate in this study and receive complimentary timely euthanasia training using the training tool described above. Invitations to participate were sent via email to farm personnel who had actively participated in previous research projects and/or training activities led by two of the co-authors in the past. Farms interested in participation worked directly with the authors to schedule training visits. During a three-month period (January to March 2022), authors visited the

participating farms with seven different portable laptops and seven different headphones in order to allow each participant to complete the training individually. Any individual currently working on the farm with direct responsibility for animal care were invited to participate. A \$50 visa gift card was offered for each individual participant as an incentive upon completion of the training program.

4.3.4 Survey

Prior to obtaining access to the training program, participants were required to sign a consent form and complete a pre-training survey. The survey requested demographic information including age, sex, work experience, herd size, previous euthanasia training, previous euthanasia experience, and main work area or production type (see Appendix 1). Previous euthanasia training could include training by the farm's veterinarian or another person in the farm. It could also include simply a firearm course theoretical and/or practical. Respondents were considered to have previous euthanasia experience if they ever euthanized an animal, regardless if it was before or after they started working with cows. In addition, participants were asked to respond to eight statements regarding participants' perceived knowledge of euthanasia practices. The questions were answered on a 5-point scale: 1) strongly disagree, 2) disagree, 3) neither agree nor disagree, 4) agree, or 5) strongly agree. An additional "prefer not to answer" option was also available. The eight statements included:

1. I can determine when a cow/calf needs to be euthanized
2. It is easy to identify a sick or compromised cow/calf
3. I do not have enough knowledge to know what to do with sick or compromised cows/calves
4. I do not have enough knowledge to know if a cow/calf needs to be euthanized

5. I do not have enough knowledge to diagnose what is wrong with sick cows/calves
6. I am confident I can make good euthanasia decisions when needed
7. I am aware of the importance of timely euthanasia
8. I understand how to make good euthanasia decisions

Upon completion of the pre-training survey, participants were provided a portable laptop and headphones and asked to complete the module from the production stage (calves, cows/heifers) in which their job responsibility was more closely aligned with. No additional information that might have contributed to their learning was provided outside of the tool itself. Participants completed all the case scenarios within the stage and received a certificate of completion for the program. Participants were then asked to fill out a post-training survey which consisted of the eight questions described in the pre-training survey and an additional four questions specific to the training program. The post-training survey was also answered using the 5-point scale. The four additional questions were:

9. The training program was realistic
10. The training program presented educational material in a relatable way
11. The training program met my needs for improving my euthanasia-decision making skills
12. The time spent completing the training program was worthwhile

4.4 Statistical Analyses

All analyses were conducted using Stata/IC 17 (StataCorp LP). Basic descriptive analyses were conducted using mean and standard deviation (SD) for numerical variables, and frequency (%) for categorical, and binary variables (further description of the variables is provided below). According to previously published literature (Campler et al., 2020), the expected maximum

difference between pre- and post-training survey scores would be 0.39 points with a variance of 1. A sample size of 82 individuals was calculated to detect 0.39-unit difference in pre- post training scores (e.g., pre = 2.40 vs. post = 2.79) while preventing type I ($\alpha = 0.10$) and type II ($\beta = 0.20$) errors. Data were initially checked for recording errors and missing data. Statement and demographic answers left blank; or selected as “prefer not to answer” were considered missing and excluded from analyses that used those parameters. First, to determine the effect of training on participant knowledge, pre- and post-training survey answers were compared for each of the 8 statements (Table 4.1) using the Wilcoxon signed rank test.

Table 4.1. Descriptive statistics on demographic information and euthanasia experience from study participants.

Variables	
Age, yr	
Median	32
Range	18-70
Ethnicity, % (n)	
Hispanic or Latin	64 (52)
White	31 (25)
African American	3 (2)
Asian	1 (1)
Preferred not to answer	1 (1)
Sex, % (n)	
Male	78 (63)
Female	22 (18)
Dairy experience, yr	
Mean	14
Median	8
Range	0.02-56
Role on farm, % (n)	
Caretakers	58 (47)
Department heads	9 (7)
Multiple roles	7 (6)
Farm managers	15 (12)
Milker	4 (3)
Farm owner	1 (1)
Veterinarians	6 (5)
Previous euthanasia experience (i.e., have you ever euthanized an animal?), % (n)	
Yes	33 (27)
No	63 (51)
Preferred not to answer	4 (3)
Previous euthanasia training, % (n)	
Yes	37 (30)
No	63 (51)
Performed euthanasia in the last six months, % (n)	
Yes	32 (26)
No	68 (55)

Second, a multivariable mixed-effects logistic regression model was created for each question (1 to 8) in order to investigate the effect of age, sex, dairy experience (in yr), farm size, role at the farm, race, previous experience with euthanasia, previous euthanasia training, veterinarian degree, stage of production (cows or calves) on score change; which was the main outcome of interest. This score change was determined as an increase (1) or no increase (0). An

increase in scores from pre-to post-training survey was called “agreement score improvement”. Due to the clustering of participants within dairy farms, farm was included as a random effect for all models. Model-building steps included first checking for linearity between continuous variables and the log odds of the outcome. Since the linearity assumption was not met, variables were categorized as follows: age was divided into two categories [0: ≤ 30 yr of age ($n = 37$) and 1: >30 yr of age ($n = 44$)]; dairy cattle experience was divided into two categories [0: ≤ 2 yr of experience ($n = 11$); 1: 3-9 yr of experience ($n = 26$) and 2: ≥ 10 yr of experience ($n = 34$)]; race was divided up into 3 categories [(1 = white ($n = 25$); 2 = Hispanics or Latin origin ($n = 52$); and 3 = African American or Asian ($n = 3$)]; farm size (number of cows per farm) was divided up into five categories; [1: ≤ 500 ($n = 30$); 2: 501–1,000 ($n = 15$); 3: 1,001-2,000 ($n = 14$); 4: 2,001-3,000 ($n = 9$); and 5: $\geq 3,001$ ($n = 13$)] and role on farm was divided up into 5 categories [1 = caretaker ($n = 47$); 2 = department head ($n = 7$); 3 = milker or multiple roles ($n = 9$); 4 = farm manager or owner ($n = 13$); 5 = veterinarians ($n = 5$)].

Univariable mixed-effects logistic regression models were then built and a P value < 0.2 was used for screening predictors to be used in the full final model building. Multivariable mixed models were then built using a backward stepwise approach. During construction of the final models, confounders were assessed by removing the variables individually and assessing other variable’s coefficients for a change of $\geq 20\%$. If this was the case, variables were retained in the models. Additionally, the Spearman correlation method was used to check for collinearity between all independent predictors, with a cutoff of 0.80. Final statistical significance was declared at $P < .05$ and tendency at $.05 \leq P < .10$.

4.5 Results

A total of 92 individuals across 30 dairy farms participated in the study. Of the 92 participants, 11 participants failed to complete the training and were excluded from the post-training analyses. Among the participants whose data were removed from the post-training analyses, one was not used because they couldn't read the questions asked by the program (but was assisted by the researcher to answer the pre-training survey), three were sent links to access the program but were only able to access the pre-training survey, three had to go back to work before finishing the training, one was struggling to finish the training and decided to abandon it, one farmer had to interrupt the training in order to show their cow during an exposition, and two veterinarians only went through two cases and then decided to interrupt the training to make a copy of the program to distribute it. Final participation number was 81 with an 88.0% completion rate (19 farms = one participant/farm; three farms = two participants/farm; two farms = three participants/farm; two farms = five participants/farm; two farms = eight participants/farm; two farms = 12 participants/farm). Descriptive information regarding demographics, role on the farm, work experience and previous euthanasia training can be found in Table 4.1. Fifty-one participants (63.0%) completed case scenarios within the cow/heifer production stage and 30 respondents (37.0%) completed the case scenarios within the calf production stage. Thirty-one (38.3%) and fifty (61.7%) participants completed the training in English and Spanish, respectively. The mean size of farm on which survey participants worked was 2,000 cows with a range from 100 to 5,500 head.

4.5.1 Wilcoxon Signed Rank Test

Table 4.2 depicts results from Wilcoxon signed rank test and descriptive values for pre- and post-training survey scores of the eight statements specific to perceived knowledge about euthanasia.

Table 4.2. Results from Wilcoxon signed rank test and descriptive values for pre- and post-training survey scores¹.

Statement	Pre-training survey			Post-training survey			Num Diff	P
	n	Mean	SD	n	Mean	SD		
1	87	3.69	1.08	80	4.33	0.82	0.64	< 0.01
2	91	3.93	0.96	81	4.28	0.81	0.35	< 0.001
3	89	2.40	1.19	80	2.03	0.98	-0.38*	0.004
4	84	2.26	1.02	80	2.03	1.04	-0.24*	0.002
5	90	2.38	1.16	80	2.09	1.06	-0.29*	0.02
6	82	3.85	0.96	80	4.25	0.93	0.40	< 0.01
7	86	4.13	0.93	80	4.39	0.77	0.26	< 0.01
8	84	4.04	0.91	80	4.31	0.84	0.28	< 0.01

**Due to negation in statement, a lower score is better*

SD = standard deviation; Num Diff = numerical difference

¹The scores were calculated using a 5-point scale: 1) strongly disagree, 2) disagree, 3) neither agree nor disagree, 4) agree, or 5) strongly agree

The Wilcoxon signed rank test revealed an increase in agreement score for statement 1 (“I can determine when a cow/calf needs to be euthanized”; $P < 0.01$; Table 4.2), 2 (“It is easy to identify a sick or compromised cow/calf”; $P < 0.001$); 6 (“I am confident I can make good euthanasia decisions when needed; $P < 0.01$ ”); 7 (“I am aware of the importance of timely euthanasia”; $P < 0.01$) and 8 (“I understand how to make good euthanasia decisions”; $P < 0.01$); indicating that participants reported increased knowledge about timely euthanasia and its process post-training. In addition, there was a decrease in agreement scores for statements 3 (“I do not

have enough knowledge to know what to do with sick or compromised cows/calves”; $P = 0.004$; Table 4.2), 4 (“I do not have enough knowledge to know if a cow/calf needs to be euthanized”; $P = 0.002$; Table 4.2) and 5 (“I do not have enough knowledge to diagnose what is wrong with sick cows/calves”; $P = 0.02$; Table 4.2).

