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Calf and human perspectives about handling and restraint during western Canadian beef calf processing events

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Calf and human perspectives about handling and restraint during western Canadian beef calf processing events

by

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A THESIS

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Abstract

Beef calf processing involves individually handling and restraining calves for procedures such as castration, branding, and vaccination. It also serves an important sociocultural purpose for those in the ranching community. The method by which people handle and restrain calves during processing differs among operations. In western Canada, the most common methods are roping and wrestling (RW), roping and Nord fork (RNF), and using a tilt table (TT). However, the calf welfare implications of these methods, as well as how these common methods are perceived by participants in western Canadian beef calf processing events, are unknown.

The first study (Chapter 2) compared the effects of the three common methods of handling and restraint (i.e., RW, RNF, and TT) used to process calves on behavioural indicators associated with calf welfare. It was found that overall, differences detected in the effect of these methods on various indicators during processing were inconsistent. After processing, RNF calves displayed the highest rates of foot stomping, followed by RW calves, then TT calves. This was the first study to evaluate the effects of common handling and restraint methods used in western Canadian beef calf processing events on behavioural indicators associated with calf welfare, as well as include the roping and Nord fork method.

The second study (Chapter 3) described how people who participate in processing events perceive common handling and restraint methods used for pre-weaned beef calves on western Canadian cow-calf operations. In this study, it was revealed that participants in western Canadian beef calf processing events prefer the roping and wrestling method the most and the tilt table the least. However, the underlying values behind participants' indicated preferences shared much in common. Specifically, the values of calf safety and minimizing calf stress, efficiency, convenience, and human safety and limiting labour intensity were shared by many participants

when considering handling and restraint methods for processing, regardless of their noted preferences. This was the first time the current perceptions of participants in western Canadian beef calf processing events regarding the common handling and restraint methods were described.

Preface

Two manuscripts are included within this MSc thesis. The first will be submitted for publication in Applied Animal Behaviour, and the second in Translational Animal Science. Both works may be used in combination with other studies (i.e., a public survey study and economic analysis) for future publications.

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Dedication

To Petunya and Tycho; we did it. :)

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of responses are displayed for each rank of method. The mean score and standard deviation for each bar graph in order of RW, RNF, and TT are as follows: A.) 2.1 ± 0.9, 2.2 ± 0.4, 1.7 ± 1.0 B.) 2.2 ± 0.8, 2.2 ± 0.6, 1.4 ± 0.8 C.) 2.1 ± 0.9, 2.2 ± 0.4, 1.8 ± 1.0.

Chapter 1: Literature Review and Background

1.1 The Canadian Beef Industry

Canada has one of the largest beef industries in the world, ranking as the 9th top producer of beef internationally (Canada Beef, 2022). The Canadian beef industry produces over 1.35 million tons of beef annually, with beef exports valued at $4.45 billion (Government of Canada, 2021). Domestically, the beef industry contributes approximately 347,000 jobs and $22 billion to Canada's gross domestic product annually (Canadian Cattle Association, 2022). Western Canada largely drives the Canadian beef industry, with Alberta housing the largest population of beef cattle in Canada, contributing approximately 55,125 jobs and $4 billion to the provincial gross domestic product from 2018 to 2020 (Canada Beef, 2016; Canfax Research Services, 2021).

1.2 Cow-Calf Operations

Cow-calf operations are an integral part of the Canadian beef industry, and there are approximately 5.8 million cattle on cow-calf operations in the western provinces (Statistics Canda, 2022). In this region, calves on cow-calf operations are most commonly born between the months of January and May (Pearson et al., 2019). They typically undergo processing in the spring, which involves animal handling and various management practices (Canadian Cattlemen's Association, 2008; Moggy et al., 2017a, 2017b), prior to turnout to summer pasture. Calves are generally weaned in the fall at 5-8 months of age (National Farm Animal Care Council, 2013a; University of Saskatchewan, 2017) and are then sold into subsequent stages of the beef production system (e.g., backgrounding or feedlot operations) (Canadian Cattlemen's Association, 2020).

1.3 Animal Welfare

Although the topic of animal welfare and how to assess it continues to evolve, it is well recognized that animal welfare is a complex, value-based concept. The most current, globally accepted meaning of animal welfare is described by the World Organization for Animal Health (OIE) as:

> "the physical and mental state of an animal in relation to the conditions in which it lives and dies. An animal is in a good state of welfare if it is healthy, comfortable, well nourished, safe, able to express innate behaviour, and is not suffering from unpleasant states such as pain, fear, and distress, and is able to express behaviours that are important for its physical and mental state. Good animal welfare requires disease prevention and appropriate veterinary care, shelter, management and nutrition, a stimulating and safe environment, humane handling, and humane slaughter or killing. While animal welfare refers to the state of the animal, the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment." (OIE, 2022).

Different conceptual frameworks for animal welfare have been suggested over the past few decades. Historically, some researchers have emphasized basic health and proper physiological and behavioural functioning of animals (Broom, 1986; 2010), while other researchers have placed an emphasis on the feelings experienced by animals (Duncan, 1981; 2005; 2006). In 1997, the Three Circle Model was developed to combine these concepts (i.e., functioning and affective experiences) with the concept of natural behaviour (Fraser et al., 1997), and this integrative model is still used today to help assess welfare under different conditions.

There also exist different frameworks for assessment of animal welfare. In the 1960's, the Farm Animal Welfare Council developed the Five Freedoms to outline the principles of animal welfare (Webster, 2016). These are: 1. Freedom from hunger and thirst, 2. Freedom from discomfort, 3. Freedom from pain, injury, or disease, 4. Freedom from fear and distress, and 5. Freedom to express normal behaviour. Though the Five Freedoms were originally meant to serve as general guideposts for industries and the public, they have since been used by many as a means of assessing welfare. However, limitations have been identified in this framework. For example, the Five Freedoms generally lack detail and are only able to reflect the state of animal welfare at a particular point in time. Additionally, it has been pointed out by some (Webster, 2016; Mellor, 2016) that they fail to note that the absence of negative experience does not necessarily suggest positive welfare, and the last freedom, "freedom to express normal behaviour," is quite limiting and should be updated to, "freedom of choice". Thus, there has been a consequent push to develop more comprehensive frameworks that reflect the evolution of animal welfare principles.

The result is the concept of the Five Domains (Mellor, 2016), which are comprised of four physical or functional input domains (i.e., nutrition, environment, health, and behaviour) and an affective experience output domain (i.e., mental state). Unlike the Five Freedoms, which serve to simply outline the principles of animal welfare and assess the efficacy of human actions in relation to animal welfare, the Five Domains aims to evaluate the welfare of animals by considering the effects of the four input domains on the single output domain (Mellor, 2016). Regardless of the species or purpose of animal, this model provides a framework by which an observer can both identify and evaluate how physical components affect the animal's mental

state (i.e., positive or negative), through which the observer can assess the welfare of the animal (Fraser et al., 1997; Mellor, 2016).

Assessments other than the Five Freedoms and Five Domains have also emerged. These include on-farm assessments for animal welfare, such as those developed based on the Codes of Practice (National Farm Animal Care Council, 2015) and the European based, Animal Welfare Quality Project (Canali and Keeling, 2009).

Specifically regarding the livestock industry, there is increased public interest and concern for production animal welfare (Bassi et al., 2019; Duncan, 2005; McLennan, 2018; Nalon et al., 2021; Sonoda et al., 2018; Spooner et al., 2014; Tamioso et al., 2018; Verbeke, 2009). Research is also beginning to record a shift among producers about knowledge and attitudes regarding industry practices (Bassi et al., 2019). Further, development of livestock animal welfare recommendations and requirements involves the use of current scientific evidence (Fraser et al., 2013; Rushen et al., 2008; World Organisation for Animal Health (OIE), 2022) to continue supporting good animal care, maintaining public trust, and strengthening producers' social license to operate. Thus, there is an increased need for relevant evidence to support best practice recommendations and welfare guidelines.

1.4 Code of Practice for the Care and Handling of Beef Cattle

The Code of Practice for the Care and Handling of Beef Cattle is a publicly available set of guidelines that provides requirements and recommendations for beef cattle environment, feed and water, health, husbandry, transportation, and on-farm euthanasia practices that support animal welfare (National Farm Animal Care Council, 2013b). These requirements and recommendations are based on current scientific knowledge, stakeholder input, and general

practicality. Guidelines for handling and other events specific to spring processing such as branding, disbudding, and castration are outlined under Section 4: Animal Husbandry. For example, the Code states that beef cattle should be handled quietly and calmly to minimize stress (National Farm Animal Care Council, 2013, pg. 19). Requirements and recommendations described under branding, disbudding, and castration also include the use of "proper restraint" to effectively minimize stress and promote welfare. The Code of Practice neither describes "proper restraint," nor provides recommendations for handling and restraint methods in the calf processing setting that would support calf welfare.

1.5 Stress and Measuring Stress

There exists a number of different types of stress (e.g., eustress, acute stress, chronic stress, distress) (Moberg, 2000; Rushen et al., 2008). The reaction of an individual in response to a stressor provides insight on how the individual experiences the situation (Mellor and Stafford, 1999; Moberg, 2000). Measuring stress (i.e., acute stress, chronic stress, and distress) can therefore be an informative assessment of animal welfare.

One method of evaluating stress in an animal is to assess behavioural indicators associated with stress. Some of the indicators that have been studied in cattle previously include vocalization (Canozzi et al., 2017; Simon et al., 2016; Watts and Stookey, 1998), struggling (Core et al., 2009; Fell et al., 1986), time spent standing (Allen et al., 2015; Averós et al., 2008; Kim et al., 2018), and time spent walking (de Oliveira et al., 2014; Enríquez et al., 2011; Loberg et al., 2008). Data collection for behavioural indicators associated with stress can be done using live observations, video observations, or a combination of the two. When choosing a data collection method, it is important to consider the observer effect (Leruste et al., 2013). Beef

cattle are prey animals that typically have limited exposure to humans (Fabbri et al., 2022; Leruste et al., 2013; Probst et al., 2012, 2013). The presence of a human is a potential confounder that must be considered; therefore, using observation methods that minimize human exposure to cattle is recommended (von Keyserlingk et al., 2009).

In addition to changes in behaviour, a stressful experience can cause an animal to have a physiological response. Hence, another way to evaluate stress is by studying the physiological response (i.e., hypothalamic-pituitary-adrenal (HPA) axis activation) of an animal to a perceived stressor (Coetzee, 2013; Lagrange et al., 2021; McCarthy et al., 2016; Meléndez et al., 2018; Stafford et al., 2002; Sylvester et al., 2004). For example, in beef cattle research, change in cortisol has been used to evaluate the effects on calves of processing procedures such as castrating (Coetzee, 2013; McCarthy et al., 2016; Park et al., 2018; Stafford et al., 2002), branding (Marti et al., 2019; Meléndez et al., 2018), and dehorning (Mills et al., 2020; Sylvester et al., 2004). However, the high variability of physiological data due to different factors such as environment and genetics, as well as its association with both negative and positive experiences, have made its use in measuring stress a point of contention among researchers (Mormède et al., 2007).

1.6 Pain and Measuring Pain

Pain is a subjective, aversive experience in response to a noxious stimulus (Coetzee, 2011, 2013). This is distinct from nociception, which is the neural response of the body to perceived or actual tissue damage, which can lead to pain (Mischkowski et al., 2018). There exist different types of pain (e.g., acute or chronic) but regardless of type, painful experiences negatively impact animal welfare (Coetzee, 2011; McLennan, 2018; Millman, 2013).

One method of assessing pain experienced by animals is by observing their behaviour (Coetzee, 2011; Millman, 2013). Some examples of behavioural indicators associated with pain in cattle include tail swishing (Molony et al., 1995; Turner et al., 2020), head shaking (Molony et al., 1995; Turner et al., 2020), foot stomping (de Oliveira et al., 2014; Meléndez et al., 2018; Molony et al., 1995), and lesion licking (Molony et al., 1995). Such indicators can be collected through live observation, video observations, or a combination of the two. Further, there are various tools researchers can use to assess pain in animals such as the Visual Analogue Scale and Numeric Rating Scale (Meléndez et al., 2017, 2018; Olson et al., 2016; Remnant et al., 2017; Tschoner, 2021). The facial grimace scale is another tool used for assessing pain, and its use has been studied extensively in the context of humans (Amanda, 2002; Tschoner, 2021). Facial grimace scales have also been described more recently for laboratory (Miller et al., 2022; Mogil et al., 2020), companion (Evangelista et al., 2022), and farm animals (Dalla Costa et al., 2014; di Giminiani et al., 2016; Häger et al., 2017; Orth et al., 2020; Vullo et al., 2020). However, the validity of this tool for assessing pain in various non-human animals is still being researched (Evangelista et al., 2022; Mogil et al., 2020; Tschoner, 2021).

Painful experiences can elicit a physiological response among animals; therefore, measuring physiological indicators associated with pain can serve as another method of assessing pain experienced by animals (Coetzee, 2011; Tschoner, 2021). For example, cortisol is a biomarker that has been used in past works assessing pain experienced by cattle during and after husbandry procedures such as branding (Marti et al., 2019; Meléndez et al., 2018), castrating (Canozzi et al., 2017; Marti et al., 2019; McCarthy et al., 2016; Meléndez et al., 2018), and dehorning (Heinrich et al., 2010; Mills et al., 2020; Stafford and Mellor, 2011). However, the high variability associated due to numerous factors (e.g., environmental, genetic, sampling

379 method) makes clear interpretations difficult (Canozzi et al., 2017; Tschoner, 2021). Additional,
380 more recent physiological measures for pain assessment in cattle include heart rate and heart rate
381 variability (Stewart et al., 2009, 2010), mechanical nociceptive threshold (K. A. Allen et al.,
382 2013; Heinrich et al., 2010; Stock et al., 2015), and eye temperature measured using infrared
383 thermography (Harris et al., 2021; Stewart et al., 2009, 2010).
384
385 ## 1.7 Processing
386 Beef calves in western Canada are typically processed at approximately 6-12 weeks of
387 age. During processing, calves are individually handled and restrained to carry out various
388 painful and stressful husbandry procedures such as vaccination, castration, and branding
389 (Canozzi et al., 2017; Coetzee, 2011; McCarthy et al., 2016; Moggy et al., 2017a) for
390 management, production, and health purposes (Chamorro et al., 2016; González et al., 2010).
391 There are several methods for handling and restraining calves for processing, with the most
392 common of these methods in western Canada being roping and wrestling, roping and Nord Fork,
393 and the use of a tilt table (Moggy et al., 2017b). Results from an unpublished preliminary study
394 suggests that there are differences in physiological indicators associated with stress between the
395 restraint methods of roping and tilt table (Schachtschneider et al., 2019). Previous studies support
396 the use of calm, quiet handling techniques to minimize the negative experience of animals
397 (Breuer et al., 2003; Grandin, 1997; Grandin and Shivley, 2015; Petherick et al., 2009). Yet, no
398 research has been published focusing on evaluating the welfare implications of common calf
399 handling and restraint techniques (i.e., roping and wrestling, roping and Nord Fork, and tilt table)
400 used to process pre-weaned beef calves in western Canada.
401

1.7.1 Roping and Wrestling

The method of roping and wrestling entails roping a calf's hindlegs by a person on horseback, dragging it away from the herd to an area cleared for husbandry procedures, manually restraining it on its side, and then releasing the rope from the calf. The calf is usually restrained by two wrestlers, one at its head and the other at its hind legs, and it is held down in this position until all processing procedures have been completed. In western Canada, 13% of cow-calf producers use roping and wrestling as a handling method for calves that are 1 week to 3 months old (Moggy et al., 2017b); however, there is currently a lack of research regarding the effects of roping and wrestling during calf processing on calf welfare.

1.7.2 Roping and Nord Fork

Similar to the roping and wrestling method, the roping and Nord Fork method begins with roping a calf's hind legs by a person on horseback and dragging it away from the herd towards the processing area. As the calf is dragged, a Nord Fork, a metal device that is positioned behind the calf's ears, is placed on the calf to help restrain it. Then, the calf is tipped on its side and immobilized by the Nord Fork and roper on horseback as the calf is processed. Although the Nord Fork is reportedly used by 9% of western Canadian cow-calf producers for calves that are 1 week to 3 months old (Moggy et al., 2017b), there is no research studying the effects of this method of restraint on the welfare of calves during processing.

1.7.3 Tilt Table

The tilt table, also known as the calf tipping table or calf table, is a mechanical device used to restrain calves for processing. It is used by 33% of cow-calf producers in western Canada

for calves aged 1 week to 3 months (Moggy et al., 2017b). To process a calf using this device requires that the calf is first removed from the herd and moved down an alley that leads to the tilt table. When the calf's head passes the head gate of the table, the head gate is closed and then the sides of the table itself are squeezed inwards until the calf is secure. Then, the tilt table containing the calf is tipped over 90 degrees such that the calf is held on its side. The calf is kept in this position inside the tilt table for the duration of processing. Similar to the other common processing handling and restraint methods used in western Canada, there is no research evaluating the impacts of this method on the welfare of beef calves during processing. However, some inferences can be made from previous dairy and beef cattle studies that have included the use of a tilt table. Restraint by tilt table in general is suggested to be a stressful experience for cattle (Pesenhofer et al., 2006; Rizk et al., 2012). For example, one study notes that both blindfolded and non-blindfolded beef calves display struggling behaviour and changes in heart rate when restrained in a tilt table (Mitchell et al., 2004). However, when compared to a walk-in crush (i.e., a mechanical device that restrains cattle in the standing position), the tilt table is suggested to be the faster and less stressful method of restraint for hoof trimming of dairy cows (Pesenhofer et al., 2006). Given this, there remains uncertainty about the effects of handling and restraining calves by tilt table during processing on calf welfare, as well as how the three methods described here within compare to each other.

