An Investigation into Dairy Cow Welfare in Canada: A Cow and a Human Perspective

by

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ABSTRACT

AN INVESTIGATION INTO DAIRY COW WELFARE IN CANADA:
A COW AND A HUMAN PERSPECTIVE

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This thesis is an investigation into better understanding dairy cow welfare in Canada. A national cross-section study was undertaken to assess and provide producers feedback on dairy cattle housing, management and care in Canada. This included the assessment of hock and knee injuries and their risk factors for cows housed in tiestall systems. On average, 56% of cows within a herd were discovered to have hock injuries, and 43% of cows within a herd were discovered to have knee injuries. Factors associated with greater odds of hock and knee injuries included factors such as stall dimensions, stall surface, BCS, DIM and lying time. One year following this project, phone interviews were undertaken with these producers. Simultaneously, a separate survey was undertaken with dairy experts to assess the difficulty of making changes to improve cow welfare on farm. It was discovered that a majority (72%) of producers implemented some sort of change related to improving animal welfare following the intervention, however 17% of producers implemented changes that were not related to the weaknesses identified on their farm. The most common barriers identified to implementing changes to improve dairy cow welfare were lack of time and lack of fund. Dairy experts identified stall design...
changes as the most difficult to improve dairy cow welfare. Lastly, a Delphi survey was completed by dairy experts in Canada to better understand how the dairy industry defines and measures dairy cow welfare and seek consensus on a set of gold standard animal-based targets for realistically optimal dairy cow welfare. The study resulted in consensus within dairy stakeholders on how to define and measure dairy cow welfare. Most (72%) responded that they include a combination of natural living, health, affective state and production factors in their definition of dairy cow welfare, and all stated they would use animal-based measures, often in combination with other measures to assess dairy cow welfare. Lameness was the most frequently mentioned animal-based measure to assess dairy cow welfare. The survey participants were able to come to a consensus on 16 of 21 animal-based targets to describe a herd with realistically optimal welfare.
DEDICATION

Dedicated to
Peter & Corinne Nash,
Claude & Renata Avi
and Georges & Madeleine Chalvignac
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CHAPTER 1

The definition, direct assessment and motivation to improve dairy cow welfare – A review

INTRODUCTION

The work presented in this thesis utilizes a variety of research methodologies to address the specific objectives of each chapter, however the main themes of the research are the assessment and improvement of dairy cow welfare in Canada. To introduce these themes, this literature review has 3 main objectives, to: 1) provide an overview of the definition of dairy cow welfare, 2) outline the animal-based measures used to assess dairy cow welfare and their strengths and weaknesses, and 3) briefly discuss how producers are motivated to improve dairy cow welfare on farm.

DEFINING DAIRY COW WELFARE

To understand animal welfare, it is logical that we must first define it. Though this statement is simple, the lack of consensus around the definition of animal welfare has slowed the progress towards optimizing animal welfare in food animal production industries (Hewson, 2003a), and slowed the development of detailed legal guidelines around the care and use of domesticated animals (Moberg, 1993).

The 3 schools of thought

Perspectives on what is important to define animal welfare have been grouped into three major aspects: natural living, biological functioning, and affective state (Fraser, 2003; Duncan, 2005). That is to say that to maximize their welfare, cows are to be free to express natural
behaviours (naturalness), lead a healthy, productive, life free of injury and disease (biological functioning), and/or lead a happy life free of pain, suffering, fear, hunger and thirst (affective state). Though these three aspects cover all perspectives and can overlap, the combination of all three do not necessarily reflect the perspectives of every stakeholder. Duncan (2005) characterized biological function and affective state as separate schools of thought, natural living would be a third. Disagreement can occur when individuals differ in the schools, or combinations of schools they subscribe to. Some researchers have argued that animal welfare should only consider aspects that affect an animals affective state (Duncan, 2005), whereas other have strongly suggested the opposite, stating that an animals welfare is reduced only when it impacts its biological functioning (McGlone, 1993; Curtis, 2016). When generalizing to dairy stakeholder groups, veterinarians and producers have traditionally leaned towards biological aspects in their definition, such as measures of health and production, animal welfare researchers towards aspects of affective state such as reducing fear and loneliness (Curtis, 2016), and consumers towards aspects of natural living, such as being exposed to sunlight (von Keyserlingk et al., 2009). Some of these factors overlap, such as reducing illness (biological functioning) and reducing pain (affective state), but some conflict, such as reducing illness (biological functioning) and increasing social interaction (naturalness and affective state). This conflict has led to compromises when trying to improve animal welfare, for example when trying to develop animal welfare legislation. This conflict may not necessarily lead to the best outcomes for the animals (Gonyou, 1993; Hewson, 2003a).