4.5.2. Mixed-effect logistic regression models

Tables 4.3, 4.4 and 4.5 depicts univariable regression model results for predictors with two-(age, sex, production stage, euthanasia experience), three- (dairy experience and race), and five- (farm size and role on farm) levels, respectively.

Table 4.3. Results from univariable regression models using agreement score improvement as the outcome and two-level predictors of interest¹.

Statement	Two-level variables											
	Age ² , (older vs. younger) ²			Sex, (female vs. male) ³			Production stage, (calves vs. cows) ³			Euthanasia experience ⁴ , (yes vs. no) ³		
	OR	95%CI	P	OR	95%CI	P	OR	95%CI	P	OR	95%CI	P
1	0.91	0.33-2.48	0.85	0.32	0.84-1.18	0.09	1.98	0.71-5.56	0.19	0.28	0.10-0.78	0.02
2	0.40	0.14-1.14	0.09	1.55	0.45-5.33	0.49	1.93	0.69-5.47	0.21	0.52	0.17-1.63	0.26
3	0.93	0.35-2.44	0.88	0.32	0.08-1.23	0.10	1.26	0.47-3.41	0.65	0.58	0.20-1.66	0.31
4	0.60	0.22-1.64	0.32	0.11	0.13-0.86	0.04	1.37	0.50-3.74	0.54	0.98	0.35-2.80	0.98
5	0.77	0.30-2.02	0.60	0.59	0.17-2.01	0.40	2.06	0.77-5.47	0.15	0.44	0.14-1.35	0.15
6	0.55	0.21-1.45	0.23	1.18	0.40-3.49	0.76	0.86	0.32-2.28	0.77	1.09	0.40-3.01	0.86
7	1.89	0.68-5.27	0.22	1.25	0.40-3.90	0.70	0.91	0.33-2.57	0.87	0.49	0.16-1.56	0.23
8	0.73	0.25-0.16	0.57	0.99	0.31-3.14	0.99	0.76	0.27-2.16	0.61	0.83	0.27-2.62	0.76

OR = odds ratio

95% CI = 95% confidence interval

Agreement score improvement was determined as an increase in scores from pre-to post-training survey

¹All predictors with a P-value of 0.20 or less were subsequently offered to the multivariable model

²Age category was older (0: ≤ 30 years) and younger (> 30 years)

³For categorical variables with categories in parentheses, the former was compared with the latter (the reference) to calculate OR and 95% CIs with the regression analysis.

⁴Respondents were considered to have previous euthanasia experience if they ever euthanized an animal, regardless if it was before or after they started working with cows.

Table 4.4. Results from univariable regression models using agreement score improvement as the outcome and three-level predictors of interest

Statement	Dairy experience ²	Three-level variables						
		OR	95%CI	P	Race ³	OR	95%CI	P
1	2	0.28	0.04-2.00	0.21	2	1.56	0.46-5.3	0.48
	3	0.20	0.03-1.56	0.13	3	4.41	0.31-63.65	0.28
2	2	0.35	0.80-1.54	0.17	2	1.22	0.33-4.56	0.76
	3	0.19	0.43-0.89	0.04	3	1.87	0.16-21.61	0.62
3	2	1.26	0.19-8.51	0.81	2	0.86	0.28-2.62	0.79
	3	0.80	0.14-4.69	0.80	3	5.11	0.39-66.86	0.21
4	2	0.83	0.19-3.67	0.81	2	0.73	0.25-2.13	0.56
	3	0.53	0.11-2.42	0.41	3	6.00	0.54-67.28	0.15
5	2	0.33	0.07-1.5	0.15	2	1.00	0.34-2.91	1.00
	3	0.41	0.09-1.77	0.23	3	7.70	0.68-87.25	0.10
6	2	0.65	0.15-2.77	0.56	2	1.58	0.56-4.48	0.39
	3	0.60	0.14-2.66	0.50	3	4.00	0.31-51.03	0.29
7	2	NA	NA	0.98	2	1.84	0.58-5.88	0.88
	3	NA	NA	0.98	3	3.80	0.42-34.08	0.34
8	2	3.65	0.39-34.18	0.26	2	1.14	0.38-3.46	0.81
	3	1.23	0.15-10.04	0.85	3	2.30	0.26-20.34	0.45

OR = odds ratio; NA = model did not convert

95% CI = 95% confidence interval

Agreement score improvement was determined as an increase in scores from pre-to post-training survey

¹All predictors with a P-value of 0.20 or less were subsequently offered to the multivariable model

²Dairy experience was divided up into three categories: 1: ≤ 2 years of experience (reference); 2: >2 years of experience and 3: ≥ 10 years of experience.

³Race was divided into 3 categories: 1 = white (reference); 2 = Hispanics or Latin origin; and 3 = African American or Asian.

Table 4.5. Results from univariable regression models using agreement score improvement as the outcome and five-level predictors of interest¹.

Statement	Farm size ²	OR	95%CI	Five-level variables				
				<i>P</i>	Role on farm ³	OR	95%CI	<i>P</i>
1	2	1.21	0.30-4.92	0.79	2	1.67	0.24-11.62	0.61
	3	0.54	0.14-2.15	0.38	3	0.20	0.03-1.64	0.14
	4	0.26	0.03-2.12	0.21	4	0.15	0.03-0.82	0.03
	5	2.46	0.29-21.12	0.41	5	0.10	0.01-1.49	0.10
2	2	2.70	0.73-10.05	0.14	2	0.38	0.05-2.98	0.36
	3	0.60	0.15-2.36	0.47	3	0.12	0.01-1.37	0.09
	4	0.43	0.08-2.42	0.34	4	0.12	0.01-1.05	0.06
	5	0.27	0.05-1.46	0.13	5	1.54	0.14-16.49	0.72
3	2	1.12	0.30-4.15	0.86	2	1.62	0.10-3.77	0.60
	3	0.82	0.22-3.09	0.77	3	1.10	0.23-5.31	0.90
	4	0.44	0.08-2.52	0.35	4	0.94	0.25-3.59	0.93
	5	0.58	0.15-2.31	0.44	5	1.01	0.14-7.29	1.00
4	2	1.06	0.25-4.45	0.94	2	0.80	0.14-4.65	0.80
	3	1.32	0.34-5.19	0.69	3	0.80	0.14-4.65	0.80
	4	0.60	0.10-3.51	0.57	4	1.00	0.26-3.90	1.00
	5	0.79	0.17-3.71	0.77	5	0.50	0.05-4.90	0.55
5	2	1.30	0.34-4.97	0.71	2	0.25	0.03-2.25	0.22
	3	0.93	0.23-3.78	0.92	3	0.43	0.08-2.30	0.32
	4	0.78	0.13-4.62	0.78	4	0.27	0.05-1.38	0.12
	5	1.04	0.25-4.62	0.96	5	0.37	0.04-3.63	0.40
6	2	1.55	0.36-6.61	0.58	2	0.47	0.08-2.70	0.40
	3	1.80	0.48-6.81	0.38	3	1.56	0.31-7.90	0.59
	4	0.77	0.16-3.75	0.75	4	0.58	0.15-2.26	0.44
	5	0.66	0.14-3.12	0.60	5	0.29	0.03-2.85	0.29
7	2	1.48	0.33-6.57	0.61	2	1.50	0.29-7.65	0.63
	3	0.37	0.07-2.01	0.25	3	0.67	0.12-2.08	0.65
	4	0.63	0.11-3.68	0.61	4	0.40	0.08-2.08	0.28
	5	1.59	0.39-6.38	0.52	5	0.50	0.05-4.90	0.55
8	2	0.90	0.19-4.34	0.90	2	0.27	0.30-2.46	0.25
	3	1.06	0.25-4.45	0.94	3	3.25	0.53-19.82	0.20
	4	0.60	0.10-3.51	0.57	4	0.33	0.06-1.68	0.18
	5	1.81	0.47-6.97	0.39	5	0.41	0.04-3.96	0.44

OR = odds ratio

95% CI = 95% confidence interval

Agreement score improvement was determined as an increase in scores from pre-to post-training survey

¹All predictors with a *P*-value of 0.20 or less were subsequently offered to the multivariable model

²Farm size (cows per farm) was divided up into five categories: 1: ≤ 500 (reference); 2: 501–1,000; 3: 1,001-2,000; 4: 2,001-3,000; and 5: ≥ 3,001

³Role on farm was divided up into 5 categories: 1 = caretaker (reference); 2 = department head; 3 = milker or multiple roles; 4 = farm manager or owner; 5 = veterinarians.

Table 4.6 depicts the final multivariable regression models using improvement on scores as the outcome. For statement 1 (“I can determine when a cow needs to be euthanized”), sex, production stage, previous experience with euthanasia, and role on farm were included in the final model. The final mixed effect logistic regression models revealed that caretakers (reference) had higher odds of improving their agreement score than farm managers and owner (OR 0.11; 95% CI 0.02-0.64; P = 0.01). In addition, participants without previous euthanasia experience (reference) were more likely to improve their score than participants with previous euthanasia experience (OR 0.22; 95% CI 0.06-0.74; P = 0.02).

Table 4.6. Results from multivariable regression models using agreement score improvement as the outcome and following a backwards stepwise variable selection including all predictors with *P*-value < 0.2 in univariable analyses.