1.8 The Role of Industry Perspectives

Perception is a person's interpretation of a subject (American Psychological Association, 2022a), while preference means favoring an option upon making comparisons among available alternatives (American Psychological Association, 2022b). Values are the fundamental, trans-

448 situational constructs that guide decision-making (American Psychological Association, 2022c;
449 Sonoda et al., 2018).
450 Understanding the values, perceptions, and perspectives of industry professionals is
451 valuable for agricultural sustainability, as this knowledge can help inform future communications
452 (e.g., communication with producers about optimal handling and restraint methods), education
453 efforts, and development of relevant and practical best practice recommendations (Driessen,
454 2012; Kuczewski et al., 2022; Sonoda et al., 2018; Spooner et al., 2012; Ventura et al., 2013;
455 Weary et al., 2016). Management decisions on Canadian cow-calf operations are based on
456 several factors, such as those relating to culture, consumer demands, and animals' quality of life
457 (Bassi et al., 2019; Rondeau and Joanne, 2013; Spooner et al., 2012). Deciding a method of
458 handling and restraint for calf processing is a management decision that producers must make,
459 and a preliminary study by Rondeau and Joanne (2013) suggests that producers prefer to use
460 different handling and restraint methods during processing based on factors such as human
461 labour costs and perceived efficiency. Additionally, a study by Moggy and colleagues (2017)
462 points out that in general, beef producers often seek to use husbandry practices that minimizes
463 excessive handling. However, research exploring the preferences and perceptions of participants
464 of calf processing regarding the common handling and restraint methods used during western
465 Canadian processing events is largely absent.
466
467 ## 1.9 Qualitative Research Methods and their Use in Veterinary and Agriculture Research
468 Qualitative research methods can be used to better understand peoples' perceptions,
469 preferences, and values with regards to a given topic. There exist various data collection methods
470 in qualitative research. Examples of commonly used methods include use of qualitative surveys

(Braun and Clarke, 2020; Kielland et al., 2010; O'Kane et al., 2017), interviews (Menger et al., 2016; Spooner et al., 2012), expert panels (Stebler et al., 2015; VHSV Expert Panel and Working Group, 2010), or a combination of these (Doidge et al., 2021; Moggy et al., 2017c; Smid et al., 2021, Ventura et al., 2013, 2021). Qualitative data analysis can take on an inductive or deductive approach. (Green and Thorogood, 2013). An inductive approach involves the generation of new theories through categorization and exploration of the data collected, while a deductive approach identifies a pre-existing theory or categorical framework by which data analysis is guided (Braun and Clarke, 2006; Green and Thorogood, 2013).

Qualitative research methods are used in veterinary and agricultural fields to understand perceptions of stakeholders relevant to the industry (e.g., the public, producers, or veterinarians) (Biesheuvel et al., 2021), as rich insights gained from such works can be useful for bridging communication gaps, guiding policy development and implementation, and providing context for future extension efforts (Moggy et al., 2017c; Spooner et al., 2012, 2014; Ventura et al., 2021). Within the livestock industry, there is a limited but increasing number of qualitative studies (Biesheuvel et al., 2021). Many of these studies are purposed to understand the perceptions and attitudes of the public, veterinarians, and undergraduate and veterinary students (Biesheuvel et al., 2021; Ferree et al., 2022; Podberscek, 2000; Ruston et al., 2016; Serpell, 2005; Skjølstrup et al., 2022; Sonoda et al., 2018; Sullivan et al., 2022; Tamioso et al., 2018; Ventura et al., 2021). Qualitative works conducted with the purpose of understanding producer perceptions are mainly based in Europe and North America, and focus on topics such as disease prevention, animal welfare, and uptake of best practice recommendations (Biesheuvel et al., 2021). Based on current literature, it is suggested that various factors such as perceived risk, knowledge, and values of producers drive the making of management decisions (Doidge et al., 2021; Jansen et al., 2009;

494 O'Kane et al., 2017; Smid et al., 2021), whereas economic factors play a more restrictive role
495 (Jumper et al., 2021). However, there is no knowledge exploring the perceptions of people who
496 participate in beef calf processing events about different calf handling and restraint methods.
497

498 1.10 Overall Aim of Study

499 To address these knowledge gaps outlined above, this thesis describes two studies. The
500 first study provides an animal-based assessment of the effects of common handling and restraint
501 methods for calf processing (i.e., roping and wrestling, roping and Nord Fork, and tilt table) on
502 behavioural indicators associated with pain and stress in beef calves. The second study explores
503 the preferences and perceptions of participants of western Canadian beef calf processing events
504 regarding those common methods.
505

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Chapter 2: Calf handling and restraint methods during the processing of beef calves

2.1 Abstract

Beef calves in western Canada are often processed at approximately 6-12 weeks of age, when they are individually handled and restrained to conduct various husbandry procedures. Best practice recommendations for safeguarding animal welfare suggest using calm, quiet handling techniques and proper restraint for safe and effective execution of husbandry procedures. The most common methods for handling and restraining calves in western Canada are roping and wrestling (RW), roping and Nord fork (RNF), and using a tilt table (TT), but the animal welfare implications of these methods are unknown. Thus, the objective was to compare the effects of these 3 methods on indicators of welfare. A total of 117 beef bull calves were assigned to 3 groups (RW, RNF, or TT), consisting of 39 calves each (30 processed calves, 9 control calves). Control calves were handled and restrained according to their assigned group but did not undergo any processing procedures. Video recordings were used to quantify duration of handling and restraint, and behaviours associated with stress or pain. Statistical analysis of these variables used the Kruskal-Wallis H-test, while a Fisher's exact test was used to analyze visual eye white (VEW) and gait scores. All results are reported in the format of medians and interquartile range (i.e., [75th percentile – 25th percentile]). During processing, vocalization rate was highest for RNF calves (RNF: 11.7 [12.3]; RW: 5.0 [7.8]; TT: 1.6 [7.8] count/min; $P < 0.05$) and struggling rate was highest for TT calves (TT: 4.6 [4.0]; RW: 2.3 [2.6]; RNF: 1.9 [2.7]; count/min; $P < 0.05$). There was no relationship between VEW and method of restraint. For gait score, RNF calves had a higher ($P < 0.05$) occurrence of running upon release from restraint compared to the other groups. Both durations of handling and restraint were highest for TT calves (handling= TT: 23.4s [19.7]; RNF: 18.1s [3.6]; RW: 14.7s [3.5]; restraint = TT: 78.4s [7.4]; RW: 67.5s [16.8]; RNF:

933 64.8s [22.7]; $P < 0.05$). After processing, foot stomping rate differed among groups and was
934 highest for RNF calves, followed by RW calves, then TT calves (RNF: 1.9 [2.3]; RW: 1.0 [0.9];
935 TT: 0.5 [0.5]; $P < 0.01$). Overall, differences detected during processing for effects of common
936 handling and restraint methods on calf behavioural responses were inconsistent. Immediately
937 after processing, only foot stomping rate differed consistently among the three methods post-
938 processing.
939
940 Keywords: welfare, behaviour, stress, processing, handling, restraint
941

942 ## 2.2 Introduction

943 In western Canada, beef calves are often processed in the spring at approximately 6-12
944 weeks of age. During processing, calves are individually handled and restrained in order to
945 perform husbandry procedures such as castration, branding, and vaccination. These procedures
946 have important management, production, and health implications (Chamorro et al., 2016;
947 González et al., 2010), but they are also a painful and stressful experience for calves (Canozzi et
948 al., 2017; Coetzee, 2011; McCarthy et al., 2016; Moggy et al., 2017a). Numerous studies
949 (Coetzee, 2013; McCarthy et al., 2016; Meléndez et al., 2018; Stafford et al., 2002) have
950 evaluated the welfare of calves undergoing specific processing procedures, such as castrating and
951 branding, for which the use of non-steroidal anti-inflammatory drugs and local anesthesia is
952 indicated for mitigating pain relating to these procedures. However, currently there is a lack of
953 knowledge concerning the welfare implications of the handling and restraint methods used when
954 carrying out these processing procedures.

There are several methods for handling and restraining calves for processing, the most common of these methods in western Canada being roping and wrestling (RW), roping and Nord Fork (RNF), and using a tilt table (TT) (Moggy et al., 2017b). Results from a preliminary study suggests that there are differences in indicators of stress responses between calves handled and restrained by RW and TT to undergo husbandry procedures (Schachtschneider et al., 2019). Furthermore, previous studies support the use of calm, quiet handling techniques to reduce stress experienced by animals (Breuer et al., 2003; Grandin, 1997; Grandin and Shivley, 2015; Petherick et al., 2009). To date, no research has focused on the potential stress and pain experienced by beef calves in response to the three predominant processing handling and restraining methods used in western Canada.

Thus, the objective of this study was to evaluate and compare the effects of different methods of handling and restraint (i.e., RW, RNF, and TT) used during calf processing on behavioural indicators of pain and stress. Behavioural indicators of stress and pain were hypothesized to be observed with the highest frequency in calves handled and restrained using RNF due to the high human variability involved with this method, especially during handling and release. These indicators were hypothesized to be seen at the second highest frequency in calves handled and restrained using the TT due to the long processing time and loud mechanical noises associated with this method. Lastly, it was thought these indicators would be observed the least in calves handled and restrained using RW compared to those handled and restrained using either RNF or the TT.

2.3 Methods

2.3.1 Enrollment population

This study was approved by the University of Calgary Veterinary Science Animal Care committee on May 14, 2021 (AC21-0031) and conducted at W.A. Ranches at the University of Calgary in Alberta, Canada in June of 2021. A total of 117 Angus cross beef bull calves were enrolled in the study. Calves ranged from 6 to 8 weeks of age at the time of processing.

2.3.2 Approach Test Protocol

During the week prior to the first day of processing, calf behaviour was evaluated to establish a baseline of individual behavioural reactivity using an approach test modified from Flörcke and colleagues (2012). Reactivity is an expression of temperament that is influenced by factors such as sex, genotype, age, and experience and is highly repeatable (Dodd et al., 2012; Flörcke et al., 2012; Gosling, 2001). To collect this data, all calves were recorded continuously using a handheld video camera (Panasonic 4K and Canon handheld video camera) as they were approached by two researchers in a utility terrain vehicle (UTV) with the starting distance of the UTV being greater than 18.3 meters (i.e., 20 yards) from the entrance of the pen. The initial distance between a calf and the vehicle was measured using a rangefinder (RX-1400i TBR/W Rangefinder, 179640, Leupold and Stevens, Inc., OR, United States of America), and each calf was approached from the side to remain within its field of vision. The maximum speed of the UTV was 5km/hr throughout the entirety of the approach test, and the order in which calves were approached was opportunistically selected based on proximity to the UTV upon entrance to the field. When leaving a calf, the vehicle was driven away in an outward circular motion so as to minimize disturbance.

Calves were recorded for their immediate behavioural response upon being approached by the UTV. Responses included standing, walking, trotting, or running with their tail elevated. Calves that did not display a change in behaviour when the UTV reached a distance of 4.6 meters from the calf were recorded as no response. The distance between calves and UTV upon immediate behavioural response as well as calf identification numbers were also recorded using the rangefinder and binoculars.

2.3.3 Treatment Groups

Calves were allocated to 3 treatment groups, consisting of 39 calves each. There were 30 processed calves per treatment group. This number was calculated by first estimating values from an unpublished, non-peer reviewed report from Oregon State University (Schachtschneider et al., 2019), from which it was determined that 20 calves per treatment group would be necessary to provide a power of 0.80 and type 1 error rate of 5%. Then, based on the assumption that the variability of this field study could be greater, the sample size was increased to 30 calves per treatment group for sufficient power. Additionally, there were 9 control calves in each treatment group (White, 2018). Calves belonging to the control groups were handled and restrained using the same methods specific to their treatment group. However, they did not undergo any processing procedures.

The 3 treatment groups were:

1. Roping and wrestling (RW): In an outdoor grass pasture, calves to be processed that day were isolated from dams in a small corral made using temporary metal panels. The calf's hind legs were roped by ranch staff on horseback, and the calf was dragged to the

designated processing area clear from the other calves. It was then manually restrained in a standardized lateral position by 2 trained staff members while processing took place. The calf was restrained on the ground for the duration of the processing event and was released upon completion of all processing procedures.

2. Roping and Nord Fork (RNF): In an outdoor grass pasture, calves to be processed that day were isolated from dams in a small corral made using temporary metal panels, as done in RW. The calf's hind legs were roped by ranch staff on horseback, and the calf was dragged to the designated processing area clear from the other calves. As the calf was being dragged, a Nord Fork was placed over their neck behind their ears. The Nord Fork was secured to a rubber tube tied to a metal pole that was staked into the ground. The calf was dragged until the rope between the Nord Fork and the pole was tight. Once this was done, the calf was tipped over and restrained laterally by the Nord Fork and rope while processing took place. The calf was restrained on the ground for the duration of the processing event and released upon completion of all processing procedures.

3. Tilt table (TT): Calves to be processed that day were isolated from dams in an indoor dirt holding pen, from which they were individually moved through a narrow alley leading to a calf tilt table. Once the calf entered the tilt table and its head passed the head gate, the head gate was closed by a trained ranch staff member, thus restraining the calf. The tilt table was then tipped over so that the calf was in a lateral position. Following this, the panel on the side of the table was opened and a rope was used to restrain one rear leg for castration. The tilt table remained tipped over for the duration of the processing event, and once all processing procedures were completed, the table was returned to its original, upright position, and the head gate was opened, releasing the calf.

2.3.4 Processing Protocol

Calf processing spanned over 3 consecutive days and, on each day, 13 calves per treatment group (i.e., 10 processed calves and 3 control calves) were processed. The order of treatment group processing was balanced over the 3 days to control for any time of day effect. Additionally, all treatment groups were processed every day to control for any day effect. On the day of processing, cow-calf pairs were brought in from pasture, and the calves were separated from the cows. Calves were then allocated to treatment groups using sequential convenience sampling, separating them into 3 pens. Each day of processing, 16 cows for the RW and RNF groups and 3 cows for the TT group were placed in a pen adjacent to the calf processing pen to allow cow-calf fence-line contact in an attempt to minimize separation stress (Averós et al., 2008; Johnsen et al., 2015).

Once a calf was captured and restrained according to the method specific to its treatment group, trained ranch staff carried out routine processing procedures on the calf. This included:

- Meloxicam administration: 10ml of a non-steroidal anti-inflammatory drug (Meloxicam Oral Suspension, USP, Solvet, AB, Canada) administered orally before the other procedures
- Vaccination: 5ml of a subcutaneous multivalent vaccine against clostridial pathogens and *Histophilus somni* (Ultrabac 7/Somubac, Zoetis Inc., MI, United States of America), 2ml of a subcutaneous modified live multivalent vaccine against Bovine Viral Diarrhea Virus Type 1 and 2, and *Mannheimia haemolytica* (OneShot+BVD, Zoetis Inc., MI, United States of America), and 2ml of an intranasal modified live

vaccine against Bovine Respiratory Syncytial Virus, Bovine Herpesvirus Type 1, and. Parainfluenza Virus Type 3 (Inforce 3, Zoetis Inc., MI, United States of America)

- Surgical castration
- Implant injection: Growth stimulating hormone (Synovex Plus, Zoetis Inc., MI, United States of America) injected subcutaneously at the base of the ear
- Radiofrequency identification tag (Z Tags, Datamars Livestock, Lamone, Switzerland) scanning into a cattle record management system (Herdtrax, TELUS Agriculture, Alberta, Canada)

Staff members and duties performed by each staff (e.g., roping, wrestling, placing the Nord Fork on the calf, castrating, etc.) were standardized throughout all processing days. The experiment was designed to emphasize external validity; therefore, the length of time for processing was not controlled across all treatment groups. Control calves were restrained and observed for 30 seconds, but not processed. After calves were released from restraint, they were moved into a post-processing pen specific to their treatment group for 1 hour before being reunited with their dams.

2.3.5 Data collection

Calves' behavioural responses during restraint were collected through both live data collection and the use of hand-held video recorders (Canon VIXIA HF R800 High-Definition Camcorder, 1960C014, Canon Canada Inc., ON, Canada; Panasonic HC-VX1 4K HD Camcorder, VX1, Panasonic Canada Inc., ON, Canada). After processing, calves were recorded for 1 hour using the Lorex camera system (Smart Indoor/Outdoor 1080p Wi-Fi Camera,

LBV8541X-C, Lorex Technology Inc., ON, Canada). All videos were imported to the Behavioural Observation Research Interactive Software (BORIS) analysis system (Version 7.12.2; Universita Degli Studi di Torino, Italy) and behaviours were quantified through continuous observation based on an ethogram (Table 2.1).

For the approach test, 2 evaluators scored 69 calves and 1 evaluator score all calves to determine inter-rater and intra-rater reliability, respectively. For videos recorded during processing, 2 evaluators scored 15 calves and 1 evaluator scored 15 calves to determine inter-rater and intra-rater reliability, respectively. Additionally, 1 evaluator reassessed a total of 18 calves (i.e. 6 calves (2 per treatment group) every 33 calves) to calculate intra-rater reliability. Finally, 2 evaluators scored 3 calves and 1 evaluator scored 6 calves from the post-processing videos to determine inter-rater and intra-rater reliability, and 1 evaluator reassessed a total of 15 calves (i.e. 3 calves (1 per treatment group) every 23 calves) to calculate intra-rater reliability.