Statement	Variable	Categories	OR	95%CI	<i>P</i>
1	Role on farm ¹	Department head	1.46	0.21-10.10	0.70
		Milker or multiple roles	0.22	0.03-1.76	0.15
		Farm manager or owner	0.11	0.02-0.64	0.01
		Veterinarians	0.21	0.01-2.98	0.25
	Euthanasia experience ²	(Yes vs. no) ³	0.22	0.07-0.74	0.02
2	Age ⁴	(Older vs. younger) ³	0.25	0.08-0.83	0.02
	Farm Size ⁵	≤ 500 cows	2.6	0.36-18.40	0.35
		501–1,000 cows	16.0	1.78-144.43	0.01
		1,001-2,000 cows	0.9	0.09-7.83	0.89
		2,001-3,000 cows	0.6	0.05-6.94	0.67
	Role on farm ¹	Department head	0.2	0.02-2.66	0.25
		Milker or multiple roles	0.1	0.00-0.83	0.04
Farm manager or owner		0.2	0.03-1.05	0.06	
Veterinarians		1.9	0.26-14.65	0.52	
3	Sex	(Female vs. male) ³	0.32	0.08-1.23	0.10
4	Sex	(Female vs. male) ³	0.11	0.01-0.86	0.04
	Race ⁶	Hispanic or Latin	0.31	0.09-1.10	0.07
		African American or Asian	6.96	0.32-152.40	0.22
5	Role on farm ¹	Department head	0.24	0.03-2.20	0.21
		Milker or multiple roles	0.43	0.08-2.37	0.33
		Farm manager or owner	0.25	0.05-1.29	0.10
		Veterinarians	0.58	0.05-6.24	0.66

Agreement score improvement was determined as an increase in scores from pre-to post-training survey

¹ Role on farm was divided up into five categories: caretaker (reference), department head, milker or multiple roles, farm manager or owner, veterinarians

² Respondents were considered to have previous euthanasia experience if they ever euthanized an animal, regardless if it was before or after they started working with cows.

³ For categorical variables with categories in parentheses, the former was compared with the latter (the reference) to calculate OR and 95% CIs with the regression analysis.

⁴ Age category was older (> 30 years) and younger (≤ 30 years)

⁵ Farm size (cows per farm) was divided up into five categories: ≤ 500, 501–1,000, 1,001-2,000, 2,001-3,000, and ≥ 3,001 (reference)

⁶ Race was divided into three categories: white (reference); Hispanic or Latin; and African American or Asian.

For statement 2 (“It is easy to identify a sick or compromised cow”) participants’ age, farm size, dairy experience and role on farm were included in the final model. The final mixed-effect logistic regression model revealed that younger participants (reference) were more likely to improve their agreement scores than older participants [> 30 yr); OR 0.25; 95% CI, 0.08-0.83; $P = 0.02$]. In addition, respondents working in medium sized farms (501-1,000 cows) were more likely to improve their agreement scores (OR 16.0; 95% CI 1.78-144.43; $P = 0.01$) when compared to respondents working in larger farms ($> 5,000$ cows; reference). Finally, caretakers (reference) were more likely to improve their agreement score compared to milkers or workers without specific roles on farm (OR 0.1; 95% CI, 0.004-0.83; $P = 0.04$) and caretakers tended to be more likely to improve their agreement score compared to farm managers or owner (OR 0.2; 95% CI, 0.03-1.05; $P = 0.06$).

For statement number 3 (“I do not have enough knowledge to know what to do with sick or compromised calves”), sex was the only variable included in the final model ($P = 0.10$). The final model revealed that male participants (reference) tended to be more likely to improve their agreement score (0.316; 95% CI 0.08-1.23; $P = 0.10$) compared to female participants.

For statement 4 (“I do not have enough knowledge to know if a calf needs to be euthanized”), sex and race were included in the final model. The final model stated that male participants (reference) were more likely to improve their agreement score compared to female participants (OR 0.11; 95% CI, 0.01-0.86; $P = 0.04$), and white respondents (reference) tended to be more likely to improve their agreement score compared to Hispanic/Latin respondents (OR 0.31; 95% CI 0.089-1.10, $P = 0.07$).

For statement 5 (“I do not have enough knowledge to diagnose what is wrong with sick calves”), production stage, euthanasia experience, dairy experience, race, role on farm were

included in the final model. The final mixed effect logistic regression models revealed that caretakers (reference) tended to be more likely to improve their agreement score than farm managers or owner (0.25; 95% CI, 0.05-1.29; P = 0.10).

There were no statistically significant predictors for statements 6 (“I am confident I can make good euthanasia decisions when needed”), 7 (“I am aware of the importance of timely euthanasia”), and 8 (“I understand how to make good euthanasia decisions”).

4.5.3 Post-Training Evaluation

Table 4.7 depicts the descriptive values for the four post-training survey statements’ scores according to dairy experience (these four statements were only included in the post-training survey). Dairy participants with less experience (< 2 yr working with dairy cows) had numerically higher averages than participants with more experience (> 10 yr working with dairy cows). Table 4.8 depicts the descriptive values for the four post-training survey statements’ scores according to role on farm. Veterinarians had the numerically highest agreement scores whereas milkers and respondents without specific role on farm had the lowest agreement scores.

Table 4.7. Agreement to survey statement (mean + SD) on a 5-point scale (1= strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree) according to dairy experience (number of years) ^{*,1}.

Statement	< 2 (n =7)		2-10 (n = 31)		> 10 (n = 33)	
	Mean	SD	Mean	SD	Mean	SD
9	4.71	0.49	4.61	0.79	4.47	0.57
10	4.86	0.38	4.67	0.78	4.63	0.49
11	4.83	0.41	4.64	0.78	4.60	0.56
12	4.71	0.49	4.70	0.77	4.53	0.57

**Ten respondents did not disclose their dairy experience*

SD = standard deviation

¹The scores were calculated using a 5-point scale: 1) strongly disagree, 2) disagree, 3) neither agree nor disagree, 4) agree, or 5) strongly agree

Table 4.8. Agreement to survey statement (mean + SD) on a 5-point scale (1= strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree) according to role on farm¹.

Statement	Caretakers (n = 47)		Department heads (n = 7)		No specific role (n = 6)		Farm Managers and owner (n = 13)		Milker (n = 3)		Veterinarians (n = 5)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
9	4.45	0.93	4.57	0.53	4.33	0.52	4.62	0.62	4.00	0.00	5.00	0.00
10	4.57	0.89	4.71	0.49	4.33	0.52	4.69	0.61	4.33	0.58	5.00	0.00
11	4.53	0.89	4.57	0.53	4.50	0.55	4.77	0.58	3.67	0.58	5.00	0.00
12	4.53	0.88	4.57	0.53	4.50	0.55	4.62	0.74	4.33	0.58	5.00	0.00

SD = standard deviation; NA = not applicable

¹*The scores were calculated using a 5-point scale: 1) strongly disagree, 2) disagree, 3) neither agree nor disagree, 4) agree, or 5) strongly agree*

4.6 Discussion

Euthanasia itself is a complex, multi-step process that begins with identifying compromised cattle and undertaking a series of decision-making steps to choose to treat, monitor or euthanize (Wagner et al., 2020a). Due to its complexity, ethical issues and mental health impacts, euthanasia should only be performed by skilled individuals that are able to assess each situation and determine the best outcome for the animal (Sivula and Suckow., 2018; AVMA, 2020). However, educational information is deficient for providing dairy caretakers with training resources thus preventing individuals in gaining the skills necessary to confidently euthanize (Wagner et al., 2020a, 2020b). Therefore, the main objective of this study was to develop and evaluate the efficacy of an interactive training program on timely euthanasia for those working on dairy farms. In accordance with a previous report (Campler et al., 2020), targeting participants directly involved in on-farm euthanasia decision-making was determined to be the most effective method to evaluate the efficacy of the training program. In addition, recruiting Latino/a participants to complete the training program solidified the study's external validity given Hispanic labor encompasses the primary labor source for large-herd operations in the US (Grusenmeyer et al., 2004; Jenkins et al., 2009).

The multimedia training tool developed in this study effectively increased participant knowledge regarding timely euthanasia and its decision-making process as demonstrated in post-training response scores. Overall, individuals participating in the study who completed the training program felt more confident in properly identifying compromised animals, determining when an animal should be euthanized (i.e., make good euthanasia decisions), and understanding the importance of timely euthanasia upon completion of the program. These results are in agreement with the previously developed multimedia training program educating swine

caretakers on timely euthanasia and decision-making (Mullins et al., 2018). This program replicated teaching strategies used in the swine euthanasia program and focused heavily on the use of images, videos, and voice-overs, to ensure all participants, regardless of literacy level, could retain the information. Therefore, the results from both the swine and dairy training clearly indicate that this is an effective approach to training caretakers on euthanasia and is supported by the increase in perceived knowledge scores achieved post-training.

Although post-training scores improved for all statements, it is valuable to note that specific factors, including age, experience, sex, farm size, and role on farm individually influenced scores for different questions and should be considered when delivering the training program to future participants. For example, when comparing scores between participants, younger (≤ 30 yr) and less experienced caretakers (< 2 yr) were more likely to improve their ability to identify a sick or compromised cow (statement 2) and effectively determine when a cow requires euthanasia (statement 1) compared to older (> 30 yr) and more experienced caretakers (> 10 yr). Although difficult to disentangle, these results are supported by previous work in swine (Campler et al., 2018) which demonstrated that more experienced caretakers (more than 2 yr of swine experience) were more confident and knowledgeable about making euthanasia decisions than younger caretakers. Whether this is because younger caretakers intrinsically have less dairy experience because of their age, or because age plays a role in the caretaker confidence in making decisions, younger, less experienced individuals on-farm should be prioritized to receive training and provide ample opportunities for continuing education specific to euthanasia decision-making. It is worth restating that National Dairy FARM Program Animal Care Version 4.0 does have requirements for continuing education on euthanasia for caretakers that have that responsibility on the dairy (FARM, 2020). It is with access to resources

such as this program that caretakers can develop the confidence and skillset to effectively make humane euthanasia decisions, thus improving overall animal welfare on the dairy farm.

In addition to age and experience, male respondents were less likely to feel they had enough knowledge to know what to do with sick or compromised cattle (statement 3) and to know if an animal needs to be euthanized (statement 4) post-training compared to females. These results are in agreement with Campler and colleagues (2018) who demonstrated that male participants were four times less likely to be grouped in the confident cluster in regards to euthanasia decision-making for swine when compared to females. This is an alarming concern, given that 73 percent of current dairy farm workers are males (USDA, 2019). Although female workers have been described as having more negative attitudes toward euthanasia than male workers (Matthis, 2005), including more painful emotions and complex feelings (Denis-Robichaud et al., 2023), the females' willingness to perform euthanasia was not different from males' (Matthis, 2005). In fact, most of the females (89%) opted for the most suitable method (i.e. less painful) to perform euthanasia (Matthis, 2005), therefore it may be valuable to include females in the decision-making roles on the farm.

Farm size also influenced overall results, with caretakers working on medium size farms (501-1,000 cows) more likely to improve their ability to identify a sick or compromised cow (statement 2) when compared to those working on large farms. One potential reason for this may be due to the fact that larger dairy farms are more likely to require formal employee training (Robbins et al., 2016) and therefore, individuals may have been exposed to and received previous educational training specific to euthanasia.

Lastly, when evaluating the overall acceptance of the program, veterinarians participating in the study demonstrated the highest likeability scores. As demonstrated in previous literature,

veterinarians are heavily relied upon for training caretakers and assisting with the development of euthanasia protocols to ensure timeliness (Wagner et al., 2020b). Given this, veterinarians may find greater value to the training program given these resources directly support their work and provide science-based guidance to inform decisions and recommendations specific to euthanasia. Therefore, in order to promote the dissemination of this training program to all workers on dairy farms, individual veterinarians and veterinary organizations (e.g. American Association of Bovine Practitioners) may serve as strong advocates to promote and support structured euthanasia training programs on a national level.

This study is novel and provides significant value for the dairy industry as it provides the first US multimedia program on timely euthanasia free of charge and readily available to all individuals working in the dairy industry. In addition, this study provides direct insight on challenges associated with euthanasia by utilizing an inclusive survey methodology encompassing diverse participant demographics with a wide range of ages, experience levels, cultures and perceived skill levels regarding timely euthanasia. One limitation of the study is the absent definition of previous euthanasia training used in the survey. Therefore, participant interpretation of what euthanasia training was considered could have been different. Given this, previous euthanasia training may not have been significant given potential variations and details of training programs currently available on farm. Further limitations of the study include a potential selection bias of the respondents due to the incentive offered upon completion of the training; a potential selection bias by using a convenient sample of proactive and open farms personnel; limited farm numbers and farm owners included in the study and the lack of some type of assessment to determine if the program actually changed behavior on farm related to euthanasia. Future studies should include a more specific definition of previous euthanasia

training and assess long-term efficacy of the program by assessing knowledge retention and behavioral change of respondents and compare this to animal condition and welfare assessment data.

4.7 Conclusions

In conclusion, the interactive training program appeared to effectively increase short-term participant knowledge regarding timely euthanasia and its decision-making process. Upon completion of the training program, individuals felt more confident in identifying compromised animals, determining when an animal should be euthanized, and understanding the importance of timely euthanasia.

However, it was also noted that respondents' demographics influenced their perceived knowledge; therefore, certain demographics should be considered when delivering the training program to future participants. Specifically, younger, less experienced caretakers on-farm should be prioritized to receive training. Ensuring that individual veterinarians and veterinary organizations have access to this program may aid in promoting and supporting the training program on a national level.

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4.10 Conflict of interest

The authors have not stated any conflicts of interest.

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CHAPTER 5

Dairy workers' attitudes toward dairy cattle euthanasia

Victoria R. Merenda, Eduardo B. de Oliveira, Magdiel Lopez-Soriano, Andréia G. Arruda, Ashley Robbins, and Monique D. Pairis-Garcia.

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5.1 Abstract

Implementing timely and humane euthanasia in dairy farms remains a critical concern. One of the possible barriers for the implementation of timely euthanasia on-farm is dairy workers' attitudes towards the act. The objectives of this study were to investigate dairy workers' attitudes toward dairy cattle euthanasia and their association to individuals' demographic characteristics. A total of 81 workers from 30 dairy farms (ranging in size from less than 500 to more than 3,000 cows) participated in the survey and most participants were caretakers ($n = 45$; 55.6%) or farm managers ($n = 16$; 19.8%), with an average work experience of 14.8 years. Dairy workers' attitudes toward dairy cattle (empathy affect, empathy attribution, and negative attitudes about cattle), working environment (relying on others, perceived time constraints) and euthanasia decision-making (feeling comfortable with euthanasia, feeling confident, seeking knowledge, using different sources to obtain advice, having negative attitudes about euthanasia, having insufficient knowledge, having trouble deciding when to euthanize and avoiding if possible) were identified and used for cluster analyses. Cluster analyses identified three distinct clusters: (1) confident but uncomfortable with euthanasia ($n = 40$); (2) confident and comfortable with euthanasia ($n = 32$); and (3) unconfident, lacking knowledge and detached from cattle ($n = 9$). Dairy workers' demographic characteristics (age, sex, race and ethnicity, dairy experience, role on farm, farm size, and previous euthanasia experience) were used as predictors for the risk factor analyses. The risk analysis demonstrated that there were no predictors for cluster one, but white workers ($P = 0.04$) and caretakers that had previous euthanasia experience tended to be more likely to be members of cluster two ($P = 0.07$) while respondents that worked in farms with 501-1,000 cows were more likely to be grouped in cluster three. This study provides vital information about variability in dairy workers' attitudes toward dairy euthanasia as well as its

association with race and ethnicity, farm size, and previous euthanasia experience. This information can be used to implement appropriate training and euthanasia protocols to increase both human and dairy cattle welfare on farm.

5.2 Introduction

Optimizing animal welfare conditions on dairy farms in the United States (US) requires producers to prioritize animal welfare from birth to death. Much improvement has been accomplished to improve health, expression of natural behavior and positive affective states on dairy farms (Von Keyserlingk and Weary, 2017); however, implementing timely and humane euthanasia remains a critical concern (Walker et al., 2020). A National Animal Health Monitoring System report (NAHMS, 2014) estimates that more than 300,000 dairy cows and 500,000 calves and heifers die unassisted, without the benefit of euthanasia, on an annual basis. Mortality on dairy farms varies across production stage. Pre-weaned heifer mortality was primarily attributed to digestive and respiratory problems (56.4 and 24%, respectively); whereas mature cow deaths were identified as or attributed to non-ambulatory, mastitis, injuries and unknown reasons (25, 13.2, 11, and 11.9%, respectively; NAHMS, 2014).

Ensuring timely and humane euthanasia to compromised cows whose likelihood of recovery is poor is an ethical obligation for all individuals who provide care to dairy cattle. However, the act itself is difficult to perform and one major factor associated with failed euthanasia implementation is the emotional component involved in making the decision to euthanize (Román-Muñiz et al., 2021). Choosing to end the life of an animal is highly dependent upon the attitude, willingness, and the emotional response of the individual performing the act (Edwards-Callaway et al., 2020; Wagner et al., 2020). From a companion animal standpoint, caretakers have been reported to use soft metaphors such as “put to sleep” or “put down” rather than stronger terms as “killing” to describe euthanasia as a strategy for coping with euthanasia (Kemp et al., 2016). Additionally, the use of metaphors as “doing the right thing” or the “best

thing for me and the animal” also seemed to relieve the experience of human suffering (Kemp et al., 2016).

Requesting an unexperienced employee to perform euthanasia may cause a significant amount of stress, which may ultimately lead to job dissatisfaction. Job turnover rates are high in the livestock industry, driven by job satisfaction issues and workforce instability (Limeade, 2020). This situation is even more concerning given that traditional sources of farm workers (family members) are decreasing as family members seek employment opportunities outside of the livestock industry (Panikkar and Barrett, 2021). Additionally, there is a growing challenge in managing and motivating teams of employees, many of whom come from non-farm backgrounds and have no prior experience working with livestock (English, 2002). Therefore, understanding farm workers’ attitudes toward animals and whether their attitudes are related to their demographic characteristics may help on selecting the most competent employees to perform euthanasia on-farm.

Previous studies have identified some factors influencing human attitudes towards animals and their welfare (Kellert 1984; Hemsworth 2003; Serpell 2004). For instance, the 1984 study reported that gender, pet ownership, age, education and place of residence were demographic characteristics that could influence individuals’ attitudes. More specifically, Kellert (1984) found that farmers, individuals over 76 years of age, residents of rural areas, and males were the least likely to have a humanistic (i.e. strong affection for individual animals) attitude towards animals; whereas livestock producers were the most likely to have negativistic attitudes (i.e. active avoidance of animals due to dislike or fear). In the dairy industry, similar results were reported. For instance, farmers with more negative behavioral attitudes towards cows had a lower proportion of cows that accepted being touched (des Roches et al., 2016), whereas

farmers' positive attitudes towards cows were associated with calmer cows (Ebinghaus et al., 2018).

Specific to attitudes toward livestock euthanasia, research in the swine industry reported that caretakers' attitudes toward pigs not only influenced their inclination to perform euthanasia (Coleman and Hemsworth, 2014) but impacted the reliability, consistency and quality on how euthanasia was executed (Hemsworth et al., 1994). Furthermore, researchers also found that demographic characteristics such as lack of training and knowledge concerning euthanasia were moderately correlated with swine caretakers' inadequate decision-making and euthanasia avoidance (Rault et al., 2017). In agreement with the aforementioned results, Campler and colleagues (2018) found that insufficient perceived knowledge about swine euthanasia was correlated with indecisiveness and avoidance to perform the act and resulted in caretakers feeling guilty.

Specific to attitudes toward dairy cattle euthanasia, a recent study in Canada (Denis-Robichaud et al., 2023) found that participants who felt troubled about the responsibility for ending the life of their animals reported negative emotions more often than those who felt comfortable with this act. In addition, sex and farm size were reported to be associated with attitudes toward euthanasia with women and farmers from small farms more likely to report negative emotions toward euthanasia (Denis-Robichaud et al., 2023). Furthermore, a 2000 study reported that female caretakers showed more positive behavior toward veal calves compared with male caretakers (Lensink et al., 2000).

In the US, dairy workers' attitudes toward dairy cattle euthanasia and individuals' demographic characteristics that lead to appropriate euthanasia performance are unknown. Most importantly, euthanasia can negatively impact caretaker mental health and hinder animal welfare

via euthanasia avoidance overtime (Román-Muñiz et al., 2021). Given this, the objective of this study aimed to investigate dairy workers' attitudes toward dairy cattle euthanasia and its association to individuals' demographic characteristics.

5.3 Materials and Methods

This study was reviewed and approved by North Carolina State University Institutional Review Board (IRB:24324) for The Use of Human Subjects in Research.