Individual calf handling difficulty scores were recorded, as reported by ropers for the RW and RNF group or handlers inside the holding pen for the TT group. This subjective score originally ranged from 1 to 3. An additional score, 3+, was added during data collection by ropers and handlers to accurately reflect their assessment. A score of 1 reflected a quick capture time and minimal struggling by the calf, a score of 2 reflected a moderate capture time and some struggling by the calf, a score of 3 reflected a prolonged capture time and struggling by the calf that consequently involved several handling attempts, and a score of 3+ reflected a prolonged capture time as well as struggling or escaping of the calf that consequently involved multiple handling attempts. Furthermore, based on observations of the processing events, a single researcher (LA) recorded a visual analog score (VAS) throughout the study. The VAS scoring was done by marking a line on a 10cm line, ranging from a description of the calf as “calm” to

1113 "extremely stressed". The order in which the calf was processed, length of time of processing,
1114 and injuries for both the human handlers and the calf were also recorded. Lengths of time for
1115 handling and restraint of individual calves were recorded using a stopwatch. Handling time was
1116 defined to start when (RW, RNF) the calf was roped securely at the hindlegs or (TT) when the
1117 calf's head enters the alley. It ended when both wrestlers successfully secured the calf in lateral
1118 position (RW), the calf was in lateral position, restrained by the tension of the staked Nord Fork
1119 and rope (RNF), or the tilt table head gate had been successfully closed on the calf and the table
1120 was tipped such that the calf was in lateral position (TT). Restraining time started at the end of
1121 handling time and ended when all processing procedures had been completed and all sources of
1122 restraint (i.e., human wrestlers, rope, Nord fork, and tilt table) were no longer in contact with the
1123 calf. Lengths of time for handling and restraint were also verified through time-stamped videos
1124 taken by the hand-held video recorder.
1125

1126 ## 2.4 Statistical Analysis

1127 All data were imported to Microsoft Excel (Version 16.62; Microsoft Corporation. Dubai,
1128 UAE) and then transferred to RStudio: Integrated Development for R (Version 1.3.1093;
1129 RStudio, PBC. Massachusetts, USA) for statistical analysis. The distribution of the data was
1130 examined using histograms, and the Shapiro-Wilk test was used to test for normality of
1131 distribution. All outcome variables were non-normally distributed and variety of transformations
1132 did not result in normal distribution of any variables; therefore, nonparametric statistical methods
1133 were used. Comparisons were made: 1. among treatment groups for processed calves (RW, RNF,
1134 TT); 2. between processed (RW, RNF, TT) and control (CRW, CRNF, CTT) calves within each
1135 treatment group; and 3. among treatment groups for control calves (CRW, CRNF, CTT).

2.4.1 Before Processing

Approach test data collected before processing were analyzed as two separate outcome variables: distance of response and response type. Chi-squared analysis was used to compare if distance of response differed by treatment group. Response types were collapsed to three types (i.e., non-reactive, reactive, and highly reactive) based on their immediate behavioural response upon being approached by the UTV. Specifically, non-reactive was defined as when there was no visible change of behaviour after the calf was approached by the vehicle. Reactive was defined as when the calf got up from a lying position such that its body was supported in an upright position by three or more legs (i.e., standing) or the calf moved away with a steady, four-beat gait in which the hind legs landed in a similar position as the front feet (i.e., walking) (Zinpro Co. et al., 2013). Highly reactive was defined as when the calf moved away with a two-beat gait such that the front foot and opposite hind foot hit the ground at the same time (i.e., trotting) or the calf moved away with a high-speed three or four-beat gait (i.e., high-tail running). A Fisher's exact test was used to compare if response type differed by treatment group.

2.4.2 During Processing

Durations of handling and restraint, VAS scores, vocalization rates (count per minute), and struggling rates (count per minute) during processing were analyzed using the Kruskal-Wallis H-test. Pairwise comparisons were then performed using the Pairwise Wilcoxon Rank Sum test. Fisher's exact tests with post-hoc pairwise comparisons were used to analyze calf handling difficulty scores, visual eye white (VEW), and gait scores.

2.4.3 After Processing

Event behaviours recorded in the period after processing (i.e., foot stomping, tail flicking, and head shaking) were converted to rates (count per minute), while state behaviours (i.e., standing, relaxed movement, lying sternal, lesion licking, self-grooming, and exploratory/grazing) were converted to percentages of time observed. Event rates and state percentages were both analyzed using the Kruskal-Wallis H-test and then pairwise comparisons were performed using the Pairwise Wilcoxon Rank Sum Test. Behaviours that could not be statistically analyzed due to lack of data were categorized as low frequency behaviours and only descriptive statistics are reported.

2.5 Results

2.5.1 Sample population

For data collected during processing, some video data collected were lost due to technical issues. Therefore, analysis of data collected during processing was based on a final sample size of 99 calves (RW = 25; CRW = 8; RNF = 27; CRNF = 6; TT = 26; CTT = 7). Data collected post-processing was based on the original sample size of 117 calves, consisting of 39 calves per treatment group (30 processed calves; 9 control calves).

Statistical analysis of the approach test data showed that distance of response did not differ by treatment group (distance less than 4.6m = RW: 7 calves; RNF: 17 calves; TT: 14 calves; distance 4.6m – 10.7m = RW: 15 calves; RNF: 11 calves; TT: 10 calves; distance greater than 10.7m = RW: 11 calves; RNF: 5 calves; TT: 9 calves; $P > 0.05$). Response type also did not differ by treatment group (non-reactive = RW: 2 calves; RNF: 3 calves; TT: 3 calves; reactive = RW: 28 calves; RNF: 26 calves; TT: 27 calves; highly reactive = RW: 3 calves; RNF: 4 calves;

TT: 3 calves; P > 0.05). Inter- and intra-rater reliability were high for the approach test for both comparisons (Kappa (K) > 0.8). Inter- and intra-rater reliability were high as well for processing and post-processing videos, which all had an Interclass Correlation Coefficient (ICC) and K value greater than 0.7, with most above 0.8. A kappa score or ICC of > 0.7 is considered to be fair agreement, and a kappa score or ICC of > 0.8 is considered to be excellent (Cicchetti, 1994; Koo and Li, 2016).

2.5.2 Effect of handling and restraint methods among processed calves

Both the durations of handling and restraint were higher for TT calves compared to RNF and RW calves (median and interquartile range (i.e., [75th percentile – 25th percentile]): handling = TT: 23.4s [19.7], RNF: 18.1s [3.6], RW: 14.7s [3.5]; restraint = TT: 78.4s [7.4] , RW: 67.5s [16.8], RNF: 64.8s [22.7]; $P < 0.05$). The RNF calves vocalized at a higher rate compared to all other treatment groups (Table 2.2). Struggling rate was highest for TT calves compared to all other treatment groups. There was no significant relationship between VEW and method of handling and restraint (P > 0.05). However, there was a significant relationship between gait score and method of handling and restraint, with RNF calves having the highest occurrences of running upon release from constraint compared to RW and TT calves. All results are shown in Table 2.2. Calf handling difficulty scores did not significantly differ among treatment groups (P > 0.05). For handling, pairwise comparisons of VAS scores were higher for both RNF and RW calves compared to those of TT calves, but the VAS scores were not significantly different between RNF and RW calves (P > 0.05) (Table 2.3).

During the post-processing period, foot stomping rate was highest for RNF calves compared to both RW and TT calves, and RW calves had a lower foot stomping rate than RNF

calves but a higher foot stomping rate than TT calves (Table 2.4). There were no detectable differences among treatment groups for all other behaviours evaluated post-processing (Table 2.4).

The medians and interquartile ranges of low frequency behaviours for the post-processing period have been summarized in Table 2.5.

2.5.3 Effect of handling and restraint methods between processed and control calves

When comparing the behaviour of processed and control calves during processing (Table 2.2), vocalization rates were significantly higher for RNF calves compared to CRNF calves, and TT calves compared to CTT calves. There were no differences detected for vocalization rate among RW and CRW calves. No differences were detected for struggling rate, VEW, or gait score ($P > 0.05$ for all comparisons).

During the post-processing period (Table 2.4), RW and TT calves tail flicked at a higher rate than CRW and CTT calves, while no difference was detected between RNF and CRNF calves. Foot stomping rates were higher for TT calves compared to CTT calves, whereas no differences were detected among RW, CRW, RNF, and CRNF. The CTT calves spent a higher percentage of time self-grooming compared to TT calves, but there were no detectable differences among RW, RNF, CRW, and CRNF calves ($P > 0.05$). No differences were detected between processed and control calves for all treatment groups for head shaking rate, percentage of time standing, percentage of time spent relaxed moving, percentage of time lying sternal, and percentage of time exploring/grazing ($P > 0.05$ for all comparisons) (Table 2.5).

2.5.4 Effect of handling and restraint methods among control calves

Among the control groups, no significant differences were detected among the 3 treatment groups for vocalization rate, struggling rate, and VEW ($P > 0.05$ for all comparisons) (Table 2.2). Gait score differed among control calves, with CRNF and CRW calves trotting more than CTT calves, which walked more when released (Table 2.2).

Similarly to the post-processing behaviours exhibited by processed calves, there were no significant differences detected for control calves among the 3 treatment groups for tail flicking rate, head shaking rate, percentage of time standing, percentage of time spent relaxed moving, percentage of time lying sternal, and percentage of time exploring or grazing (Table 2.4). Foot stomping rate was higher for CNF and CRW calves compared to CTT calves during the post-processing period, but there was no significant difference between CNF and CRW calves ($P > 0.05$). In contrast, CTT calves spent a higher percentage of time self-grooming compared to CRNF calves during the post-processing period, but the percentage of time spent self-grooming by CRW calves did not significantly differ from those of either CTT or CRNF calves.

2.6 Discussion

This study compared the effects of three common methods of processing handling and restraining pre-weaned beef calves on behavioural indicators associated with their welfare. Overall, the differences in behavioural indicators associated with stress or pain were inconsistent among methods both during or after processing, suggesting that none of the methods presented a clearly preferable approach.

During processing, there were no consistent differences in behavioural indicators among the calves that received husbandry procedures. This was in contrast to evidence from a

preliminary study (Schachtschneider, 2019), which reported that calves handled and restrained by RW for processing may be less stressed compared to calves processed using the tilt table based largely on physiological results of blood cortisol. However, differences among groups were detected for some of the indicators. For example, RNF calves displayed the highest rates of vocalizations, while TT calves displayed the highest rates of struggling. These differences may be attributed to the nature of the restraining devices and what the calves were or were not able to behaviourally express. For example, the ability of a calf to vocalize may have been affected by the human handler applying pressure to its neck during restraint by RW. For calves restrained by TT, it is possible that calf size affected the ability of calves to struggle. In addition, duration of handling and restraint may explain the high rate of struggling demonstrated by TT calves. Previous literature has reported that longer durations of handling and restraining result in animals experiencing higher levels of stress (Apple et al., 2005; Breuer et al., 2003; Grandin and Shivley, 2015; Moggy et al., 2017b; National Farm Animal Care Council, 2013).

When comparing processed and control calves during processing, the only difference found was that vocalization rates were higher among processed RNF and TT calves compared to CRNF and CTT calves. No other differences were detected among the three methods. This was surprising as differences are often reported in other studies between control calves and those receiving processing procedures such as castration (Coetzee, 2013; McCarthy et al., 2016; Stafford et al., 2002), branding (Meléndez et al., 2018), and dehorning (Stafford and Mellor, 2011; Sylvester et al., 2004). However, the lack of statistical differences detected may be due to low power due to a small control group sample size.

Among the control calves, CTT calves had comparatively slower speed gaits upon release. This could be interpreted as these calves being less motivated to escape, suggesting that

this method may be less stressful (Millman, 2013; Sinclair et al., 2016). Alternatively, the slower speed may be attributed to the darker, indoor setting where these calves were handled and restrained, as opposed to the brighter, outdoor setting where the other two methods were employed (Wilson et al., 2021). Overall, aside from this one indicator, there were no differences during processing among the three methods. However, this should be interpreted with caution due to the small control group sample size and large variations for behavioural indicators.

In the one hour after processing, tail flicking rate was higher for RW and TT calves compared to CRW and CTT calves. This is not surprising given that tail flicking has been associated with pain of procedures such as castration (Meléndez et al., 2018; Turner et al., 2020). It is curious as to why no such difference was detected between RNF and CRNF calves, as it is difficult to explain how a method of handling and restraint would impact this behavioural response. Another difference observed was that CTT calves spent a greater percentage of time self-grooming compared to all other treatments and all other controls. This may indicate that these calves were exhibiting comparatively less stress immediately after processing (Mattiello et al., 2019). An alternate explanation could be that these calves spent a greater percentage of time self-grooming due to irritation from being restrained in the tilt table. There have been different interpretations for why calves may display self-grooming behaviour; it has also been attributed to factors such as hygiene and injury (Horvath and Miller-Cushon, 2019; Mattiello et al., 2019). As such, the significance of these findings is unclear.

A difference was observed among post-processing behaviours when comparing among processed calves in that RNF calves displayed the highest rates of foot stomping, followed by RW calves, then TT calves. A similar observation was made when comparing among control calves, as foot stomping rate was higher among CRNF and CRW calves compared to that of

CTT calves. Additionally, foot stomping rates did not differ between RNF and CRNF calves or RW and CRW calves, whereas it was higher for TT calves compared to that of CTT calves. This could possibly be explained by the roping component that is involved in both roping and Nord fork and roping and wrestling. Foot stomping has been associated with pain resulting from castration (de Oliveira et al., 2014; Meléndez et al., 2018; Molony et al., 1995), but results of this study displayed that foot stomping also occurred in control calves when they have been roped. This suggests that whether or not a calf receives painful husbandry procedures, the action of roping and dragging a calf by its hindlegs, which is done in both roping and Nord fork and roping and wrestling, may result in the calf expressing discomfort after processing. Further, maintaining rope tension at the hindlegs throughout the duration of processing, which is done when restraining a calf by Nord fork, may explain why these calves had the highest stomping rate, potentially indicating that this method could cause the most foot pain.

The primary objective of this study was to compare calves' behavioural responses to different handling and restraint methods under industry relevant conditions. In future such studies, a greater number of control calves would be useful to increase the statistical power for comparing calves' behavioural responses between processed and control calves. Additionally, this study was designed to emphasize external validity, resulting in consequent differences in setting whereby calves that were handled and restrained using either roping and wrestling or roping and Nord fork were processed in an outdoor pen, while the calves handled and restrained by use of the tilt table were processed in an indoor facility. In addition, controlling for certain variables such as duration of handling or processing were purposely not done. This had the benefit of being more representative of how these methods are employed on farm, but it may have also contributed to increase in variation and lack of differences detected among indicators.

2.7 Conclusions

This research indicates that during processing, different methods of handling and restraint are inconsistent in their impact on behavioural indicators of calf welfare. Calves that were handled and restrained by roping and Nord fork and using the tilt table both demonstrated higher levels of behavioural indicators associated with stress during processing but did so through different indicators. In evaluating a variety of behavioural indicators after processing, there were few consistent differences among behavioural effects of the common methods compared in this study, with the exception of foot stomping. Roping and dragging the calves at the hind legs, which is done in both roping and wrestling and roping and Nord fork, seem to lead calves to experiencing increased levels of discomfort at the hindlegs after processing, whether or not they received husbandry procedures. Overall, based on observations of calf behaviour during and after processing in this study, it is not clear whether one method of processing handling and restraint is preferable for optimizing calf welfare.

2.8 Tables

Table 2.1: Experimental ethogram of calf behaviour.

	Behaviour	Scoring	Definition
Processing	Vocalization	Rate (count per time)	Sound emitted from the calf's mouth while its mouth is visibly open.
	Struggling	Rate (count per time)	Kicking, stepping, and head shaking motions.
	Visual eye white	Presence/Absence	When over 50% of calf's eye white is visible
	Gait	Category (walking, trotting, or running)	Walking: moving with a steady, four-beat gait in which hind feet are landing in a similar position as front feet (Zinpro Co. et al., 2013); trotting: two-beat gait in which the front foot and opposite hind foot hit the ground at the same time; running: high-speed three or four-beat gait.
Post-processing	Tail flicking	Rate (count per time)	Forceful tail movement beyond the widest part of the rump. While standing, one action is counted when the tail returns to the center point of the rump after moving from one side of the rump to the other. While lying, tail movement to one side is counted as one action (Turner et al., 2020; Molony et al., 1995).
	Head shaking	Rate (count per time)	Vigorous, consecutive toss of the head from side to side at least once per side (Turner et al., 2020).
	Foot stomping	Rate (count per time)	Hind leg is lifted and forcefully placed on the ground or kicked outward while standing (Meléndez et al., 2018; Molony et al., 1995).
	Jumping	Rate (count per time)	Bucking (i.e., both hind legs are kicked into the air) and/or two or more hooves are raised off the ground, and body is moving upwards (Jensen et al., 1998, 2015; Mintline et al., 2013).
	Standing	Percent of time (%)	Calf's body is supported in an upright position by three or more legs for at least 1 second.

Relaxed movement	Percent of time (%)	Moving (i.e., walking, trotting, or running) forward or backwards more than 4 total steps (i.e., each foot takes 1 step, leading to 4 total steps) steadily and without restriction.
Abnormal movement	Percent of time (%)	Moving (i.e., walking, trotting, or running) forward or backwards more than 4 total steps (i.e., each foot takes 1 step, leading to 4 total steps) with restriction, may be with hunched back and/or stiff, short steps (de Oliveira et al., 2014).
Lying sternal	Percent of time (%)	Lying in sternal recumbency with legs folded under the body or 1 hind or front leg is extended (Molony et al., 1995).
Lying lateral	Percent of time (%)	Lying with hip and shoulder on the ground with at least 3 limbs extended (Molony et al., 1995).
Lesion licking	Percent of time (%)	Calf's head is directed towards the area between its hind legs, paired with vertical motions of its head and neck while in standing position (Molony et al., 1995).
Self-grooming	Percent of time (%)	Scratching (i.e., hind leg is lifted and rubbed against its own body) and when calf's head is turned towards the body and muzzle and/or tongue is visibly in contact with its own body (i.e., shoulder, hip, and/or dorsal area), followed up by up and down movements of the head (Horvath and Miller-Cushon, 2019; Toaff-Rosenstein et al., 2016). Does not include lesion licking.
Allo-grooming	Percent of time (%)	Calf's tongue visibly comes in contact with another calf's body.
Exploratory/Grazing	Percent of time (%)	Sniffing, pawing, licking, or eating (i.e., calf's muzzle is in contact with the ground, visibly ripping grass off) materials in their environment.

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Table 2.2: Vocalization and struggling rates (count/min), presence of visual eye white (VEW; count), and gait immediately upon release from restraint (count) of processed (n = 79) and control (n = 21) calves by treatment groups. Treatment groups were calves handled and restrained by roping and wrestling (RW), roping and Nord fork (RNF), and using the tilt table (TT).

		Method of handling and restraint (Median (IQR*))		
Treatment	**Behaviour**	**RW**	**RNF**	**TT**
Processed (n = 79)	Vocalization (count/min)	5.0 (7.8)[a]	11.7 (12.3)[b,1]	1.6 (7.8)[a,3]
	Struggling (count/min)	2.3 (2.6)[c]	1.9 (2.7)[c]	4.6 (4.0)[d]
	Presence of VEW			
	Yes	25	25	25
	No	3	2	1
	Gait[e]			
	Walking	9	4	10
	Trotting	14	14	14
	Running	1	8	2
Control (n = 21)	Vocalization (count/min)	3.0 (4.0)	2.0 (3.0)[2]	0.0 (0.0)[4]
	Struggling (count/min)	2.5 (2.3)	0.5 (1.0)	2.0 (1.5)
	Presence of VEW			
	Yes	8	6	6
	No	0	0	1
	Gait[f]			
	Walking	2	0	5
	Trotting	6	4	2
	Running	0	1	0

*Interquartile range (IQR) = 75th quartile – 25th quartile

[a,b,c,d] Medians within a row with different superscripts differ (P < 0.01) and compare among processed calves

[1,2,3,4] Medians within a column with different superscripts differ (P < 0.01) and compare processed calves with control calves

[e] Significant relationship between treatment groups and gaits of walking and running, with RNF calves having the highest occurrences of running upon release from constraint (P < 0.05) compared to all other processed groups

[f] Significant relationship between treatment groups and gaits of walking and trotting, with control TT calves having the lowest occurrences of trotting upon release from restraint (P < 0.05) compared to all other control groups

Table 2.3: Handling difficulty score (count) and visual analogue scale (VAS; median and interquartile range (IQR)[*]) score during handling and restraint of processed (n = 79) and control (n = 21) calves by treatment groups. Treatment groups were calves handled and restrained by roping and wrestling (RW), roping and Nord fork (RNF), and use of the tilt table (TT).

			Method of handling and restraint		
Treatment	**Scores**		**RW**	**RNF**	**TT**
Processed (n = 90)	Handling difficulty (number of calves)				
		1	12	11	18
		2	8	13	10
		3	8	4	2
		3+	2	2	0
	VAS (median and IQR)				
		Handling	3.5 (3.0)[a]	4.1 (3.0)[a]	2.5 (1.9)[b]
		Restraint	3.0 (2.1)	3.6 (2.4)	2.2 (3.3)
Control (n = 26)	Handling difficulty (number of calves)				
		1	6	5	4
		2	2	4	5
		3	0	0	0
		3+	0	0	0
	VAS (median and IQR)				
		Handling	1.8 (1.8)	2.2 (0.5)	2.4 (1.0)
		Restraint	2.2 (0.9)	1.8 (1.3)	2.8 (2.5)

[*] Interquartile range (IQR) = 75th percentile – 25th percentile

[a, b] Medians within a row with different superscripts differ ($P \leq 0.01$)

Table 2.4: High-frequency behaviours of processed (n = 90) and control (n = 27) calves recorded after processing by treatment groups. Treatment groups were calves handled and restrained by roping and wrestling (RW), roping and Nord fork (RNF), and using the tilt table (TT).

		Method of handling and restraint (Median and IQR*)		
Treatment	**Behaviour**	**RW**	**RNF**	**TT**
Processed (n = 90)	Foot stomping (count/min)	1.0 (0.9)[a]	1.9 (2.3)[b]	0.5 (0.5)[c,3]
	Tail flicking (count/min)	10.5 (9.4)[1]	7.9 (10.1)	12.3 (6.5)[5]
	Head shaking (count/min)	0.04 (0.04)	0.05 (0.06)	0.04 (0.08)
	Self-grooming (percent of time)	0.8 (1.8)	0.3 (0.5)	0.7 (1.1)[7]
	Standing (percent of time)	84.3 (14.3)	77.1 (18.5)	84.8 (10.7)
	Relaxed movement (percent of time)	8.4 (7.7)	10.5 (16.2)	11.2 (5.6)
	Lying sternal (percent of time)	15.3 (22.9)	26.4 (26.4)	15.7 (15.2)
	Lesion licking (percent of time)	0.1 (0.1)	0.2 (0.4)	0.2 (0.5)
	Exploratory/grazing (percent of time)	3.8 (3.3)	3.2 (2.2)	2.8 (8.0)
Control (n = 27)	Foot stomping (count/min)	1.09 (0.94)[d]	1.66 (1.66)[d]	0.20 (0.28)[e,4]
	Tail flicking (count/min)	3.35 (4.10)[2]	5.80 (7.76)	2.25 (3.61)[6]
	Head shaking (count/min)	0.08 (0.02)	0.07 (0.07)	0.09 (0.16)
	Self-grooming (percent of time)	1.11 (0.69)[fg]	0.20 (0.15)[f]	2.11 (0.62)[g,8]
	Standing (percent of time)	55.32 (34.95)	84.77 (27.17)	82.37 (12.98)
	Relaxed movement (percent of time)	10.05 (4.49)	10.06 (4.99)	9.41 (11.65)
	Lying sternal (percent of time)	31.81 (6.26)	29.89 (12.28)	13.81 (13.94)
	Exploratory/grazing (percent of time)	7.67 (7.28)	4.08 (3.21)	5.12 (5.85)

*Interquartile range (IQR) = 75th quartile – 25th quartile percentile

[a,b,c,f,g] Medians within a row with different superscripts differ ($P < 0.01$) among treatment groups

[d,e] Medians within a row with different superscripts differ ($P < 0.05$) among treatment groups

[1,2,3,4,5,6,7,8] Medians for the same behaviour within a column with different superscripts differ ($P < 0.01$) and compare processed calves with control calves

Table 2.5: Median and interquartile range (IQR)* for low-frequency behaviours of processed (n = 90) and control (n = 27) calves recorded during the post-processing period by treatment groups. Treatment groups were calves handled and restrained by roping and wrestling (RW), roping and Nord fork (RNF), and using the tilt table (TT).

		Method of handling and restraint (Median and IQR)		
Treatment	**Behaviour**	**RW**	**RNF**	**TT**
Experimental (n = 90)	Jumping (count/min)	0.07 (0.00)	0.04 (0.00)	0.07 (0.03)
	Abnormal movement (percent of time)	3.73 (4.00)	5.95 (6.53)	0.86 (0.00)
	Lying lateral (percent of time)	0.10 (0.07)	-	9.53 (0.00)
	Allo-grooming (percent of time)	0.64 (0.55)	-	-
Control (n = 27)	Jumping (count/min)	-	0.02 (0.00)	0.03 (0.01)
	Abnormal movement (percent of time)	0.77 (0.69)	2.16 (5.98)	-
	Lying lateral (percent of time)	-	-	-
	Lesion licking (percent of time)	0.34 (0.0)	-	-
	Allo-grooming (percent of time)	-	-	0.12 (0.00)

*Interquartile range (IQR) = 75th quartile – 25th quartile percentile

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Chapter 3: Perceptions of participants in western Canadian beef calf processing events about common calf handling and restraint methods

3.1 Abstract

Calf processing events play important animal health, management, and sociocultural roles for the beef cattle industry. During processing, calves are handled and restrained to receive various husbandry procedures (e.g., castration and vaccination). There are different methods for handling and restraining calves during processing, and the specific method by which this is done differs across operations. In western Canada, the three most commonly used methods are roping and wrestling, roping and Nord fork, and use of the tilt table. Currently, there is a lack of knowledge about how people who participate in western Canadian beef calf processing events view these common methods. Thus, the objective of this study was to understand the preferences and perceptions of participants about calf handling and restraint methods commonly used during western Canadian beef calf processing events. Data was collected by using a mixed-methods online questionnaire. Quantitative analysis was used to describe the study participants and determine preference rankings. Qualitative, thematic analysis was used to explore participants' perceptions about the common handling and restraint methods and to identify shared values among participants. The majority of participants were farm hands or staff members (92.8%), followed by owners (4.9%), family members (1.4%), friends (0.5%), and others (0.4%). The most and least preferred methods of handling and restraint were roping and wrestling and use of the tilt table, respectively. Participants' explanations for why they chose a method as their most or least preferred revealed that though their choice of preferred method varied, the reasoning behind their choices had much in common. Specifically, participants shared values of calf safety and stress minimization, efficiency, convenience, human safety, and limiting labour intensity

when considering calf handling and restraint methods. This study provides valuable insights that can be used to develop and implement practical recommendations for handling and restraining beef calves during processing, as well as inform future extension efforts and communications among western Canadian beef industry stakeholders.

Keywords: cattle, mixed methods, perceptions, processing, values

3.2 Introduction

Calf processing events, commonly known as "brandings", are important sociocultural events for people within the ranching community (Rondeau and Joanne, 2013), with family, friends, and neighbours often coming together for these events annually. It is also an event during which beef calves approximately 6-12 weeks of age are handled and restrained to receive various husbandry procedures for management and health purposes (Chamorro et al., 2016; González et al., 2010). The specific method by which people handle and restrain calves in this context varies by operation (Moggy et al., 2017a; Schachtschneider et al., 2019). In western Canada, the most common methods include roping and wrestling, roping and Nord fork, and use of the tilt table (Moggy et al., 2017a).

Currently in Canada, there exists the Code of Practice for the Care and Handling of Beef Cattle, which is a national guideline developed by the National Farm Animal Care Council (National Farm Animal Care Council, 2013). It aims to inform people in the Canadian beef industry about requirements and recommendations relevant to the industry, such as those pertaining to husbandry procedures carried out during calf processing events (e.g., castration and branding) (National Farm Animal Care Council, 2013). However, absent in the Codes are clear

recommendations about the optimal methods for handling and restraint involved during calf processing.

Qualitative research methods are increasingly used in the veterinary and agricultural fields to gain rich understandings of industry stakeholder perceptions, preferences, and values (Biesheuvel et al., 2021). Perception is how a person understands and gives meaning to a subject (American Psychological Association, 2022a), while preference means favoring an option among other alternatives upon comparison (American Psychological Association, 2022b). Human values are core principles that guide individual decision-making (American Psychological Association, 2022c; Sonoda et al., 2018). Such knowledge (i.e., perceptions, preferences, and values) can be useful for providing context for the development and effective implementation of pragmatic recommendations, as well as informing education efforts and bridging communications among industry stakeholders (e.g., the public, producers, and veterinarians) (Biesheuvel et al., 2021; Moggy et al., 2017b; Spooner et al., 2012, 2014; Ventura et al., 2021).

Currently, there are qualitative studies within the livestock industry that focus on gaining insights from the public, veterinarians, and students (e.g., undergraduate and veterinary) (Biesheuvel et al., 2021; Ferree et al., 2022; Podberscek, 2000; Ruston et al., 2016; Serpell, 2005; Skjølstrup et al., 2022; Sonoda et al., 2018; Sullivan et al., 2022; Tamioso et al., 2018; Ventura et al., 2021). However, there is a limited number of scientific works exploring the perceptions of people who work with livestock animals (Biesheuvel et al., 2021). The majority of these are based in Europe and North America and aim to better understand topics such as disease prevention, animal welfare, and uptake of best practice recommendations (Biesheuvel et al., 2021; Brennan and Christley, 2013; Doidge et al., 2021; Smid et al., 2021; Valeeva et al., 2007),. It is noted that various factors (e.g., perceived risks and values) are considered in the decision-

making process of industry experts (Doidge et al., 2021; Jansen et al., 2009; O'Kane et al., 2017; Smid et al., 2021). Within the beef cattle community, it is suggested that management decisions on cow-calf operations are influenced by factors such as honouring tradition, meeting consumer demands, economic costs, and improving animals' quality of life (Bassi et al., 2019; Buddle et al., 2021; Rondeau and Joanne, 2013; Spooner et al., 2012). A specific example of a management decision made on cow-calf operations is deciding what method of handling and restraint to use for calves during processing events. Yet, there are no peer-reviewed published studies that explore the perceptions of those involved in these events about the common methods used in western Canada.

Therefore, the objective of this study was to understand how people who participate in processing events perceive common handling and restraint methods used for pre-weaned calves on western Canadian cow-calf operations.

3.3 Materials and Methods

3.3.1 Inclusion criteria

Adults who participated in at least one calf processing event in western Canada (i.e., British Columbia, Alberta, Manitoba, or Saskatchewan) within the last 5 years were eligible for inclusion in this study.

3.3.2 Positionality statement

The initial idea and design for this study was provided by CG and EP, experts in animal behaviour and welfare. Input was then provided by all authors of this study, who all work in the field of veterinary medical science or animal welfare. The original questionnaire was developed

by LA. All authors as well as the staff of W.A. Ranches at the University of Calgary provided input integral to the development of the final questionnaire. Study data collection was supervised by CW and EP, and thematic analysis was conducted primarily by LA with input from CA, CG, CW, and EP. Finally, all authors read and contributed to the writing of this manuscript. The lead author, LA, is an Asian-American international graduate student currently conducting research about production animal welfare and behaviour at a Canadian public university. As a graduate student, she has observed and helped with a number of calf processing events in Alberta. Though these experiences were limited in number, each one of these opportunities provided her with a deeper insight into western Canadian processing events and undoubtedly contributed to the lens through which the data of this study was interpreted. Lastly, although she has a background in production animal science and animal care, much of her knowledge comes from veterinary clinics, research laboratories, university lectures, and published literature, which may differ from the on-farm knowledge of many of the participants of this research.

3.3.3 Ethical considerations

This study was approved by and conducted in accordance with guidelines set by the Conjoint Faculties Research Ethics Board of the University of Calgary (REB21-1809). Informed consent was obtained from each participant before their participation in the survey. Before obtaining consent, potential participants were provided with information about the purpose of this study, inclusion criteria, what was expected from the participant, what type of personal information would be collected, benefits of participating, what would happen to the information provided, and what it meant to consent to participating in this study. Participants were encouraged to ask questions to clarify any points of confusion and make sure that they

understood the provided information. Additionally, the first question of the survey asked potential participants to confirm that they 1) had experience participating at a calf processing event (i.e., spring processing, processing, or branding) in western Canada within the last five years and 2) consented to participating in the survey study. Those who answered to both questions, "Yes" were then directed to the questionnaire, while those who answered, "No" were then thanked for their time, and the questionnaire was terminated. Participants were free to choose not to answer any questions throughout the questionnaire.

Upon completion of the questionnaire, participants had the choice to provide their name and email address to be entered for a chance to win one of ten $50 gift cards. During data analysis, all personal identifying information was removed and participants were assigned random, computer-generated numbers to ensure anonymity. Further, all data collected for this study was made accessible only to the researchers directly involved in this study to maintain confidentiality of the data.

3.3.4 Data collection

The questionnaire (Appendix A) was developed in Qualtrics (Version 2022; Qualtrics, Provo, UT) and initially reviewed by experts in beef calf processing and qualitative research. Then, a pilot study of the questionnaire was conducted with ranch staff of W.A. Ranches at the University of Calgary prior to distribution to evaluate the quality of questions asked, possible points of confusion, and overall design.

The finalized questionnaire took approximately 30 minutes to complete. It used a mixed-method approach to collect both quantitative and qualitative data from participants. Responses were collected over a period of three months. Questions at the beginning of the questionnaire

asked participants what their role at their operation was (i.e., family member, friend or neighbor, farm hand or staff member, or other), and whether or not their main source of income came from cow-calf operations. Participants were then asked what tasks they typically perform during processing (e.g., roping, wrestling, placing the Nord fork on the calf, working the tilt table, castrating, vaccinating). Questions were also asked how many calves on average are processed per day, average number of days spent processing calves, and average number of people participating each day during calf processing events at the participants' respective operations. Following these, participants were asked to rank different factors (e.g., economic cost, time, efficiency, age or size of calves, human safety, tradition) from 0 (not important) to 6 (extremely important) with respect to its importance for choosing a processing handling and restraint method. In addition, they were also asked to rate the acceptability from 1 (totally unacceptable) to 5 (totally acceptable) for the common handling and restraint methods used in Canada (i.e., roping and wrestling, roping and Nord fork, or use of tilt table), as well as rank their most and least preferred method. Then, they were asked to provide a short response explaining why they chose a method as their most or least favorite method. Afterwards, participants were asked to rank the most and least preferred of the three methods based on what they believed the public would prefer. Finally, demographic information (i.e., province, age group, gender identity, and highest level of education) was collected from participants at the end of the questionnaire. Additional questions for separate studies were included about handling training experience (Questions 21 through 28, Appendix A) and attitudes towards animal welfare (Questions 42 and 43, Appendix A), and thus their analysis was outside the scope of this study.

The questionnaire was made available online. A recruitment letter including the QR code and link to the questionnaire was distributed through newsletters sent out by provincial beef

associations (e.g., Alberta Beef Producers, Saskatchewan Cattlemen's Association, Manitoba Beef Producers, and British Columbia Cattlemen's Association) and other associations (i.e., Alberta Farm Animal Care Association, Canadian Cattlemen's Association, and Western Canadian Association of Bovine Practitioners). Additionally, the QR code and link to the questionnaire were posted on social media (i.e., Twitter).

3.3.5 Data analysis

All responses were collected through Qualtrics and then imported to Microsoft Excel (Version 16.62; Microsoft Corporation. Dubai, UAE). Responses were only analyzed if respondents completed questions addressing participants' preferences and perceptions regarding different processing handling and restraint methods (Questions 29 through 40, Appendix A).