5.3.1 Survey

Dairy farms from North Carolina, California, and Connecticut were recruited to participate in this study and receive complimentary timely euthanasia training using a training tool as part of a larger 2022 interactive euthanasia training program (Merenda et al., 2023). Invitations to participate were sent via email to farm personnel who had actively participated in previous research projects and/or training activities led by two of the co-authors (Eduardo B. de Oliveira and Ashley Robbins). Interested farms worked directly with the authors to schedule training visits. During a three-month period (January to March 2022), two authors visited the participating farms with seven different portable laptops and seven different headphones in order to allow each participant to complete the training and survey individually. Any individual currently working on the farm with direct responsibility for animal care was invited to participate.

Prior to obtaining access to the survey and the training program tested in Merenda et al. (2023), participants were required to sign a consent form allowing the use of their anonymous answers and demographic information by the researchers. Upon signing the consent form, the participants had access to the survey. The surveys were created in both Spanish and English using QualtricsXM software (Qualtrics, Provo, Utah). The participants were free to choose which language they felt most comfortable with and which production type (cows or calves) was most aligned with their work. Statements between production types were the same with the

exception between the word “cow” or “calves” (i.e. “cows are sociable creatures” or “calves are sociable creatures”).

The survey was composed of two sections. The survey questions of both sections were adapted to dairy farm workers from previous framework developed by Rault et al. (2017). Rault et al. (2017) designed a questionnaire to assess caretakers’ attitudes towards swine euthanasia, factors related to decision-making (e.g. inadequate knowledge, knowledge seeking, and confidence by self-assessment), and to obtain various caretaker demographic characteristics.

The first section (Appendix 2) asked questions specific to the participant’s demographic information including age, sex, race and ethnicity, place where participants grew up, dairy experience, role on farm, farm size where the participants worked, previous euthanasia experience, previous livestock experience, previous euthanasia training, and recent euthanasia experience (regardless of the method used).

The second section of the survey consisted of 49 questions in which responses were reported on a 5-point scale, from 1) strongly disagree, 2) disagree, 3) neither agree nor disagree, 4) agree to 5) strongly agree (Table 5.1). An additional “prefer not to answer” option was also available. The statements addressed empathy, including such statements as “I try to understand cows by imagining how things look from their point of view”. In addition, some statements were related to perceived skillsets and personal knowledge regarding identification, evaluation, and decision-making of sick cows and included statements such as “I have enough time during my workday to identify sick and compromised cows”. Finally, there were statements related to management, attitudes, and confidence when working with cows and included statements such as “I can determine when a cow needs to be euthanized”.

Table 5.1. Second section of the survey: survey statements and attitudes¹

Attitude, Cronbach's alpha	Survey statements
Positive attitudes	
Empathy affect, 0.86	Imagining how a cow feels is something I do often I try to understand cows by imagining how things look from their point of view When I see cows having fun, I feel really happy If I see a cow injure itself, I know how it feels When I see an unhappy cow, it upsets me more than it would upset most people Seeing a contented cow makes me feel really good I am better at telling if a cow is happy than most other people
Empathy attribution, 0.83	Cows are generally able to feel sadness I think of cows as generally able to feel happiness Cows have feelings like people have feelings Cows are sociable creatures I consider that each cow is an individual with its own personality
Comfortable with euthanasia, NA	I feel comfortable doing euthanasia
Confidence, 0.79	When I see a sick cow, I usually know if it will get better When I see a sick cow, I usually know what is wrong with it I can determine when a cow needs to be euthanized It is easy to identify a sick or compromised cow
Relying on others, 0.53	I can rely on my coworkers to monitor sick cows when I am away from work Coworkers are as good as I am at caring for sick cows I do not like to rely on others to continue the care of my sick cows (R)
Seek knowledge, 0.59	I regularly check work instructions to know how to deal with sick cows Our vet regularly gives us instructions on how to treat sick cows I update my knowledge on sick cow management regularly
Use different sources to obtain advice, 0.77	I use the internet to help me diagnose what is wrong with sick cows My supervisor helps me diagnose what is wrong with sick cows My vet helps me diagnose what is wrong with sick cows I use written protocols to help me identify what is wrong with sick cows I rely on coworkers to help me diagnose what is wrong with sick cows I ask coworkers for advice on diagnosing sick cows
Negative attitudes	
Negative attitudes about euthanasia, 0.47	If I had the choice, I prefer someone else to euthanize cows rather than myself I dislike euthanizing cows I try to save all cows I try not to think about the cow feelings when I euthanize it
Insufficient knowledge, 0.81	I do not have enough knowledge to know what to do with sick or compromised cows I do not have enough knowledge to know if a cow needs to be euthanized I do not have enough knowledge to diagnose what is wrong with sick cows
Negative attitudes about cattle, 0.58	Seeing a neglected animal does not affect me as much as it would affect some people Cows are unfriendly Cows' behavior is not affected by the way we treat them I think of cows as generally being dirty
Perceived time constraints, 0.67	I have too many animals to look after Cows are too crowded for me to easily inspect them all properly I do my other routine jobs before I inspect the cows each day I have enough time during my workday to identify sick and compromised cows (R) I have as much time on the weekends to inspect the cows as I do on the weekdays (R)
Trouble deciding when to euthanize and avoid if possible, 0.62	I tend to wait longer than I should before euthanizing a cow I often feel that there are good reasons for not euthanizing a cow I often disagree when a coworker says a cow needs to be euthanized I am more likely to euthanize a cow now than 5 years ago (R) I am less likely to euthanize a cow that is closer to calving than other cows I know that euthanasia is the right thing to do to stop suffering but I feel bad about doing it

(R) = The scale was later reversed for analyses with higher score corresponding to a higher agreement.

¹Responses were reported on a 5-point scale, from 1) strongly disagree, 2) disagree, 3) neither agree nor disagree, 4) agree to 5) strongly agree

NA = non-applicable

To assure that statements were answered carefully and help correct for agreement bias, four statements were reverse worded to contain a negation. The scale for these specific questions was reversed with the higher agreement corresponding to a higher score.

5.4 Statistical Analyses

Cluster, univariate, and multivariable analyses were conducted using Stata/IC 17 (StataCorp., College Station, Texas). The sample size used in this study was based on previous calculations for a larger 2022 interactive euthanasia training program (Merenda et al., 2023). In Merenda et al. (2023), participants were required to fill out a survey before the training (pre-survey), complete the euthanasia training, and then fill out a post-training survey (post-survey). Pre- and post-survey scores were compared and the expected maximum difference between pre- and post-training survey scores was 0.39 points with a variance of 1. A sample size of 82 individuals was calculated to detect 0.39-unit difference in pre- post training scores (e.g., pre = 2.40 vs. post = 2.79) while preventing type I ($\alpha = 0.10$) and type II ($\beta = 0.20$) errors. However, the final participation number was 81 individuals.

Data were initially checked for missing data and recording errors. Statement and demographic answers left blank; or selected as “prefer not to answer” were considered missing and excluded from analyses that used those parameters. Basic descriptive analyses were performed including descriptive plots, and basic statistics (mean, SD, range) followed by multivariable analysis in the form of cluster analysis and multivariable risk factor analyses. Then, based on previous research conducted in swine (Rault et al., 2017), responses from different questions were averaged into twelve different variables (Table 5.1). For instance, seven questions related to the evoked feelings in the dairy worker were averaged into one variable called “empathy affect” while the responses from four questions related to empathy toward cows

were averaged into one variable called “empathy attribution,” for further analysis (Rault et al., 2017). Post-hoc analyses of the scale reliability coefficients (Cronbach's alpha) for these specific 12 variables (divided between positive or negative) are depicted in Table 5.1.

Cluster analyses were used as a tool for grouping study participants into groups that were similar in regard to their survey responses. The set of questions included in the cluster analysis was composed by the 12 specific variables from the survey, which did not include the demographic questions. Cluster analyses identified three distinct clusters that were further used in the following risk factor analyses.

Three separate mixed effect logistic multivariable models (one for each cluster) were created using membership for each identified cluster as a dichotomous outcome (‘yes’ or ‘no’) and age, sex, dairy experience (in years), farm size, role at the farm, race and ethnicity and previous euthanasia experience, as predictors. Because previous euthanasia training could include training by another person in the farm or the farm’s veterinarian and participant interpretation of what euthanasia training was considered could have been different, it was not included in the model as a risk factor. Respondents were considered to have previous euthanasia experience if they ever euthanized an animal, regardless if it was before or after they started working with cows. Respondents were considered to have recent euthanasia experience if they euthanized an animal in the last 6 months. Farm was included as a random effect for all models due to the clustering of respondents within dairy farms. The first step of model-building was checking for linearity between continuous variables and the log odds of the outcome. Given that this assumption was not met, variables were categorized as follows: dairy cattle experience was divided into two categories (0: ≤ 2 years of experience; 1: >2 years of experience and 2: ≥ 10 years of experience); age was divided into two categories (0: ≤ 30 years of age and 1: >30 years

of age); race and ethnicity was divided up into 3 categories (1 = white; 2 = Latin-Americans; and 3 = African American); farm size (number of cows per farm) was divided up into five categories; (1: ≤ 500 ; 2: 501–1,000; 3: 1,001-2,000; 4: 2,001-3,000; and 5: $\geq 3,001$) and role on farm was divided up into 5 categories (1 = caretaker; 2 = department head; 3 = milker or multiple roles; 4 = farm managers; 5 = veterinarians). Following this step, univariable mixed-effects logistic regression models were built and a P value < 0.2 was used for screening predictors to be used in the full final model building. Multicollinearity between variables that moved to the final model was checked using the Spearman correlation coefficient and a cut-off of 0.80. Finally, multivariable mixed models were built using a backward stepwise approach, with final statistical significance declared at $P < .05$ and tendency at $.05 \leq P < .10$.

5.5 Results

A total of 92 individuals across 33 dairy farms participated in the study. Of the 92 participants, 11 participants failed to complete the questions (missing data points) or chose not to answer and were excluded from the analysis. Therefore, final participation number was 81 workers from 30 different farms. Table 5.2 depicts the descriptive statistics on demographic information and euthanasia experience from study participants. The Cronbach's alpha was low (< 0.70) for “relying on others”, “seek knowledge”, “negative attitudes about euthanasia”, “negative attitudes about cattle”, “perceived time constraints”, and “trouble deciding to euthanize and avoid if possible” (Table 5.1).