3.3.5.1 Quantitative data

All quantitative data were statistically analyzed using a combination of Microsoft Excel and R Studio: Integrated Development for R (Version 1.3.1093; RStudio, PBC. Massachusetts, USA).

Participants were subcategorized into respondent types of either "owner" or "non-owner" based on their self-identified role at their operation. Percentages of participants for each demographic category were then calculated within each respondent type. Percentages of participants who noted that their main source of income does or does not come from cow-calf operations, as well as percentage of participants who noted they had experience with a particular task performed during processing, were calculated for all participant responses combined as well as within each respondent type. Data regarding number of calves processed per processing day,

number of days spent processing calves, and number of people participating in processing events each day were analyzed based on only owner responses.

The mean and standard deviation (SD) was calculated for ratings of factors with respect to importance for choosing a processing handling and restraint method, as well as the acceptability of each method. Separately, these data were treated categorically and analyzed using a chi-squared test to compare if ratings differed by factor. The mean ± SD was also calculated for preference rankings of the common methods by participants. These data were also then treated categorically and analyzed using a chi-squared test to compare if rankings differed by method. The mean ± SD was calculated as well for rankings of the common methods based on perceived preferences of the public by participants. Again, these data were treated categorically and analyzed using Fisher's exact test to compare if rankings differed by method.

3.3.5.2 Qualitative data

Questions analyzed using qualitative research methods were those asking participants to explain why they identified a particular handling and restraint method as most or least preferred. Data were organized and analyzed in Microsoft Excel. Specifically, the data was analyzed using an iterative six-step thematic analysis as described by Braun and Clarke (2006; 2020). Familiarization of the data was achieved by reading through and organizing the responses according to what method they referred to and whether it was an explanation for a method being the most or least preferred. Following this, initial codes were assigned to parts of the data and organized in a separate spreadsheet, from which groupings of codes were created by combining codes of similar meaning. Resultant codes were used to develop initial themes, which were then reviewed and defined as final themes. Lastly, comparisons were made across final themes for

each method to identify shared and divergent values of participants. All parts of the analysis from familiarization of the data to defining the themes were conducted using an iterative and reflexive approach guided by the research question itself as well as understanding of the different methods of handling and restraint included in this study. Additionally, during the development and definition of themes, findings from the study were presented to and discussed with experts in beef calf processing and qualitative research (CA, CG, CW, and EP) to critically review and inform final themes such that they were reflective of the data.

3.4 Results

A total of 999 responses were received. Of this, 853 responses were included in the study based on completion of questions addressing participants' preferences and perceptions regarding different calf handling and restraint methods used during processing. Respondents included operation owners (n = 42; 4.9%), farm hands or staff members (n = 792; 92.8%), family members (n = 12; 1.4%), friends (n = 4; 0.5%), and others (n = 3; 0.4%).

3.4.1 Demographics

Among respondents that identified as non-owners (i.e., farm hands or staff members, family members, friends, and others; n = 811), the highest percentage of respondents indicated that they process calves in Alberta (30.2%; n = 245), followed by Manitoba (24.0%, n = 195), British Columbia (23.7%, n = 192), then Saskatchewan (21.6%, n = 175). Most non-owners identified as in the age groups of 36-50 (49.4%, n = 401) or 35 years or under (42.4%, n = 344), while some identified as other (7.6%, n = 62), 51-65 (0.4%, n = 3), and over 65 years (0.1%, n = 1). For gender identity, the majority of non-owners identified as male (91.0%, n = 735), some

indicated that they preferred not to disclose this information (7%, n = 62), few identified as female (2.0%, n = 14), and none identified as other (0%, n = 0). The highest level of education among non-owners were university degree or equivalent (46.2%, n = 375), trade or technical school (45.0%, n = 365), graduate or professional degree (0.7%, n = 6), and high school (0.3%, n = 2). Some indicated that they preferred not to disclose this information (7.8%, n = 63), while none indicated that their highest level of education was before high school (0.0%, n = 0).

Among owners (n = 42), the majority of respondents' operations were located in Alberta (71.4%, n = 30), followed by Saskatchewan (23.8%, n = 10), British Columbia (2.4%, n = 1), and Manitoba (2.4%, n = 1). The predominant age groups among owners were 35 years of under (40.5%, n = 17) and 36-50 years (38.1%, n = 16), while there were some that identified to be 51-65 years (7.1%, n = 3), over 65 years (4.8%, n = 2), and other (9.5%, n = 4). For gender identity, the majority of owners identified as male (47.0%, n = 22) or female (45.0%, n = 17), some indicated that they wished not to disclose this information (8.0%, n = 3), and none identified as other (0.0%, n = 0). The highest level of education among owners were university degree or equivalent (35.7%, n = 15), trade or technical school (23.8%, n = 10), graduate or professional degree (14.3%, n = 6), and high school (11.9%, n = 5). Few indicated that they preferred not to disclose this information (7.1%, n = 3), and none indicated that their highest level of education was before high school (0.0%, n = 0).

Respondents who identified as owners were asked additional questions about their operations. Percentage of commercial and purebred or seedstock cow-calf herds (average percentage ± SD), number of cattle by production group present during spring processing season (mean ± SD), and most common breed of calves (percentage (%)) have been summarized in Table 3.1. Owners also responded to additional questions specifically about processing (n = 41).

It was reported that approximately 159 ± 18.6 calves were processed per processing day, an average of 2.8 ± 3.9 days were spent processing calves, and an average of 12.0 ± 8.5 people per day participated in a given processing event. Those who were reported to typically help process calves include family members, friends, neighbours, farm hands, and staff members (Table 3.2). The majority of owners noted that calves were 6-12 weeks of age at the time of spring processing, and most calves were processed in May and June (Table 3.2).

Among all respondents (i.e., owners and non-owners; n = 853), 96.8% (29 owners, 792 farm hands or staff members, 3 family members, 2 others) indicated that their main source of income comes from cow-calf operations, while 3.2% indicated that their main source of income does not come from cow-calf operations. All respondents were also asked what task(s) they typically perform in their role during processing, and the majority of respondents identified that they had recent experience handling and restraining calves (e.g., wrestling or working the tilt table) during processing (Table 3.3). The majority of respondents also identified castration as a task they typically perform (Table 3.3). Other tasks included vaccination, administration of a pain reliever, hormone implanting, ear tagging, dehorning, hot iron branding, placing the Nord fork on the calf, moving calves into an alley that leads to tilt table, and other tasks (i.e., administering amprolium and tattooing) (Table 3.3). None of the respondents identified freeze branding or record keeping as their tasks during processing.

The rating of factors (i.e., economic cost, time efficiency, age or size of calves, number of workers, weather, time of year, number of calves, human safety, and tradition) regarding their importance for choosing a handling and restraint method to process calves did not differ significantly among factors (Figure 3.1). The acceptability of each handling and restraint method with 1 being totally unacceptable and 5 being totally acceptable, reported in means and standard

deviations were 4.0 ± 0.8 for roping and wrestling, 4.0 ± 0.8 for roping and Nord fork, and 3.5 ± 1.1 for use of tilt table.

3.4.2 Preference of handling and restraint method used during calf processing

Among the three common handling and restraint methods used during calf processing, the most preferred method was roping and wrestling and the least preferred method was use of the tilt table (Figure 3.2). The method that was perceived to be the most preferred by the public was use of the tilt table, whereas roping and wrestling was perceived to be the least preferable method by the public (Figure 3.3). Results for method preference of participants as well as what participants perceived the public would prefer regarding the methods are summarized in Figures 3.2 and 3.3, respectively.

3.4.3 Perception of common calf handling and restraint methods used during processing

Though respondents differed in their most or least preferred method of handling and restraining preweaned beef calves, respondents revealed points of similarity when communicating their reasoning for choosing a particular method as their most or least preferred. Major themes shared among all methods regarding why a method was perceived to be most preferable included efficiency of processing, convenience associated with the method, maintaining calf safety, and minimizing stress. Major themes shared among all methods regarding why a method was chosen as least preferred included concerns regarding calf safety and stress, and concerns about human safety and labour intensity.

A few respondents noted that some or all of the methods of handling and restraint have the potential to be equally effective in the context of processing given well-trained staff. For

example, one respondent stated that, "the key to success in any type of branding situation is ensuring that the people you have working for you understand how to the handle animal safely and in the most low-stress manner."

3.4.3.1 Roping and wrestling

Many of the respondents whose chose roping and wrestling as their most preferred method referred to the perceived time-efficiency of processing using this method, which they thought made it especially useful for processing calves in large herds. Respondents also indicated this method as most preferable due to the associated convenience, noting the ease of training new people to handle and restrain calves using this method and that it is both easier and faster for these people to carry out husbandry procedures due to the secure immobilization of the calf. Another common view was that roping and wrestling was perceived to lead to decreased levels of stress experienced by calves throughout processing, as it is "quicker," associated with a "quieter," "calmer atmosphere," and there is not necessarily a need to separate cows and calves, thereby minimizing the stress associated with cow-calf separation. Lastly, some respondents noted this method as most preferable due to a perceived decreased risk of calf injury during processing. They reasoned that this method allows for better control and secure immobilization of calves, and that the ground on which calves are processed using this method (i.e., pasture) is more suitable for safely processing calves.

It should be noted that multiple respondents mentioned that this was their most preferred method specifically when working with a well-trained processing crew. This is demonstrated by one respondent who pointed out that, "when you rope and wrestle with people that are efficient

and knowledgeable at the jobs that they are doing, this is the smoothest, less stressful [method] on the livestock."

In contrast, those who indicated roping and wrestling as their least preferred method expressed concerns about increased levels of stress experienced by calves throughout processing, potential risks for calf, human, and horse injury, and difficulty finding help. Those who noted concerns that roping and wrestling may lead calves to having a more stressful experience specifically pointed out that this method, "seems rough." It was also perceived that calves may experience higher levels of stress during processing due to the method involving increased human handling of the calf. Potential risk of calf injury was also brought up as a concern with regard to this method, as some respondents heard about or witnessed calf injuries due to dragging them. Respondents also highlighted a perceived increased risk of calf injuries and accidents due to inexperienced or irresponsible ropers or wrestlers, noting that "the problem with this method is it takes a level of skill to do well and safely that many do not possess." Respondents expressed concerns about potential risks for horse injury as well, as this method was perceived to be physically demanding for the working horses. Finally, those who identified roping and wrestling as their least preferred method stated that a challenge associated with this method is the difficulty of finding help to effectively process calves. They highlighted that carrying out this method not only requires many horses and people, but also handlers that are highly skilled, and this is exhibited by one respondent, who noted that, "You need very experienced ropers and wrestlers. If the ropers and wrestlers are inexperienced this can cause safety issues for the calves and handlers."

3.4.3.2 Roping and Nord fork

Respondents who indicated roping and Nord fork as their most preferred method perceived this method to be efficient, as a number of calves can be processed at a time by "hav[ing] multiple stations going at once." Further, respondents associated this method with an improved ability to carry out husbandry procedures such as dehorning and administering injectable vaccinations, conveying this method's perceived efficiency and convenience in the context of calf processing. Additionally, some respondents who indicated roping and Nord fork as their most preferred method reasoned that it is convenient because a fewer number of people are required for processing and there is "no need to find or train wrestlers" to restrain calves. Another reason provided by respondents in favour of this method was the perception that this method minimizes calf stress throughout the processing event, as this method is perceived to be associated with a short processing time, minimized separation of cow-calf pairs, and decreased human handling. Some respondents perceived this method to be safer for calves, as "[they] are well restrained [so] it is easier to complete all tasks with less risk of injury to calves." It was also noted that there is a perceived decreased risk of calf injury during processing using this method because of the greater quality of handling overall due to workers being less tired given decreased labour required per individual calf. Finally, it was indicated that roping and Nord fork was chosen as most preferable because this method was perceived to be one that is safer for the human handlers and requires less physical exertion.

One respondent stated that honoring culture and tradition was the reason for this method being ranked as the most preferred among the three methods. This respondent explained that using roping and Nord fork to process calves, "…is a culture and tradition of [their] family, and [they] believe it's what is less stress to the animal and helps the team when process[ing] to not be as tired at the end trying to wrestle calves."

Those who indicated roping and Nord fork as their least preferred method referenced perceived risk of calf injury and increased level of stress experienced by the calf. Respondents noted that this may be caused by dragging or accidents involving or misuse of the Nord fork, which can result in "people having to run after the calf and wrestle it… [which] just causes more stress on the animal." Some respondents also perceived this method to have an increased risk of human injury due to accidents involving ropes. Others expressed concerns regarding horse safety, which one respondent expressed that, "expecting [horses] to maintain tension on the rope for the duration of processing of every calf is much more work." Additionally, the Nord fork itself was noted as a tripping hazard for both horses and humans. Some respondents noted that this was their least preferred method due to the difficulty finding help to effectively process calves using this method given that "more people [and] more horses [are] needed". Some also perceived this method to be inefficient due to the insufficient security it provides for calf restraint, leading to difficulty carrying out husbandry procedures. It was also pointed out that the environment associated with this method is perceived to be disorganized, as "most places process three or four calves at a time and drag paths are not always as predictable as multiple Nord fork setups would require them to be." Finally, there were some respondents who noted this method as their least preferred due to their lack of familiarity with the method.

3.4.3.3 Tilt table

Respondents who indicated that the tilt table was their most preferred method of handling and restraint during processing referenced minimization of calf stress due to "less human contact on the calf" and a quiet processing environment. Respondents also noted a perceived decreased risk of calf injury during processing using this method because unlike other methods (i.e., roping

and wrestling and roping and Nord fork) which involve roping, calves handled and restrained using the tilt table are not "overstretched or dragged by a horse which can injure it." Many respondents also associated the use of the tilt table for processing with increased human safety. One respondent highlighted this perceived decreased risk of accidents resulting in human injury, noting that with this method, there are, "no horses or cows running around in your work space. Less people [are] needed which leads to a more organized operation." Additionally, many respondents noted that they perceived this method to be a less physically intensive method of processing calves and pointed out the convenience of this method as it provides, "good animal restraint [and] easy access to inject safely." Moreover, this method was viewed as convenient because less labour is required per person, fewer numbers of people and horses are required, and no experienced wrestlers are needed to process calves. A few respondents indicated this as their most preferred method because of the perceived efficiency of processing, especially when processing large calves or when processing must occur over many days. Finally, some respondents noted that they preferred use of the tilt table because of the organized and "more hygienic" processing environment associated with this method.

Respondents who indicated that this was their least preferred method attributed this choice to various reasons. One reason was a perceived increased risk of calf injury, as calves can get injured, "being pushed and banged through the chute" and smaller calves are not completely immobilized, and therefore, "have more room to move and [potentially] hurt themselves." It was also perceived by one respondent that the long duration of time spent processing using this method leads handlers to become increasingly tired throughout the day, leading to decreased quality of human handling which may result in calves getting injured. Many also perceived that calves experience increased levels of stress using this method because calves, "have to be

completely separated from mothers for longer," are "in the handling system/ally/pens for long periods of time," and are exposed to a loud processing environment. Additionally, many respondents reasoned that this was an inefficient method of handling and restraining calves because processing calves using this method takes a longer duration of time as calves can only be processed one at a time. Further, some noted difficulty carrying out husbandry procedures using this method due to the insufficient security for small calves as well as the head in general for all calves. Some respondents also expressed that this was their least preferred method due to the associated human injury and labour intensity, as respondents reported shin injuries, injuries directly related to working the tilt table, and tiredness from long hours which can lead to increased risk of accidents resulting in human injury. This is exemplified by quotes from two respondents; one expressed, "It's hell on people… Pushing calves up to an alley to go on a tilt table is an excellent opportunity to get kicked all day long," while the other noted that a high level of energy is required to, "constantly tip calves over [when] most [tilt tables] are well used and are finger pinchers." Another concern for this method shared by respondents was the feasibility of structural implementation. Some respondents pointed out that "to set up a system with a snake to a tilt table at every location is not feasible," conveying the challenge of building and incorporating such a system into an existing operation. Lastly, some respondents perceived this method to be associated with an unsanitary and unnatural processing environment because, "calves are usually releasing themselves all over it," leading them to choose this method as their least preferred among the three common methods of handling and restraint.

3.4.3.4 Shared values

In this study, four values were identified as to being held by many respondents, regardless of which method was indicated as most or least preferable. These included: 1.) minimizing calf injury and stress , 2.) time efficiency, 3.) convenience, and 4.) human safety and limiting labour intensity. These values were consistently referred to when respondents were asked to explain why they preferred a particular method the most or least.

The value of minimizing calf injury and stress was upheld by a particular handling and restraint method if it was perceived by respondents to provide secure immobilization of calves, a quiet environment, minimization of cow-calf separation, short processing time, or decreased human handling. Respondents conveyed concern that this value would not be met by a method if it was perceived to be associated with an increased risk of injuries related to dragging, risk of accidents, level of sound in the environment, or cow-calf separation.

The value of time efficiency was upheld by a method if it was perceived to allow large herds or specific sizes of calves to be processed quickly, or handlers to carry out husbandry procedures more quickly and effectively. Respondents conveyed concern that this value would not be met by a method if it was perceived to be associated with a disorganized environment, insufficient security of restraint that could lead to difficulty carrying out husbandry procedures, or a system which requires calves to be processed one at a time.

A method upheld the value of convenience if it was perceived to require fewer numbers of people, no highly experienced or skilled ropers and wrestlers, or no horses to process calves. Additionally, this value was upheld by a method if it was perceived to be associated with easy training of new handlers or most practical based on the current set up of the operation. Respondents expressed concern that this value would not be supported if a method was

1953 associated with difficulty finding help (i.e., large numbers of people, highly experienced or
1954 skilled ropers, and horses) or logistical issues related to structural implementation.
1955 The value of human safety and limitation of labour intensity were referred to when
1956 explaining roping and Nord fork and use of the tilt table as most preferred methods. This value
1957 was absent in responses explaining roping and wrestling as the most preferred method. Human
1958 safety and limitation of labour intensity were supported by the two methods for respondents if
1959 they were perceived to be associated with less physical exertion to process calves or decreased
1960 risk of accidents resulting in human injury. Respondents for all three methods (i.e., roping and
1961 wrestling, roping and Nord fork, and use of the tilt table) shared the concern that this value
1962 would not be met if the method was perceived to be physically demanding or associated with an
1963 increased risk of accidents, disorganized environment, equipment, or tiredness resulting from
1964 long hours, all of which may result in human injury.
1965
1966 ## 3.5 Discussion
1967 The goal of this study was to understand and describe the preferences and perceptions of
1968 participants of western Canadian beef calf processing events regarding common calf handling
1969 and restraint methods. To the authors' knowledge, this is the first study of its kind to use a
1970 mixed-methods approach to explore how participants in western Canadian beef calf processing
1971 events perceive roping and wrestling, roping and Nord fork, and use of tilt table in the context of
1972 calf processing.
1973 Overall, there was a clear difference for ranking of preference among the common
1974 handling and restraint methods, with roping and wrestling being the most preferred and tilt table
1975 being the least preferred. Major themes developed from responses revealed that regardless of

choice for most and least preferred method, there was much common ground in the underlying values held by participants in western Canadian calf processing events. Identifying shared values among people is important, because values drive decision making (Biesheuvel et al., 2021; Kuczewski et al., 2022; Sonoda et al., 2018; Weary et al., 2016). Therefore, understanding shared and divergent values in the context of handling and restraint methods is useful for informing future conversations and education efforts, as well as developing and implementing recommendations that could support or transform current practices surrounding calf handling and restraint during processing (Kuczewski et al., 2022; Sonoda et al., 2018; Weary et al., 2016). Based on survey responses, four values (i.e., calf injury and stress, efficiency, convenience, and human safety and labour efficiency) were identified as shared among participants in western Canadian calf processing events when considering calf handling and restraint methods. Three of these (i.e., calf injury and stress, efficiency, and convenience) were repeatedly referenced for why a particular method was preferred both the most or the least. This indicates that how a particular method was perceived to honour these values impacted whether a method was viewed as favourable or unfavourable.

The value of human safety and minimizing labour intensity was referred to as a shared concern by respondents for all three methods when explaining why a given method was chosen as their least preferred. Human safety and labour intensity have both been previously identified to be important considerations for people who work with cattle (Ceballos et al., 2018; Lindahl et al., 2013; Menger et al., 2016). This suggests that handling and restraint methods perceived to fail to uphold values of human safety and labour intensity will likely be viewed negatively by participants in western Canadian beef calf processing events.

Interesting to note was the general absence of economic cost when respondents provided explanations for why a method was indicated as most preferred. This is consistent with a previous survey study that revealed that finance was not a primary motivator among cow-calf producers (Jumper et al., 2021). It is also in line with evidence from qualitative works in other livestock industries (i.e., dairy and sheep) highlighting that economic factors are not the only influencers of on-farm decisions (Biesheuvel et al., 2021; Doidge et al., 2021; Jansen et al., 2009). Some respondents did note concerns related to implementing the systems necessary to carry out methods such as the tilt table, which has some economic implications. However, the general lack of economic cost in all explanations suggests that though it may have a limiting effect, economic cost is not a primary factor considered when deciding the handling and restraint method to use for calf processing.

Lastly, the vast majority of survey respondents identified as farm hands or staff members. However, based on responses from operation owners, the majority of people who come to help process calves are family members, friends, and neighbours. Historically, much of the western Canadian industry has consisted of family-run ranches (Rondeau and Joanne, 2013), and this disconnect may possibly mean that how individuals self-identify (e.g., family member or staff member) may not be the same as what operation owners perceive them to be. It could also point to a population of western Canadian processing event participants that were not reached by this survey possibly due to age restrictions (i.e., must be an adult to take this survey) or distribution limitations.

A limitation of this study is that it has a risk of selection bias (Thrusfield, 2005) because survey respondents had to have access to an electronic device (e.g., computer or smart phone) to participate in this study. It is also possible that respondents may have misunderstood questions or

response options within the questionnaire, leading to misinterpretation bias. However, to minimize this, the questionnaire was developed in conjunction with experts in the field and piloted with ranch staff from W.A. Ranches at the University of Calgary before data collection. Given that this is a survey study conducted by a public research university, there is also the possibility of social desirability bias (Green and Thorogood, 2013) in which respondents may have provided responses that would be seen as socially acceptable but not necessarily true. To minimize this bias, all respondents were made aware that their responses would be anonymized to maintain confidentiality. Finally, it should be noted that responses were not received for all questions from all respondents, which means analysis could only be conducted on the responses provided for those questions. This was because the questionnaire was designed in line with the Conjoint Faculties Research Ethics Board ethics guidelines such that respondents were allowed to skip questions if they wished not to answer them.

3.6 Conclusion

This research indicates that based on responses from participants in western Canadian beef calf processing events, there are distinct differences for rank of preference among the common handling and restraint methods. Analysis of responses for why a method was identified as most or least preferred reveal that regardless of preference, many of the participants share the same values (i.e., calf safety and minimizingstress, efficiency of processing, convenience, and human safety and labour intensity) in the context of calf handling and restraint during processing. Interestingly, values relating to economics are largely absent among responses explaining choice of method. Findings of this study can be used to provide context for the development and implementation of pragmatic requirements and recommendations for handling

and restraining beef calves during processing, as well as inform future communications and education efforts.

3.7 Tables and Figures

Table 3.1: Operation demographic information based on responses to a questionnaire by people who participated in western Canadian processing events and identified as owners of a cow-calf operation (n = 42).

Operation demographic descriptors	Mean ± SD[a] or Counts (Percentage)[b]
Percentage of cow-calf herd designated as commercial or purebred/seedstock (n = 40)[a]	
Commercial	91.2 ± 18.0
Purebred/Seedstock	8.8 ± 18.0
Number of cattle present on the operation during spring processing by production group (n = 39)[a]	
Nursing cows and heifers (i.e., those that calved during that year's calving season)	234.0 ± 168.0
Calves of processing age (i.e., those born during that year's calving season)	221.8 ± 164.2
Most common breed of calves on the operation (n = 42)[b]	
Angus	34 (81.0)
Charolais	1 (2.4)
Hereford	1 (2.4)
Limousin	0 (0.0)
Simmental	1 (2.4)
Commercial crossbred	0 (0.0)
Other[c]	5 (11.9)

[a] Percentages of cow-calf herd and the number of cattle types present on the operation are presented in means and standard deviations (SD).
[b] For most common breed of calves on the operation, participants could only choose one response. These values are presented in counts and percentages.
[c] Respondents identified the most common breed of calves on their operation as: Corriente; Speckle Park; Angus cross; or more than one most common breed (e.g., equal split between Angus, Charolais, and Gelbvieh; Angus and Simmental).

Table 3.2: Description of spring processing based on responses to a questionnaire by people who participated in processing events on western Canadian that identified as owners of the cow-calf operation (n = 42).

Spring processing descriptors	Count (Percentage)
Type of people who help process calves[a]	
Family members	36 (85.7)
Friends/neighbours	31 (73.8)
Farm hand/staff members	13 (31.0)
Other	0 (0.0)
Age of calves at time of spring processing	
Less than 6 weeks	10 (23.8)
6-12 weeks	28 (66.7)
12 or more weeks	4 (9.5)
Month(s) during which spring processing takes place[a]	
March	2 (4.8)
April	6 (14.3)
May	29 (69.0)
June	17 (40.5)
July	4 (9.5)
Other[b]	1 (2.4)

[a] Respondents could select all responses that applied to their operations for "Type of people who help process calves" and "Month(s) during which spring processing takes place" so the sum of percentages for these is greater than 100%.

[b] One respondent indicated that calves were processed during the month of November at their operation.

Table 3.3: Tasks typically performed during processing by respondents who identified as owners of cow-calf operations (n = 42), those who identified as non-owners (n = 810), and all respondents combined (n = 852) who responded to a questionnaire about processing events on western Canadian cow-calf operations.

	Owners	Non-owners	All respondents
Task performed during processing	**Count (Percentage)**	**Count (Percentage)**	**Count (Percentage)**
Castration	21 (50.0)	800 (98.9)	821 (96.4)
Roping	16 (38.1)	796 (98.3)	812 (95.3)
Wrestling	18 (42.9)	796 (98.3)	814 (95.5)
Working the tilt table	12 (28.6)	793 (97.9)	805 (94.5)
Vaccination	30 (71.4)	16 (2.1)	46 (5.4)
Administration of a pain reliever	24 (57.1)	9 (1.1)	33 (2.9)
Hormone implanting	18 (42.9)	7 (0.9)	25 (2.9)
Ear tagging	24 (57.1)	10 (1.2)	34 (4.0)
Dehorning	12 (28.6)	5 (0.6)	17 (2.0)
Hot iron branding	22 (52.4)	9 (1.1)	31 (3.6)
Freeze branding	0 (0.0)	0 (0.0)	0 (0.0)
Record keeping	0 (0.0)	0 (0.0)	0 (0.0)
Placing the Nord fork on the calf	11 (26.2)	5 (0.6)	16 (1.9)
Moving calves into ally that leads to tilt table	9 (21.4)	6 (0.7)	15 (1.8)
Other [a]	0 (0.0)	3 (0.4)	3 (0.4)

[a] Some noted that another task they typically performed during processing included administering amprolium and tattooing calves.

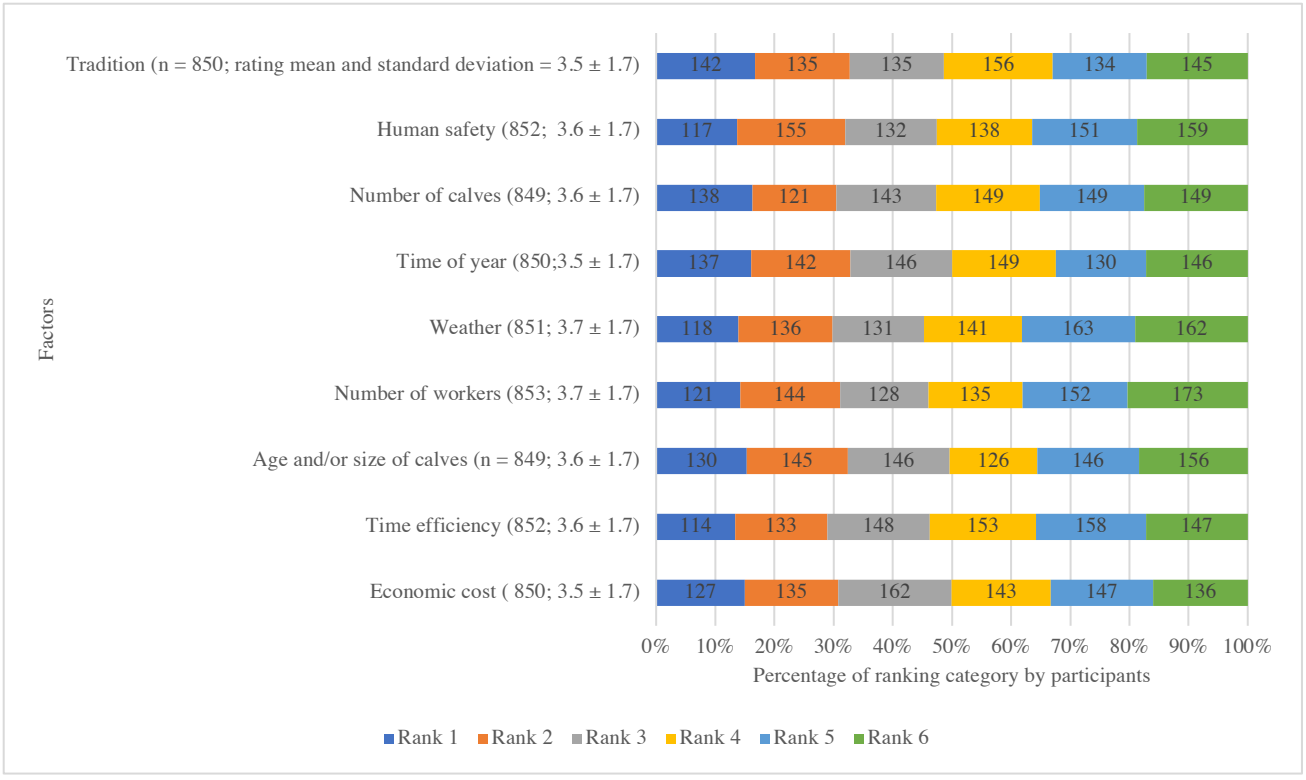
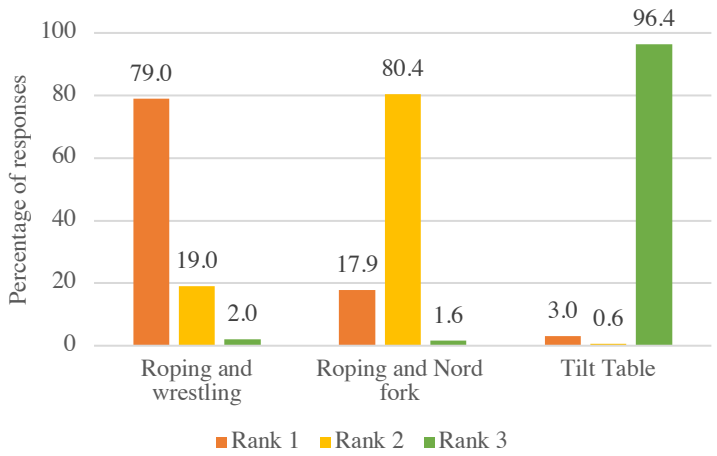


Figure 3.1: Bar graph showing the percentages and counts of ranking categories from 1 (not important) to 6 (extremely important) by all participants combined (i.e., owners, farm hands, staff members, family members, friends, and others) for each factor. The total number of responses (n), as well as the mean and standard deviation for each factor are displayed below each factor on the y-axis. Chi-Square Test: $p = 0.66$.

2081 A.)



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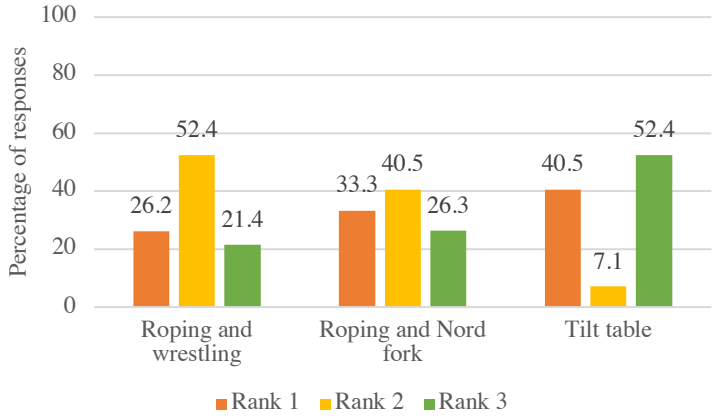
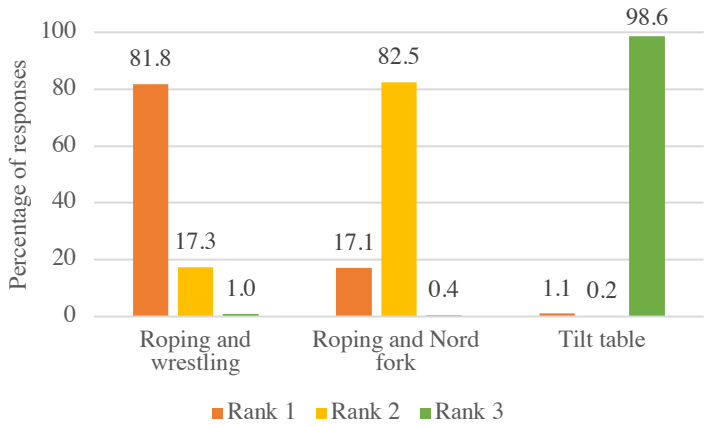
2083 B.)



2084

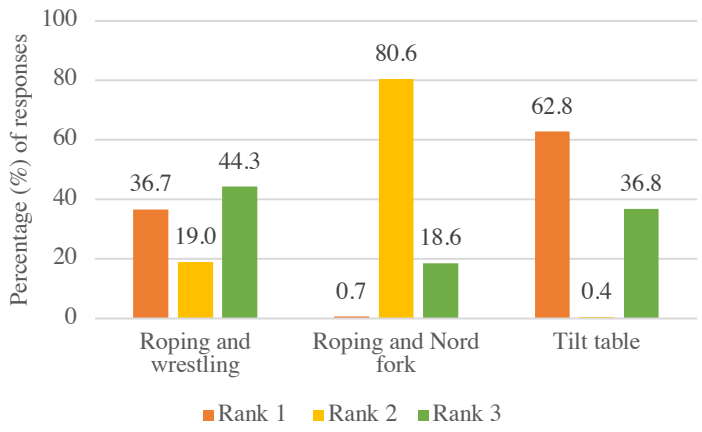
2085 C.)



2086

Figure 3.2: Bar graphs showing preferences of participants of western Canadian processing events for: A.) all participants combined, B.) those who identified as owners, and C.) those who identified as non-owners (i.e., farm hands, staff members, family members, friends, and others)) regarding the three common beef calf handling and restraint methods (i.e., roping and wrestling (RW), roping and Nord fork (RN), and use of the tilt table (TT)). Rankings range from 1 (most preferred) to 3 (least preferred). Percentages (%) of responses are displayed for each rank of method. The mean score and standard deviation for each bar graph for RW, RNF, and TT, respectivetly, are as follows: A.) 1.2 ± 0.5, 1.8 ± 0.4, 2.9 ± 0.4; B.) 2.0 ± 0.7, 1.9 ± 0.8, 2.1 ± 0.9; C.) 1.2 ± 0.4, 1.9 ± 0.4, 2.9 ± 0.2.