Table 5.2. Descriptive statistics on demographic information and euthanasia experience from study participants

Variables	
Age, yr	
Average	35
Range	18-70
Sex, % (n)	
Male	78 (63)
Female	22 (18)
Race and ethnicity, % (n)	
Hispanic or Latin-American	60 (49)
White	36 (29)
African American	4 (3)
Place growing up, % (n)	
City	17 (14)
Town	21 (17)
Rural area	62 (50)
Dairy experience, yr	
Mean	14 .8
Median	8
Range	0.07-56
Role on farm, % (n)	
Caretakers	56 (45)
Department heads	9 (7)
Multiple roles	10 (8)
Farm managers	20 (16)
Veterinarians	6 (5)
Farm size, n cows	
Less than 500	42 (34)
Between 501-1,000	14 (11)
Between 1,001-2,000	14 (11)
Between 2,001-3,000	16 (13)
> 3,001	15 (12)
Previous euthanasia training, % (n)	
Yes	37 (30)
No	63 (51)
Performed euthanasia in the last six months, % (n)	
Yes	32 (26)
No	68 (55)
First euthanasia experience? % (n)	
After working with dairy cattle	38 (31)
Before working with dairy cattle	17 (14)
Never euthanized an animal	32 (26)
Preferred not to answer	12 (10)

5.5.1 Cluster Analysis

Cluster analyses identified three distinct clusters.

Cluster one (confident but uncomfortable with euthanasia). Cluster one consisted of 40 participants (49.4% of total) who were mainly Latin-Americans (72.5%) that haven't had recent euthanasia experience in the last 6 months (67.5%) but have received some euthanasia training (32.5%) and had euthanized an animal before (65%). Their average dairy experience was 14.4 yr (standard deviation = 14.0 yr; min: 4 weeks, max: 56 years; skewness: 1.27).

Participants grouped into this cluster appeared to be highly empathetic (Fig 5.1A) and likely to agree with statements regarding the cows' ability to have similar feelings as humans (i.e. happiness, unhappiness, sadness after an injury) and in trying to understand how cows feel by imagining how things look from cows' point of view (Table 5.1). These individuals also scored high for empathy attribution (Fig 5.1A) because they were likely to agree with statements regarding cows being friendly, sociable and having their own personality (Table 5.1). The same individuals had low scores for having negative attitudes about cattle (Fig 5.1B) and they disagreed with statements that cows are unfriendly, dirty and that the cows' behavior is not affected by the way they are treated (Table 5.1). Even though these individuals were the most uncomfortable with euthanasia, they reported to be highly confident in knowing what was wrong with cows on an early inspection, how probable it was for a sick cow to improve and if a cow needed to be euthanized based on its illness (Fig 5.1A). In addition, respondents grouped within cluster one felt knowledgeable enough to be able to identify and make decisions regarding a compromised cow (Fig 5.1B).

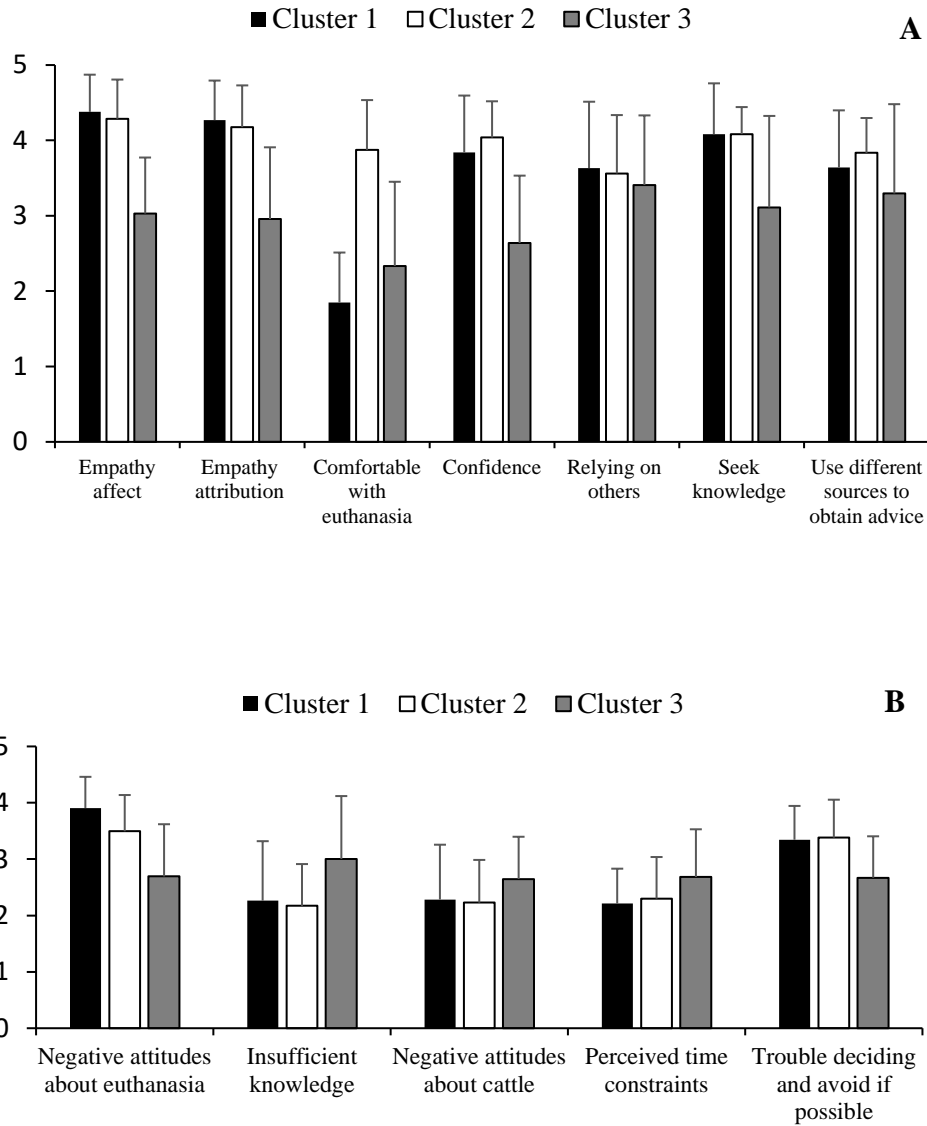


Figure 5.1. Clusters' positive (A) and negative (B) attitudes according to combined survey statements agreement (mean + SD) on a 5-point scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree). Cluster 1: confident and uncomfortable with euthanasia; cluster 2: confident and comfortable with euthanasia; and cluster 3: unconfident, lacking knowledge and detached from cattle.

Respondents in cluster one (confident but uncomfortable with euthanasia) were the most likely to trust their coworkers' skills (i.e. rely on others) to manage sick cows when they were away from work (Fig 5.1A). In addition, respondents within cluster one appeared to be knowledge-seekers (i.e. seek knowledge) and the second most likely cluster to use different sources to obtain advice about sick cow management (e.g., internet, supervisors' and coworkers' advice, written protocols and veterinarian instructions; Fig 5.1A). In addition to being the most uncomfortable with euthanasia, participants in cluster one had high scores for "trouble deciding when to euthanize and avoid if possible" (Fig 5.1B). Participants in cluster one also were likely to agree with statements that they waited longer than they should to euthanize an animal and that they usually had good reasons to not euthanize an animal. Moreover, respondents in cluster one were likely to agree with the statement that "euthanasia is the right thing to do to stop suffering but I feel bad about doing it" (Table 5.1). Finally, this group had the highest scores for 'negative attitudes about euthanasia' and was then the most likely to agree with statements that they disliked euthanizing cows, they tried to avoid euthanasia (i.e., save all cows), preferred someone else to euthanize cows, and they tried not to think about the cows' feelings while performing euthanasia (Table 5.1).

Cluster two (confident and comfortable with euthanasia). Cluster two consisted of 32 participants (39.5% of total) with its majority being born in the US (59.4%), half of the respondents having euthanized an animal at some point (85%) and in the last 6 months (46.9%) and the majority having received euthanasia training (62.5%). Their average dairy experience was 14.5 yr (standard deviation = 12.4 yr; min: 6 months; max: 40 years; skewness: 0.59). These participants were the most comfortable with euthanasia and the most confident regarding identifying a sick or injured cow, likelihood for recovery and need for euthanasia (Fig 5.1A). In

addition, this group demonstrated a high level of empathy towards cows (Fig 5.1A). Respondents in cluster two also had the highest scores for statements implying that they sought knowledge and used different sources to obtain advice about sick cattle management (Fig 5.1A). Participants in cluster two had the highest scores for statements indicating they had trouble deciding about euthanasia and that they tried to avoid it if possible (Fig 5.1B), even though they were the most confident participants (Figure 5.1A).

Cluster three (unconfident, lacking knowledge and detached from cattle). Cluster three consisted of 9 participants (11.1% of total) that were predominantly Latin-Americans (77.8%) who haven't had recent euthanasia experience in the last 6 months (100%) or ever (77.8%), reported never receiving any euthanasia training (100%) and having no previous livestock experience (88.9%). Their average dairy experience was 5.9 yr (standard deviation = 5.9 yr; min: 3 months, max: 15 years; skewness: 0.74). Cluster three participants were the least empathetic toward cows (Figure 5.1A). They were also the least confident about euthanasia decisions and the least likely to seek knowledge and use sources to obtain advice about sick cows' management. (Figure 1A). They also appeared to be moderately uncomfortable with euthanasia and were the least likely to rely on others for managing sick cows (Figure 5.1A). Respondents within cluster three had the least knowledge about diagnosing sick cows, and the lowest scores for negative attitudes toward euthanasia (Fig 5.1B). They also had the highest scores for perceived time constraints (Figure 5.1B) and were likely to be overwhelmed with too many animals to look after, too many chores at work, and that they did not have enough time during weekends to engage in managing sick animals (Table 5.1). Interestingly, they were the cluster with the lowest scores for "trouble deciding when to euthanize and avoid if possible" (Figure 5.1B).