2096 A.)



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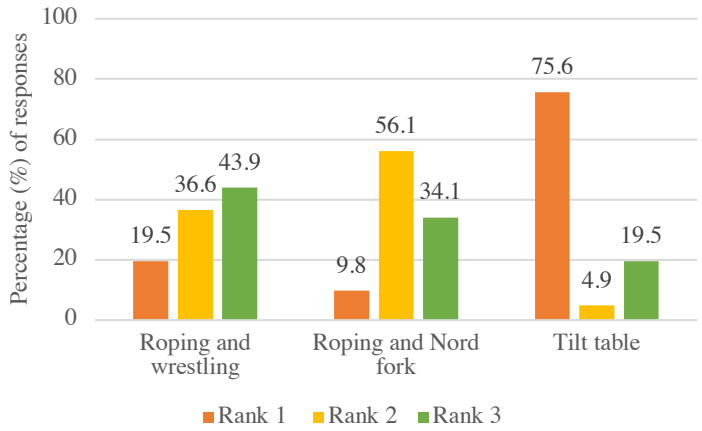
2098 B.)



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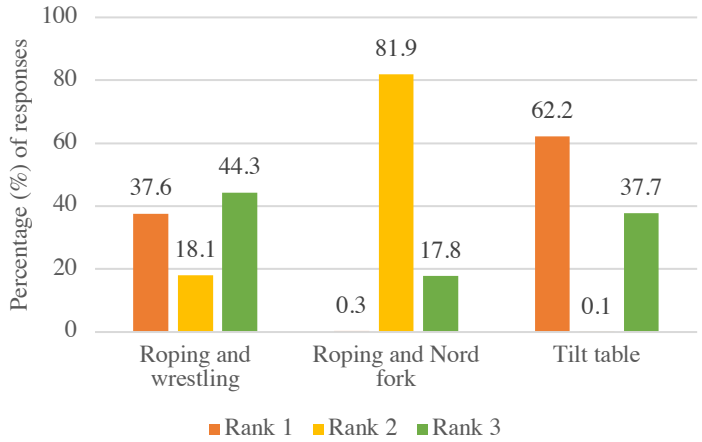
2100 C.)



2101

Figure 3.3: Bar graphs showing what participants (A, all participants combined; B, those who identified as owners; and C, those who identified as non-owners (i.e., farm hands/staff members, family members, friends, and others)) perceive the public would prefer regarding the three common calf handling and restraint methods (i.e., roping and wrestling (RW), roping and Nord fork (RN), and use of the tilt table (TT)). Rankings range from 1 (most preferred) to 3 (least preferred). Percentages (%) of responses are displayed for each rank of method. The mean score and standard deviation for each bar graph in order of RW, RNF, and TT are as follows: A.) 2.1 ± 0.9, 2.2 ± 0.4, 1.7 ± 1.0 B.) 2.2 ± 0.8, 2.2 ± 0.6, 1.4 ± 0.8 C.) 2.1 ± 0.9, 2.2 ± 0.4, 1.8 ± 1.0.

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Chapter 4: Summary of Thesis

Calf processing is an event during which beef calves receive various husbandry procedures for management and health purposes (Chamorro et al., 2016; González et al., 2010). Procedures such as castration, branding, and dehorning are painful for calves (Canozzi et al., 2017; Coetzee, 2011; McCarthy et al., 2016; Moggy et al., 2017a) and have thus been the subject of considerable research (Coetzee, 2013; McCarthy et al., 2016; Meléndez et al., 2018; Stafford et al., 2002) investigating their effects on calf welfare, as well as the effectiveness of various pain mitigation strategies. To carry out these procedures, calves must also be handled and restrained. There are different methods used in the western Canadian beef industry to handle and restrain calves, the most common three being roping and wrestling, roping and Nord fork, and tilt table (Moggy et al., 2017b). However, the implications of these common methods on calf welfare during processing are unknown.

In addition to being important to animal health and management, calf processing also plays a valuable sociocultural role for those in the western Canadian ranching community (Rondeau and Joanne, 2013). The specific method by which various cow-calf operations handle and restrain calves for processing differs by operation (Moggy et al., 2017b; Schachtschneider et al., 2019). There are currently no recommendations of specific methods outlined within published guidelines such as the Code of Practice for the Care and Handling of Beef Cattle, nor scientific evidence to support on which to base recommendations. Understanding the preferences and perspectives of those working on farm is useful for guiding practical and effective policy development and implementation, bridging future communications, and informing extension efforts (Biesheuvel et al., 2021; Kuczewski et al., 2022; Moggy et al., 2017c; Sonoda et al., 2018; Spooner et al., 2014; Ventura et al., 2021; Weary et al., 2016). Previous qualitative works

investigating perceptions of livestock producers (Doidge et al., 2021; Jansen et al., 2009; Moggy et al., 2017c; O'Kane et al., 2017; Smid et al., 2021) revealed that the making of management decisions in general is driven by various factors such as producers' knowledge and values. Deciding what handling and restraint method to use to process calves is an example of one such management decision that must be made. However, no research to date has investigated the preferences and perceptions regarding common calf handling and restraint methods of those who participate in processing events.

Based on the gaps in knowledge identified, two studies were designed with the objectives to: 1.) evaluate and compare the effects of the common methods of calf handling and restraint used during processing on calf behavioural indicators associated with stress and pain, and 2.) understand the preferences and perceptions of people who participate in western Canadian processing events regarding these common methods.

4.1 Summary of Chapter 2

To address the study objective, a total of 117 calves were enrolled. Data analysis was based on a final sample size of 99 calves, consisting of processed calves (roping and wrestling (RW) = 25; roping and Nord fork (RNF) = 27; tilt table (TT) = 26) and control calves (CRW = 8; CNF = 6; CTT = 7). The following comparisons were made for calf behaviours exhibited during and after processing: among treatment groups for processed calves (RW, RNF, TT), between processed (RW, RNF, TT) and control (CRW, CRNF, CTT) calves within each treatment group, and among treatment groups for control calves (CRW, CRNF, CTT).

Overall, the differences detected for effects of common handling and restraint methods on calf behavioural responses were inconsistent both during and after processing. However,

2286 some of the nuanced differences do present some interesting indicators of how these methods
2287 may impact how beef calves experience handling and restraint in the context of processing.
2288 During processing, no consistent differences were detected for behavioural indicators
2289 among processed calves. This result was different from findings noted in an unpublished report
2290 (Schachtschneider et al., 2019), which suggested that calves handled and restrained using RW
2291 experienced lower levels of stress during processing compared to those handled and restrained
2292 by TT. However, there were some differences detected among treatment groups for specific
2293 indicators. For example, RNF calves vocalized at a higher rate compared to RW and TT calves.
2294 It is possible that this difference is due to the nature of the handling and restraint methods
2295 themselves. Another difference detected was that TT calves struggled at a higher rate compared
2296 to RW and RNF calves. This difference may be explained by the long duration of time spent
2297 handling and restraining calves using this method, as well as the nature of the tilt table itself.
2298 Research in the past conveys that long durations of human handling and restraint lead to higher
2299 levels of stress experienced by calves (Apple et al., 2005; Breuer et al., 2003; Grandin and
2300 Shivley, 2015; Moggy et al., 2017b; National Farm Animal Care Council, 2013).
2301 Comparing processed and control calves during processing, the one difference detected
2302 was vocalization rate. Specifically, processed RNF and TT calves had higher vocalization rates
2303 compared to CRNF and CTT calves. It was surprising that this was the only difference detected,
2304 as differences for both behavioural and physiological indicators associated with stress and pain
2305 between calves that do or do not receive specific processing procedures (e.g., castration,
2306 branding, and dehorning) are usually described (Coetzee, 2013; McCarthy et al., 2016; Meléndez
2307 et al., 2018; Stafford et al., 2002; Stafford and Mellor, 2011; Sylvester et al., 2004) and because
2308 of this, we would expect to have also seen these difference across additional indicators.

Among control calves during processing, CTT calves demonstrated comparatively slower speed gaits immediately upon release from restraint compared to all other control groups. This finding may be indicative of a decreased motivation to escape, conveying that use of the tilt table may be less stressful for calves (Millman, 2013; Sinclair et al., 2016). On the other hand, this difference could be due to the darker, indoor environment in which CTT calves were handled and restrained. No other differences were detected among control calves for behavioural indicators during processing, but it is difficult to make clear interpretations due to the small number of control group calves and large variations observed for indicators.

After processing, comparisons between processed and control group calves revealed that RW calves tail flicked at a higher rate than CRW calves, and TT calves tail flicked at a higher rate than CTT calves. This was expected given previous works (Meléndez et al., 2018; Turner et al., 2020) have highlighted tail flicking as an indicator associated with pain due to husbandry procedures such as castration. This difference was not found between RNF and CRNF calves, and it is unclear how a method of handling and restraint could affect this behavioural indicator. Also, a difference was observed for self-grooming, which CTT calves displayed for a greater percentage of time compared to all other treatments and controls. This could indicate that these calves had a comparatively less stressful experience after processing (Mattiello et al., 2019). However, it should be noted that self-grooming behaviour has also been associated with factors such as hygiene and injury (Horvath and Miller-Cushon, 2019; Mattiello et al., 2019), so it is not wholly specific to stress.

An additional difference detected after processing was that RNF calves foot stomped the most, followed by RW calves, then TT calves. Among controls, CRNF and CRW calves foot stomped more compared to CTT calves. Further, no differences were detected between RW and

CRW calves, and RNF and CRNF calves for foot stomping, while TT calves displayed this behaviour more than CTT calves. Foot stomping is a behavioural indicator of pain that has been previously associated with castration (de Oliveira et al., 2014; Meléndez et al., 2018; Molony et al., 1995). However, calves that did not undergo castration were observed to display this behaviour when they were handled and restrained using the methods of roping and wrestling or roping and Nord fork. This may point to the roping and dragging that is involved in both of these methods leading calves to experience pain at the hind legs even after the processing event. Further, restraining calves using roping and Nord fork involves maintaining rope tension at the hind legs throughout the duration of processing, and it is possible that this rope tension causes greater foot pain for calves after processing, which may explain why RNF calves foot stomped the most compared to all other processed calves.

4.2 Summary of Chapter 3

This survey study took on a mixed-methods approach to collect both quantitative and qualitative information. The inclusion criteria for the questionnaire required that participants of this study must be legal adults who participated in at least one calf processing event in western Canada (i.e., British Columbia, Alberta, Manitoba, or Saskatchewan) within the last 5 years. The questionnaire began by asking participants about their background information (e.g., their role at their operation). Then, they were asked questions about tasks they typically perform during processing and operation-specific information. Additionally, participants were asked to rank the common methods of handling and restraint (i.e., roping and wrestling, roping and Nord fork, and tilt table), from most to least preferable, and provide an explanation for their most and least preferred choices. This was followed by questions asking participants to rate factors with respect

2355 to its importance for choosing a calf handling and restraint method. To collect data for separate
2356 studies, questions about handling training experience and attitudes towards animal welfare were
2357 also included. Their analysis was outside the scope of this study. Finally, participants were asked
2358 to provide demographic information at the end of the questionnaire.

2359 A total of 853 respondents were included in this study for analysis. Of these respondents,
2360 792 (92.8%) identified as farm hands or staff members, 42 (4.9%) as operation owners, 12
2361 (1.4%) as family members, 4 (0.5%) as friends, and 3 (0.4%) as others.

2362 The most preferred method of handling and restraint cited by participants was roping and
2363 wrestling and the least was the use of the tilt table. However, the most commonly used handling
2364 and restraint methods for calves 1 week to 3 months of age in western Canada is reported to be
2365 the tilt table (Moggy et al., 2017b). This conveys that the preferences of western Canadian
2366 processing event participants do not necessarily match current on-farm practices, or this
2367 difference could also be attributed to differences in population between studies.

2368 Explanations provided by participants for why they chose a method as their most or least
2369 preferred revealed that regardless of choice, the reasoning behind these choices overlapped
2370 considerably. Specifically, four values were identified among participants when considering
2371 handling and restraint methods, which were: calf injury and stress, efficiency, convenience, and
2372 human safety and labour intensity. Three of these values (i.e., calf injury and stress, efficiency,
2373 and convenience) were frequently referred to for both why a method was most or least preferred,
2374 suggesting that how a handling and restraint method was perceived to fulfill these values affects
2375 whether or not the particular method is viewed to be preferable.

2376 Human safety and labour intensity was a value referred to for all three methods when
2377 considering why a particular method was the least preferred. In the past, safety of workers and

workload have been indicated as concerns for those who work with cattle (Ceballos et al., 2018; Lindahl et al., 2013; Menger et al., 2016). This conveys that particular methods not believed to prioritize this value may be perceived negatively by participants.

Absent from most responses regarding how participants perceive the common methods was the topic of economic cost. Some responses did cite infrastructural limitations, which can have economic implications, but this was only mentioned when explaining why a method was preferred the least. This is in line with evidence noting that economic factors are not the only factors considered for making management decisions on beef cattle operations (Bassi et al., 2019; Biesheuvel et al., 2021; Jumper et al., 2021; Spooner et al., 2014), and rather play a restrictive role in the decision making process of producers (Jumper et al., 2021).

4.3 Thesis Limitations

There are a few limitations for both studies presented within this thesis that must be acknowledged. The main objective of the study presented in Chapter 2 was to compare the effects of common handling and restraint methods on calves' behavioural response under conditions that are representative of the industry. Enrolling a larger number of control calves would have provided more power for comparisons between processed and control, or among control calves. Further, the experimental design of the first study was aimed to promote external validity. Therefore, not all variables were controlled, such as the setting of processing (i.e., inside or outside) and duration of processing. Doing so allowed the study to be more representative of current on-farm practices. However, this could have also played a role in increasing variation and difficulty detecting differences among behavioural indicators.

The study presented in Chapter 3 used an online questionnaire for data collection. Thus, individuals interested in participating in this study had to have access to a computer, smart phone, or other electronic device, leading to the possibility of selection bias. Additionally, misinterpretation bias could have occurred due to participants misinterpreting contents of the questionnaire (i.e., questions or response options) or researchers misinterpreting their responses. To reduce this as much as possible, the questionnaire itself was developed under the guidance of various experts in the field, as well as piloted with beef cattle ranchers prior to distribution. Social desirability bias is another potential bias that must be considered, as participants were aware that this study was carried out by a public research university. However, to minimize this, potential participants were informed prior to completing the questionnaire that all personal identifying information would be deleted to protect confidentiality. Lastly, in line with guidelines set by the Conjoint Faculties Research Ethics Board, participants had the option to skip questions that they wished not to answer. This meant that not all questions were completed by all participants, consequently leading to missing data from those who did not respond.

4.4 Contributions to New Knowledge and Future Perspectives

This thesis was the first of its kind to include the roping and Nord fork method, and to compare the effects of the common methods of handling and restraining used during processing events on behavioural indicators related to calf welfare. It also described for the first time the current perceptions of participants in western Canadian beef calf processing events about the common handling and restraint methods.

Future research could consider assessing the more long-term effects of the common methods of calf handling and restraint on behavioural indicators associated with pain and stress

beyond the immediate post-processing period examined in this study. Further, calf injury and stress, efficiency of processing, convenience of processing, and human safety and labour intensity were highlighted as important considerations by participants of western Canadian beef calf processing events. These topics should be used in the development of future research such that results will provide relevant information that can support evidence-based decisions. Infrastructural implementation was noted to be a limitation by some for using specific handling and restraint methods, which could have economic implications. Therefore, future studies about calf handling and restraint during processing should investigate the economic costs associated with the use of each method.

To support the development of pragmatic policies and recommendations about beef calf handling and restraint during processing, those responsible for such developments should keep in mind the considerations of calf injury and stress, efficiency of processing, convenience of processing, and human safety and labour intensity noted by participants in this research. Additionally, findings of this study can be used to improve effectiveness of future communications by providing information about common handling and restraint methods from both animal (i.e., beef calf) and human (i.e., participants of western Canadian beef calf processing events) perspectives. Finally, findings from this study can also support extension efforts by providing information about calf handling and restraint through the lens of values important to participants (i.e., calf injury and stress, efficiency, convenience, and human safety and labour intensity). This will not only refine the information to be relevant to values highly upheld by current participants of western Canadian beef calf processing events, but it will also provide producers with information that will allow them to make informed decisions for their own operations.

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Appendix A: Questionnaire

Western Canadian Beef Calf Processing Survey:

Spring Processing Handling and Restraining Methods Used in Cow-Calf Operations

Researchers and Contact information:

Thank you for considering participation in our study. This consent form is only part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

- **Lindsey Arkangel**, MSc graduate student, Faculty of Veterinary Medicine, lindsey.arkangel@ucalgary.ca
- **Dr. Ed Pajor**, Professor, Faculty of Veterinary Medicine, eapajor@ucalgary.ca (project supervisor)
- **Dr. Claire Windeyer**, Associated professor, Faculty of Veterinary Medicine, c.windeyer@ucalgary.ca

Title of project: Understanding industry perceptions about different handling and restraining methods used for beef calves during processing

Sponsor: Anderson-Chisholm Chair in Animal Welfare

The University of Calgary Conjoint Faculties Research Ethics Board has approved this research study. Participation is completely voluntary and anonymous.

Purpose of the study:

The objective of this survey is to understand how people who participate in western Canadian beef calf processing events, commonly known as "brandings", perceive handling and restraining methods used on western Canadian cow-calf operations. Specifically, we are interested in views regarding how calves are handled and restrained during spring processing.

Who can take this survey?

Legal adults who have participated in at least one calf processing event in western Canada (i.e. British Columbia, Alberta, Manitoba, and/or Saskatchewan) within the last 5 years.