5.5.2 Risk Factor Analysis

Table 5.3 depicts the final risk analysis models for clusters two and three. There were no statistically significant predictors for the final model of cluster one.

The final model for cluster two included race and ethnicity and previous euthanasia experience as important variables (Table 5.3). Latin-American respondents were less likely to be grouped in the “confident and comfortable with euthanasia” cluster (cluster two) than white respondents (odds ratio [OR] = 0.36, $P = 0.038$; Table 5.3). Respondents that had previous euthanasia experience tended to be more likely to be grouped in cluster two than participants that did not have previous euthanasia experience (OR = 2.44, $P = 0.072$).

The final model for cluster three included farm size as the sole important predictor (Table 5.3). Respondents that worked in farms with 501-1,000 cows were more likely to be grouped in the “unconfident, lacking knowledge and detached from cattle” cluster (cluster three) compared to participants working in farms with less than 500 cows (OR = 5.90, $P = 0.041$; cluster three; Table 5.4).

Table 5.3. Final risk analysis models for clusters two and three

Variable	Category	OR	SE	95% CI	<i>P</i>
Cluster two (confident and comfortable with euthanasia)					
Race and ethnicity	White	Ref			
	Latin-Americans	0.36	0.18	(0.14, 0.95)	0.038
Euthanasia experience ¹	No	Ref			
	Yes	2.44	1.20	(0.92, 6.42)	0.072
Cluster three (unconfident, lacking knowledge and detached from cattle)					
Farm size	< 500 cows	Ref			
	501 – 1,000 cows	5.90	5.14	(1.07, 32.55)	0.041
	1,001 – 2,000 cows	1.03	1.25	(0.10, 11.08)	0.978
	2,001 – 3,000 cows	0.43	0.51	(0.04, 4.40)	0.477

¹Respondents were considered to have previous euthanasia experience if they ever euthanized an animal, regardless if it was before or after they started working with cows

5.6 Discussion

This study assessed dairy workers' attitudes toward dairy cattle euthanasia and its association to individuals' demographic characteristics which included experience-based factors influencing euthanasia decision-making as well as race and ethnicity and farm size. It is worth noting that 60% of the survey respondents were Hispanic or Latin-American. Recruiting Latin-American participants to complete the survey improved the study's external validity given Hispanic labor is the primary labor source for large-herd operations in the US (Jenkins et al., 2009).

Respondents were deemed eligible to participate in the study if they had direct responsibility for animal care. However, when asked about recent euthanasia experience, more than half of the participants (55%) responded that they haven't performed euthanasia in the last six months. These results suggest that either euthanasia was not warranted on the farm in the last six months or another individual was responsible for performing euthanasia. In addition, the majority of the survey respondents were caretakers (56%) and may not be granted the ability to make such a decision. These results agree with a study published in 2020 where Wagner et al., (2020a) identified farm owners or farm managers as those primarily responsible for making on-farm euthanasia decisions (34.6 and 34.6%, respectively) and performing on-farm euthanasia (farm owner = 28.5%, farm manager = 30.9%; Wagner et al, 2020a). Future studies should focus on increasing farm manager and owner participation to understand how attitudes and emotions of those directly making and performing euthanasia are different than those caring for the cattle.

The cluster analyses revealed that survey respondents grouped in the confident but uncomfortable with euthanasia cluster (cluster one) were mainly empathetic Latin-Americans with minimal euthanasia training and experience. As already mentioned, Latin-American

workers encompass the primary labor source for large-herd operations in the US (Wagner et al., 2022; Adcock et al., 2015). This reliance on foreign-born workers can also be illustrated from a dairy product standpoint, with an estimated 79% of U.S. milk being supplied by farms employing foreign-born labor (Adcock et al., 2015). Acknowledging that Latin-American workers currently serve and will continue to serve as the main pillar of labor for US dairy farms, it is critical that these individuals have the confidence to make decisions and perform euthanasia when needed.

A primary focus to ensure cluster one-type workers feel more comfortable with euthanasia is to provide opportunities to educate, train and experience euthanasia in a realistic farm setting (Walker et al., 2020). Previous work in dairy cattle (Merenda et al., 2023) and swine (Campler et al., 2020) demonstrate the importance of training programs in ensuring workers feel more confident in performing job tasks such as euthanasia (Rovai et al., 2016), which can help improve the overall quality of the animal-human relationship (Napolitano et al., 2020). In fact, recent research showed that farmers troubled by the responsibility of ending the life of their animals were the most likely to be interested in training (Denis Robichaud et al., 2023). It is worth noting that National Dairy FARM Program Animal Care Version 4.0 does have requirements for continuing education on euthanasia for caretakers that have that responsibility on the dairy [Farmers Assuring Responsible Management (FARM), 2020]. In addition, American Association of Bovine Practitioners (AABP) guidelines report that those responsible for euthanasia should have annual training and certification on certain aspects of euthanasia [i.e. recognizing animals need of euthanasia, euthanasia technique, confirmation of death, and use of euthanasia methods] (AABP, 2019)]. To date, there is a nationally accessible, free of charge, euthanasia training program available through the National Milk Producers Federation (NMPPF,

2022). This program is a 14-case study multimedia training tool that encompasses euthanasia information over two production stages (calves and cows/heifers) and materials are primarily delivered in a case scenario format. Given many workers do not have consistent experience performing euthanasia (e.g. 65.4% of all participants did not have recent euthanasia experience), training programs can serve as a realistic tool to learn and feel comfortable about the euthanasia process.

In addition to training and experience, empathetic factors must also be addressed to ensure workers feel more confident in the euthanasia process. Cluster one members expressed confidence in determining when a cow should be euthanized but preferred someone else to perform euthanasia. The fact that the members in cluster one also believed that cows had feelings just like humans might have contributed to their preference of having someone else euthanizing the cows. Previous work addressing cultural perspectives specific to dairy cattle euthanasia, demonstrated that on-farm euthanasia resulted in self-perceived emotional burdens for Latin-American workers, particularly those that were not previously familiar with or did not understand the decision-making process specific to euthanasia (Román-Muñiz et al., 2021). In addition, four of the five dairy operations participating in the 2021 study had never discussed euthanasia or their feelings about it in a group setting. When asked about mental health resources to help with the burden caused by performing euthanasia, one of the participants said the topic of depression is never addressed with employees and mental health is not commonly discussed (Román-Muñiz et al., 2021).

The controversial attitude of cluster one members (i.e., confidence in determining when a cow should be euthanized but preferring someone else to perform euthanasia) might be further explained by adapting attitude types as a coping strategy. According to English et al. (1992),

empathy is one of the main characteristics of good stockmanship and involves gentle and positive interaction with animals on a daily basis. However, in stressful work conditions, empathy in stockpersons can be negatively impacted, influencing the relationship and interaction between animal and caretaker. When stressful conditions continue or become chronic in nature, individuals will cope by adapting one of four attitude types: concerned detachment, detached detachment, concerned attachment, and attached attachment (Wilkie, 2005).

Briefly, ‘concerned detachment’ is when the animal is perceived as a sentient commodity; ‘detached detachment’ is perceiving the animal as pure commodity, ‘concerned detachment’ is when the animal is individually recognized but is decommodified and recommodified; whereas ‘attached attachment’ is the greatest degree of meaningful human animal interaction (Wilkie, 2005). Adapting this perspective for the dairy farm, dairy workers within cluster one may experience attached attachment while raising animals and caring for them while simultaneously adopting a detached detachment attitude in situations like performing euthanasia.

Specific to euthanasia, previous research suggests that repeated exposure to animal euthanasia may result in compassion fatigue (Reeve et al., 2005) and frequency can influence empathy with higher euthanasia experience leading to prolonged stress (Rollin, 1986) and decreased empathy (Wahjudi et al., 2019). Given the fact that performing euthanasia influences worker well-being (Román-Muñiz et al., 2021) and euthanasia will remain a critical task that must be performed by those working on farm, it is imperative to foster a culture of care for both the caretakers and the animals. Future research should address the implementation of coping mechanisms/strategies that decrease mental fatigue associated with dairy cattle euthanasia, such as targeted educational programs in grief counseling and stress management.

In contrast to cluster one, cluster two members were confident and comfortable with euthanasia. Although cluster one and two shared similar empathetic levels, the majority of cluster two members had previous euthanasia experience and training. This reiterates our previous discussion on the importance of training and emphasizes that experience is critical. In fact, the value of euthanasia experience was also observed in the swine industry (Edwards-Callaway et al., 2020). During focus group discussions, a participating veterinarian stated that one of the challenges of swine euthanasia on-farm was new caretakers' resistance and discomfort toward the euthanasia process (Edwards-Callaway et al., 2020). Among shelter workers', the first euthanasia experience for new caretakers may be so impactful that has been recognized as a "turning point event" (Reeve et al., 2004). Therefore, in an industry where euthanasia may not occur on a daily or weekly basis, providing a controlled environment to introduce euthanasia can help build caretakers' confidence to perform euthanasia and safeguard workers' mental health and compassion of care.

It is worth noting that even though participants in cluster two were the most confident individuals toward euthanasia, they also had trouble deciding when to euthanize and tried to avoid it when possible. Making objective end-of-life decisions can be a challenge for dairy workers who have a strong emotional investment and responsibility to help the animals under their care (Wagner et al., 2020b; Román-Muñiz et al., 2021). Even in animal shelters with established training and decision-making criteria for euthanasia, inconsistent decision points and euthanasia implementation occur (Rogelberg et al., 2007). This inconsistency is also observed in the dairy industry and several factors including, but not limited to, the human animal bond, disease progression, disease prognosis and the financial burden associated with animal production impact euthanasia implementation (Walker et al., 2021). In addition to the

aforementioned factors that influence the decision-making process, the lack of written and clear standard operating procedures on farms is a major problem, leading to discrepancies in how decisions are currently made (Walker et al., 2021). Therefore, given the multifactorial nature of euthanasia decision-making process, it is possible that individuals from cluster two felt confident about diagnosing and determining when to euthanize a cow, but still had trouble accepting the final decision.

Cluster three members were unconfident and knowledge-lacking toward euthanasia and were detached from cattle. Risk factor analyses showed that farm size was the only component effecting membership of this cluster with participants working in farms with 501-1,000 farms being more likely to be members of cluster three than participants working in farms with less than 500 cows. Members of cluster three were also identified with the highest scores for perceived time constraints (i.e. numerous animals to look after, not having enough time to identify sick animals), the lowest scores for empathy affect and attribution and the highest scores for negative attitudes about cattle.

Decreased human-animal interaction is often a common side effect of increased herd size (Robbins et al., 2016). Nonetheless, dairy workers on larger farms tend to be better trained, better paid, more satisfied, and more specialized (Robbins et al., 2016). Furthermore, previous research in swine has shown that the occurrence of negative interactions might also decrease on larger farms (Hemsworth and Coleman, 2011). Therefore, the lowest scores for empathy affect and attribution might be explained by the high workload itself (reflected by their high scores for time constraints) rather than the herds' size.

Burnout might explain some of the attitudes found in respondents within cluster three. High-level workload and continuous job demands (e.g farm work) increase the risk of burnout,

which is a serious disorder that affects workers' well-being and disrupts one's relationship with work (Schaufeli et al., 1996). Burnout occurs during prolonged stressful situations (e.g. stressful jobs and euthanasia) and displays three symptoms: cynicism, exhaustion, and inferior professional efficacy (Kallioniemi et al., 2022). Exhaustion refers to lack of energy and chronic fatigue because of excessive labor, such as farm work, consuming one's emotional resources; whereas cynicism is characterized by a loss of interest and meaningfulness related to work and is defined as a distant attitude towards work in general (Kallioniemi et al., 2022). Thus, it is reasonable that members of cluster three feel so overwhelmed by their work that euthanasia cannot be deemed a priority. However, because the survey questions were not designed to assess burnout, this hypothesis should be more carefully investigated in future research given that it may lead to new discoveries on how burnout is associated with dairy workers' attitudes toward euthanasia.

Another possible explanation for the negative attitudes of cluster three is the lack of dairy experience. Individuals in this cluster were the ones with the lowest dairy experience (5.9 yr) compared to members of cluster one and two (14.4 and 14.5 ys, respectively). In addition, none of the individuals in this cluster have performed euthanasia in the last 6 mo and most had no previous livestock experience. The lack of euthanasia experience is reinforced by the finding that 77.8% of members of cluster three have never euthanized an animal when compared with 35% in cluster one and only 15% of cluster two. Therefore, it could be that these individuals were relatively new to the livestock industry and were neither trained for euthanasia or responsible for its decision-making process.

Results presented in this study provide critical information to the dairy industry regarding workers' positive and negative attitudes and demographic characteristics involved in the

decision-making process of euthanasia. Furthermore, it aids in implementing appropriate training measures that focuses on untrained and unexperienced Latin-Americans which were the individuals most uncomfortable and unconfident towards euthanasia. Without an understanding of dairy workers' attitudes toward euthanasia, there is minimal chance for the industry to implement consistent timely and humane euthanasia.

In the long-term, a better understanding of the impact of euthanasia on caretakers may lead to improvement in work satisfaction thus retaining skillful, knowledgeable, and productive workers (Coleman et al., 2000; Hemsworth and Coleman, 2011), a critical priority for the US dairy industry now and in the future.

5.7 Limitations

This study confirms the wide range of attitudes and experience levels related to euthanasia among workers across 30 dairy farms. However, eighty-one participants characterize a small fraction of the dairy industry workforce. Nonetheless, the study's aim was not to outline all differences between workers within the dairy industry but rather to generate a snapshot of dairy workers' attitudes toward euthanasia based on current demographic information.

Additional limitations include the absent information about method used for euthanizing.

Therefore, participant interpretation of what is considered euthanasia (with certified methods approved by the AVMA) could have been different. Given this, proper euthanasia performance could have been even lower than it was reported herein. Finally, the main methodological limitation to this study was the low internal consistency for some of the constructs. However, lower values are most likely due to the number of statements within each scale, particularly taken into account missing data points.

5.8 Conclusions

These survey results describe dairy workers' attitudes toward dairy cattle euthanasia and its association to individuals' demographic characteristics. Race and ethnicity, previous euthanasia experience and farm size played a vital role influencing respondents' attitudes toward dairy cattle euthanasia. White dairy workers and individuals who had previous euthanasia experience felt more comfortable with euthanasia than Latin-Americans and individuals that did not have previous euthanasia experience. Individuals working in farms with 501-1000 cows were more likely to feel unconfident, without enough knowledge and detached from cattle. The unconfident group was also composed by individuals who had not performed euthanasia in the last six months, had the least livestock experience and have never been trained on euthanasia. Future training activities should focus on Latin-Americans, with minimum livestock experience and without previous euthanasia experience since they were the most uncomfortable respondents and had the most negative attitudes toward dairy cattle euthanasia.

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5.10 Conflict of interest

The authors have not stated any conflicts of interest.

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CHAPTER 6

Future Directions

The objective of chapter three was to explore perspectives and attitudes about euthanasia specific to the Brazilian dairy cattle industry. Based on the findings of chapter three, there are several future steps that could be accomplished in future research. First and foremost, the development of science-based standards and guidelines specific to the Brazilian dairy industry to improve the consistency of on-farm euthanasia is of utmost importance. Given the participants' expressed misconceptions about euthanasia and the lack of proper training in this area, it is important to focus on providing comprehensive training programs for dairy veterinarians. These programs should cover euthanasia protocols, effective and accessible euthanasia tools, and address any misconceptions or knowledge gaps identified in the study. Another crucial step is improving communication with dairy producers regarding euthanasia decisions. These euthanasia decisions should consider the economic constraints faced by producers but should be primarily based on the welfare and prognosis of the animals.

Even though the importance of euthanasia training was acknowledged in the Brazilian focus groups and is also recognized in the literature in the US, before this research, there was no nationally recognized euthanasia training program for dairy producers. Thus, chapter four focused on the development and evaluation of an interactive training program aimed at improving dairy workers' euthanasia decision-making skills and awareness of timely euthanasia for animals on dairy farms. This study is the first to develop a multimedia training program that can effectively address some of the challenges associated with euthanasia on dairy farms.

Following the findings of chapter four, future research should focus on a long-term evaluation of the program by conducting follow-up assessments to determine the long-term

impact of the training program on participants' knowledge and skills. This could involve revisiting the same participants after a certain period to assess their retention of knowledge and any changes in their practices. In those same lines, future research could also assess any behavioral changes after the training since it would be valuable to assess whether the training program translates into actual changes in behavior and practices on dairy farms. In order to do that, observational studies or on-farm assessments could be implemented to evaluate whether participants are applying the knowledge and skills they gained from the training program in their daily work. Future research could also adapt the training program for different countries and this could involve collaborating with dairy farmers from various countries to tailor the program to their specific needs and challenges, such as the Brazilian industry.

Chapter five focused on assessing dairy workers' attitudes towards dairy cattle euthanasia and the factors influencing their decision-making. Based on the findings of chapter five, future research should include more farm owners and managers in the study since farm owners and managers are primarily responsible for making euthanasia decisions and performing euthanasia. Inclusion of these individuals in future research can provide valuable insights into their attitudes and emotions regarding euthanasia and how they differ from the dairy caretakers.

Furthermore, additional work is needed to address the attitudes and emotions of Latin-American workers, who constitute a significant portion of the labor force in US dairy farms. Future research can focus on developing interventions and training programs tailored to the cultural perspectives and experiences of Latin-American workers to improve their confidence and comfort levels with euthanasia. Further research could investigate the specific factors related to farm size that influence workers' attitudes toward euthanasia. This can include examining

workload, resources, and management practices to identify areas where improvements can be made to support workers in making euthanasia decisions.

APPENDICES

Appendix A: Survey's demographic questions for chapter 4

What is your age? _____

What is your sex? (Please, select one option)

- Male
- Female
- Choose not to disclosure

Please specify your race:

- White, Not Hispanic or Latino Origin
- Hispanic or Latino Origin
- Black or African American
- Native American
- Asian
- Other _____
- Choose not to disclosure

How long have you worked with dairy cows?

- Months _____
- Years _____
- Choose not to disclose

How would you describe your current role on the dairy farm?

- Farm Manager
- Department Head
- Caretaker
- Other _____

What size of farm do you work on?

- Less than 500 cows
- Between 501 - 1,000 cows
- Between 1,001 - 2,000 cows
- Between 2,001 - 3,000 cows
- Between 3,001 - 4,000 cows
- Between 4,001 - 5,000 cows
- Over 5,000 cows

When was the first time you had to euthanize a livestock animal?

- Before I started working with cows
- After I started working with cows
- I have never euthanized an animal
- Choose not to disclose

I have been trained on euthanasia

- Yes
- No

I have conducted euthanasia in the last 6 months

- Yes
- No

Appendix B: First section of the survey for chapter 5

What is your age? _____

What is your sex? (Please, select one option)

- Male
- Female
- Choose not to disclosure

Please specify your race:

- White, Not Hispanic or Latino Origin
- Hispanic or Latino Origin
- Black or African American
- Native American
- Asian
- Other _____
- Choose not to disclosure

Where did you spend most of your time while growing up?

- City
- Town
- Rural
- Choose not to disclosure

How long have you worked with dairy cows?

- Months _____
- Years _____
- Choose not to disclose

How would you describe your current role on the dairy farm?

- Farm Manager
- Department Head
- Caretaker
- Other _____

What size of farm do you work on?

- Less than 500 cows
- Between 501 - 1,000 cows
- Between 1,001 - 2,000 cows
- Between 2,001 - 3,000 cows
- Between 3,001 - 4,000 cows
- Between 4,001 - 5,000 cows
- Over 5,000 cows

When was the first time you had to euthanize a livestock animal?

- Before I started working with cows
- After I started working with cows
- I have never euthanized an animal
- Choose not to disclose

Did you work with other livestock species before you worked with cows?

- Yes
- No
- Choose not to disclose

I have been trained on euthanasia

- Yes
- No

I have conducted euthanasia in the last 6 months

- Yes
- No