What will you be asked to do?

For this survey, you will be invited to share your thoughts about your experience with beef calf processing events. The majority of survey questions will be multiple choice questions with the exception of a few open-ended questions. The survey should take no more than 30 minutes to complete.

What type of personal information will be collected?

You will be asked for information about yourself and the operation at which you most frequently process calves.

Are there benefits if you participate?

Upon completion of the questionnaire, participants may choose to be entered for a chance to win one of ten $50 gift cards. To be entered, please provide your name and email address through which you wish to be contacted in the case that you are a winner. Additionally, your response will be taken into consideration for understanding different views about how calves are handled during processing, as well as developing future recommendations.

What happens to the information you provide?

Once your response has been collected, a randomly generated codename will be used to identify your questionnaire responses instead of your name to protect your privacy. Furthermore, only group information and anonymous responses will be summarized for presentation and publication of results to ensure anonymity. Your response will be stored in a password-secure, encrypted external hard drive, which will only be accessible by researchers directly involved in this study. Results of this study will be kept as anonymous data for 5 years on an encrypted computer drive, at which time it will be permanently erased. We would like to keep this information for the next 5 years to be able to add longitudinal data should there be interest in expanding this study.

Your participation is voluntary, and you are free to withdraw from this study up to 7 days after submitting your response. Should you decide to withdraw from the study, your responses will be destroyed.

Consent:

Submission of your questionnaire online will indicate your consent to participate in this survey and have your responses summarized in the final report. Your consent to participate in this survey shows that 1) you understand to your satisfaction the information provided to you about your participation in this research project, and 2) you agree to participate in the research project.

In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this research project at any time. You should feel free to ask for clarification or new information throughout your participation.

If you have any questions regarding the survey or this project in general, please feel free to contact:

Lindsey Arkangel, MSc graduate student
University of Calgary Faculty of Veterinary Medicine
lindsey.arkangel@ucalgary.ca

If you have any concerns about the way you've been treated as a participant, please contact the Research Ethics Analyst, Research Services Office, University of Calgary at 403.220.6289 or 403.220.8640; email cfreb@ucalgary.ca. A copy of this consent form is available for you to keep for your records and reference. The investigator has kept a copy of the consent form.

- ☐ **Yes, I am a legal adult and have participated in a processing event in western Canada (i.e. British Columbia, Alberta, Manitoba, and/or Saskatchewan) within the last 5 years AND consent to participate in this research study.**
- ☐ **No, I do not consent to participate in this study.**

End: Consent block

Start: Non-consent block

Logic:
***If participant answers, "Yes, I have participated in a processing event in the western Canada (i.e. British Columbia, Alberta, Manitoba, and/or Saskatchewan) within the last 5 years AND consent to participate in this research study," then participant will be directed to Q1.

***If participant answers, "No, I do not consent to participate in this study," then participant will be directed to Q41.

End: Non-consent block

Start: Participant background information block

Western Canadian Beef Calf Processing Survey:
Processing Handling and Restraining Methods Used in Cow-Calf Operations

Throughout this questionnaire, the focus is the processing of young calves, typically 1 week or 3 months of age, in the springtime prior to turnout on summer pasture, which is commonly called "branding". Processing of calves shortly after birth or around the time of weaning are **not** the focus of this study.

Participant

1. Does your main source of income come from a cow-calf operation? Please check one of the following:
   - ☐ Yes
   - ☐ No

For the following question, please think about the operation where you most ***frequently*** process calves.

2. What is your position in relation to this operation?
   - ☐ Owner
   - ☐ Family member
   - ☐ Friend
   - ☐ Farm hand/staff member
   - ☐ Other (Please specify): _____

End: Participant background information block

Start: Non-operation owner information block

Logic:
***If participant answers, "Family member", "Friend", "Farm hand/staff member", or "Other" for Q4, then the participant will be directed to Q5 (i.e. In which province is the operation located?).

***If the participant answers, "Owner" for Q4, then the participant will be directed to Q7 (i.e. In which province is your operation located?).

For this section, we would like you to answer the following questions thinking about the operation at which you process calves.

3. In which provinces do you process calves? Please check all that apply.
   - ☐ Alberta
   - ☐ British Columbia
   - ☐ Manitoba
   - ☐ Saskatchewan
4. At operations where you process calves, on average, how many calves are processed per day? *Please provide a numeric response; letters and symbols not accepted. _____
5. On the operations where you process calves, what processing procedures are typically done? Please check all options that apply.
   - ☐ Vaccination
   - ☐ Castration
   - ☐ Administration of a pain reliever
   - ☐ Hormone ear implanting
   - ☐ Ear tagging
   - ☐ Dehorning
   - ☐ Hot iron branding
   - ☐ Freeze branding
   - ☐ Record keeping
   - ☐ Other (Please specify): _____
6. In your role during processing, what tasks do you typically perform? Please check all that apply.
   - ☐ Roping
   - ☐ Wrestling
   - ☐ Placing the Nord Fork on the calf
   - ☐ Working the tilt table
   - ☐ Moving calves into ally that leads up to tilt table
   - ☐ Vaccinating (or "needling")
   - ☐ Castrating (or "cutting")
   - ☐ Administrating oral meloxicam/pain reliever
   - ☐ Implanting
   - ☐ Ear tagging
   - ☐ Dehorning
   - ☐ Hot iron branding
   - ☐ Freeze branding
   - ☐ Record keeping
   - ☐ Other (Please specify): _____

End: Non-operation owner information block

Start: Operation owner information block

Operation owners

For this section, we would like you to answer the following questions thinking about ***your*** own operation.

7. In which province is your operation located?

- ☐ Alberta
- ☐ Britich Columbia
- ☐ Manitoba
- ☐ Saskatchewan

8. What percentage (%) of the cow-calf operation would you consider to be (response should add up to 100%):
   - ☐ Commercial cow-calf herd: _____
   - ☐ Purebred/Seedstock cow-calf herd: _____
9. During spring processing season, how many of the following classes of cattle are present on this operation on an average year?
   - ☐ Nursing cows and heifers (i.e. those that calved during that year's calving season): _____
   - ☐ Calves of processing age (i.e. those born during that year's calving season): _____
10. What is the most common breed of calves at this operation?
    - ☐ Angus
    - ☐ Charolais
    - ☐ Hereford
    - ☐ Limousin
    - ☐ Simmental
    - ☐ Commercial crossbred
    - ☐ Other (please specify): _____
11. How many calves, on average, are processed per processing day? *Please provide a numeric response; letters and symbols not accepted. _____
12. In a given year, how many days are spent processing calves, on average? *Please provide a numeric response; letters and symbols not accepted. _____
13. On average, how many people participate in the processing event each day? *Please provide a numeric response; letters and symbols not accepted. _____
14. Who typically helps you process calves?
    - ☐ Family members
    - ☐ Friends/neighbors
    - ☐ Farm hand/staff members
    - ☐ Other (Please specify): _____
15. On average, how old are calves at the time of spring processing?
    - ☐ Less than 6 weeks
    - ☐ 6-12 weeks
    - ☐ 12 or more weeks
16. When are calves processed at this operation? Please check all months that apply.
    - ☐ March
    - ☐ April
    - ☐ May
    - ☐ June
    - ☐ July

- ☐ Other: _____

17. What processing procedures are typically done at this operation's processing events? Please check all options that apply.
    - ☐ Vaccination
    - ☐ Castration
    - ☐ Administration of a pain reliever
    - ☐ Hormone ear planting
    - ☐ Ear tagging
    - ☐ Dehorning
    - ☐ Hot iron branding
    - ☐ Freeze branding
    - ☐ Record keeping
    - ☐ Other (Please specify): _____
18. In your role during processing, what tasks do you perform? Please check all that apply.
    - ☐ Roping
    - ☐ Wrestling
    - ☐ Placing the Nord Fork on the calf
    - ☐ Working the tilt table
    - ☐ Moving calves into ally that leads up to tilt table
    - ☐ Vaccinating (or "needling")
    - ☐ Castrating (or "cutting")
    - ☐ Administrating a pain reliever
    - ☐ Implanting
    - ☐ Ear tagging
    - ☐ Dehorning
    - ☐ Hot iron branding
    - ☐ Freeze branding
    - ☐ Record keeping
    - ☐ Other (Please specify): _____

End: Operation owner information block

Start: Participant experience block

<u>Experience with processing events</u>

For this section, we would like you to answer the following questions thinking about your experience participating in any calf processing event(s) (i.e. "brandings") within the last 5 years.

19. On average, on how many operations do you help process calves **per year**? *Please provide a numeric response; letters and symbols not accepted. _____
20. Have you processed or attended a processing event using the following method(s)? Please check all that apply.
    - ☐ Roping and wrestling
    - ☐ Roping and Nord Fork
    - ☐ Alley and tilt table
    - ☐ Other (Please describe): _____

End: Participant experience block

Start: Handling training experience block

Handling training experience:

For this section, we would like you to answer the following questions thinking about your experience with low-stress cattle handling training.

21. Who taught you how to work with and handle cattle?
    - ☐ Family member
    - ☐ Learned myself by trial and error
    - ☐ Taught by work employer, manager, or coworker
    - ☐ Taught by veterinarian
    - ☐ Attended cattle handling training program in person
    - ☐ Watched cattle handling videos or webinars on the internet
    - ☐ Other (please specify): _____
22. Have you participated specifically in any low stress cattle handling training programs?
    - ☐ Yes
    - ☐ No

Logic:

***If participant answers, "No" for Q22, then the participant will be directed to the questions below (i.e. Q23-24).

23. What type of low-stress handling training would you find helpful to receive? Please select all that apply.
    - ☐ Attend an in-person training workshop by a trained expert
    - ☐ Watch training videos on the internet / webinars
    - ☐ None
    - ☐ Other (please specify): _____
24. How helpful would low-stress handling training programs be for your daily work experience?
    - ☐ Extremely helpful
    - ☐ Somewhat helpful
    - ☐ Slightly helpful
    - ☐ Not helpful

Logic:

***If participant answers, "Yes" for Q22, then the participant will be directed to the questions below (i.e. Q25-27).

25. How did you receive your low-stress handling training? Please select all that apply.
    - ☐ Attend an in-person training workshop by a trained expert
    - ☐ Watch training videos on the internet / webinars
    - ☐ Taught by employer
    - ☐ Other (please specify): _____
26. When did you receive your last training?
    - ☐ Within last year
    - ☐ Within last 2 years
    - ☐ More than 2 years ago
27. How helpful are low-stress cattle handling training programs for your daily work experience?
    - ☐ Extremely helpful
    - ☐ Somewhat helpful
    - ☐ Slightly helpful
    - ☐ Not helpful

Logic:

***If participant answers either "Yes" or "No" for Q22, then the participant will be directed to the question below (i.e. Q28).

28. What are potential benefits of receiving low-stress cattle handling training programs?
    - ☐ Easier and quicker to work cattle
    - ☐ Safer for myself to work cattle
    - ☐ Less handling injuries
    - ☐ None / no benefits
    - ☐ Other (please specify): _____

End: Handling training experience block

Start: Video block

Perception of handling and restraining methods

29. Below is an example of **roping and wrestling**. Please watch this video and rate in general the acceptability of this method of handling and restraint.
    (totally unacceptable) 1 2 3 4 5 (totally acceptable)
30. Below is an example of **roping and Nord fork**. Please watch this video and rate in general the acceptability of this method of handling and restraint.
    (totally unacceptable) 1 2 3 4 5 (totally acceptable)
31. Below is an example of the **tilt table**. Please watch this video and rate in general the acceptability of this method of handling and restraint.
    (totally unacceptable) 1 2 3 4 5 (totally acceptable)
32. Which handling and restraining methods do you prefer to use? Please rank the methods below such that they are numbered from most preferred (1) to least preferred (3).
    ___ Roping and wrestling
    ___ Roping and Nord Fork
    ___ Tilt table

    Logic:
    ***If the participant chooses "1" for "Roping and wrestling" on Q27, then the participant will be directed to Q28.
    *** If the participant chooses "1" for "Roping and Nord Fork" on Q27, then the participant will be directed to Q29.
    ***If the participant chooses, "1" for "Tilt table" on Q27, then the participant will be directed to Q30.
    ***If the participant chooses, "3" for "Roping and wrestling" on Q27, then the participant will be directed to Q31.
    ***If the participant chooses, "3" for "Roping and Nord Fork" on Q27, then the participant will be directed to Q32.
    ***If the participant chooses, "3" for "Tilt table" on Q27, then the participant will be directed to Q33.

33. Please explain your reasoning for answering **roping and wrestling** as most preferable.

34. Please explain your reasoning for answering **roping and Nord Fork** as most preferable.

35. Please explain your reasoning for answering **tilt table** as most preferable.

36. Please explain your reasoning for answering **roping and wrestling** as least preferable.

37. Please explain your reasoning for answering **roping and Nord Fork** as least preferable.

38. Please explain your reasoning for answering **tilt table** as least preferable.

39. Please feel free to use this space if you have anything else that you would like to add about your reasoning for how you ranked the three methods: _____.

End: Video block

Start: Factors ranking block

40. What is the importance of the following factors when deciding what method of handling and restraining to use for beef calves during processing? Please rate each factor from 1 (i.e.not important) to 6 (i.e. extremely important).

Economic cost:	1	2	3	4	5	6
Time efficiency:	1	2	3	4	5	6
Age and/or size of calves:	1	2	3	4	5	6
Number of workers:	1	2	3	4	5	6
Weather:	1	2	3	4	5	6
Time of year:	1	2	3	4	5	6
Number of calves:	1	2	3	4	5	6
Human safety:	1	2	3	4	5	6
Tradition:	1	2	3	4	5	6
Other (please specify) _____ :	1	2	3	4	5	6
Other (please specify) _____ :	1	2	3	4	5	6
Other (please specify) _____ :	1	2	3	4	5	6

End: Factors ranking block

Start: View of public acceptability block

41. Which method do you believe the **public** would prefer? Please rank the methods such that they are numbered from most preferred (1) to least preferred (3).
    ___ Roping and wrestling
    ___ Roping and Nord Fork
    ___ Tilt table

End: View of public acceptability block

Start: View of animal welfare block

42. Which of the following do you think is the ***most*** important factor influencing animal welfare?
    - ☐ Biological function
    - ☐ Mental state
    - ☐ Natural living
    - ☐ Undecided

End: View of animal welfare block

Start: Attitudes towards animals

43. The following questions are designed to assess your attitude towards animal welfare. Please indicate how strongly you agree or disagree with the following statements by selecting the circle under the appropriate number on the agreement – disagreement scale. For example, if you think you agree with a statement strongly, you might select the circle under, "Strongly Agree" for that question:

	Disagree Strongly (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
So long as they're warm and well fed, I don't think zoo animals mind being kept in cages. (1)	○	○	○	○	○
Often cats will meow and pester for food even when they are not really hungry. (2)	○	○	○	○	○
It upsets me to see animals being chased and killed by lions in wildlife programs on TV. (3)	○	○	○	○	○
I get annoyed by dogs that howl and bark when they are left alone. (4)	○	○	○	○	○
Sad films about animals often leave me with a lump in my throat. (5)	○	○	○	○	○
Animals deserve to be told off when they're not behaving properly (6)	○	○	○	○	○
It makes me sad to see an animal on its own in a cage. (7)	○	○	○	○	○

People who cuddle and kiss their pets in public annoy me. (8)	○	○	○	○	○
A friendly purring cat almost always cheers me up. (9)	○	○	○	○	○
It upsets me when I see helpless old animals. (10)	○	○	○	○	○
Dogs sometimes whine and whimper for no real reason. (11)	○	○	○	○	○
Many people are over-affectionate towards their pets. (12)	○	○	○	○	○
I get very angry when I see animals being ill treated. (13)	○	○	○	○	○
It is silly to become too attached to one's pets. (14)	○	○	○	○	○
Pets have a great influence on my moods. (15)	○	○	○	○	○
Sometimes I am amazed how upset people get when an old pets dies. (16)	○	○	○	○	○

I enjoy feeding scraps of food to the birds. (17)	○	○	○	○	○
Seeing animals in pain upsets me. (18)	○	○	○	○	○
People often make too much of the feelings and sensitivities of animals. (19)	○	○	○	○	○
I find it irritating when dogs try to greet me by jumping up and licking me. (20)	○	○	○	○	○
I would always try to help if I saw a dog or puppy that seemed to be lost. (21)	○	○	○	○	○
I hate to see birds in cages where there is no room for them to fly about. (22)	○	○	○	○	○
I feel sorry for cattle when they have problems or suffer (23)	○	○	○	○	○

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I sometimes try to understand farm animals better by imagining how things look from their perspective (24)	○	○	○	○	○
I am curious about cattle (25)	○	○	○	○	○
If I see someone hurt a farm animal I feel compassion for it (26)	○	○	○	○	○
Cattle's misfortunes do not disturb me a great deal (27)	○	○	○	○	○

End: Attitudes towards animals block

Start: Demographics block

44. What is your gender identity? Please check one of the following:
    - ☐ Male
    - ☐ Female
    - ☐ You don't have an option that applies to me. I identify as: _____
    - ☐ Prefer not to disclose
45. What is your age?
    - ☐ 35 years or under
    - ☐ 36-50 years
    - ☐ 51-65 years
    - ☐ Over 65 years
    - ☐ Prefer not to disclose
46. What is your highest level of education?
    a. Before high school (including no formal education)
    b. High school
    c. Trade or Technical school (e.g. SAIT, PolyTechnic)
    d. University degree or equivalent
    e. Graduate or professional degree
    f. Prefer not to disclose
    g. Other (Please specify): _____

47. If you wish to be entered for a chance to win one of ten $50 gift cards, please provide your name and email address:
    Name: _____
    Email: _____

This is the end of this survey.
We appreciate your participation. Thank you!

End: Survey block

Start: Non-consent block

48. Thank you for your time and consideration. We respect your choice not to participate in the study.