Weary and Robbins (2019) have also put forward that the industry should consider moving beyond the limitations of the 3 schools of thought and consider other facets of animal welfare. For example, research centered on the public showed that this group placed emphasis on
humans’ feelings towards their animal dependents such as love or compassion when considering the quality of life of dairy cattle (Ventura et al., 2016). These feelings may lead to better animal welfare, though it is not clear how these would tie into the 3 schools of thought presented above.

**The 5 freedoms**

Another paradigm included as an aspect to defining animal welfare has been the concept of the “5 Freedoms” described by Webster (2001), which summarizes the philosophy followed by the Farm Animal Welfare Council in the UK (FAWC, 1993). The 5 Freedoms are 1) Freedom from hunger and thirst, 2) Freedom from discomfort, 3) Freedom from pain, injury or disease, 4) Freedom to express normal behavior and 5) Freedom from fear and distress. These freedoms are captured by the 3 aspects summarized by Fraser (2003) above. Though animal welfare scientists have not necessarily used this framework to define animal welfare, animal welfare stakeholder groups and humane societies have used it to define their missions to improve animal welfare (e.g. ASPCA, Humane Canada, Association of Shelter Veterinarians). Yet, the 5 freedoms predominantly focus on minimizing aspects of negative welfare, and do not necessarily include aspect of positive welfare states, such as play behaviour. Mellor and Beausoleil (2015) have argued that these 5 freedoms and the thinking around animal welfare needs to be extended to include maximizing positive welfare states. This concept has been captured by the expression “a life worth living” (Mellor, 2016). Though research on positive welfare outcomes has been less common, and potentially more complex, it needs to be considered when defining animal welfare to move beyond minimum requirements (Yeates and Main, 2008).

**An operational definition**

Some of the variation observed among dairy stakeholder groups in defining animal welfare
may be due to the context in which they are trying to apply it. Gonyou (1993) described four types of definitions: legal, public, technical and animal. The legal definition is that used to establish minimum requirements and legislation. This definition is commonly influenced by the public definition used by consumers which includes aspects of ethics and human experience with animals. The concept of “social license” would be a derivation of the public definition of animal welfare (Williams and Martin, 2011). The technical definition is the definition used by animal welfare scientists using measures to quantify animal welfare. All 3 of these definitions can interact and overlap, however they can also diverge due to their different end goals. An example of this is the case of enriched (or furnished) cages for laying hens: Using the technical definition, enriched cages have been shown to reduce mortality, morbidity and aggressive interactions in hens when compared to cage-free systems, making enriched cage systems the potentially more welfare-friendly choice (Savory, 2004). However, under the public definition, cages of any kind could not be accepted, which influenced the legal definition to move towards implementing legislation banning all caged system, as was done in Switzerland (Kerswell, 2011). The definition that was forgotten in all of this was the animal definition. This is the definition that relates animal welfare directly back to the animal itself in terms of its fulfillment and how well it is coping with its environment. In the words of Gonyou (1993): “When a change is made to a legal, public or technical definition, we must be sure that the new definition better reflects the animal’s definition and is not simply accommodating the other “non-animal definitions”.

ASSESSING DAIRY COW WELFARE

Second to defining animal welfare comes being able to assess it. Though the body of animal welfare science is growing every year (Walker et al., 2014), accurately and reliably assessing and
measuring animal welfare has continued to be a challenge. This is demonstrated by the on-going
debate around how to measure and assess affective state, including animal suffering or animal
happiness (Dawkins, 2008; Yeates and Main, 2008), or whether or not aspects of animal
production are reliable measures of animal welfare (Duncan, 2005; Curtis, 2016). Differences
exist between the scientific assessment of animal welfare and the practical assessment of animal
welfare, these will be discussed throughout. The measures used to assess dairy cow welfare in a
practical setting can be split into 3 main categories: Animal-, resource- and management-based
measures. Each of these types of measures have their strengths and weaknesses, with resource-
and management-based measures generally being less subjective, more practical measures that
indirectly measure welfare, whereas animal-based measures generally being more subjective and
challenging measures that are direct measures of welfare (Whay, 2007). For the purposes of this
review, we will focus on animal-based measures, as they are the most direct measures of dairy
cow welfare and are also the most common dependent variables used in the scientific assessment
of animal welfare (Hewson, 2003b; Whay et al., 2003). These animal-based measures will be
themselves split into the 3 categories described by Fraser (2003) for the definition of animal
welfare: naturalness, biological functioning and affective state. It is important to note that some
of the measures described below can and do overlap between different categories.

**Measures of natural living**

The types of animal-based measures used to reflect natural living are generally the presence
or absence of natural behaviours. The closest wild ancestor to today’s dairy cattle, *Bos
primigenius*, has been extinct for centuries (Götherström et al., 2005). It is, therefore, challenging
to model the natural behavioural repertoire of cattle when they have no truly comparable wild
counterparts. A few populations of feral cattle exist and researchers have attempted to use these
animals as models for wild cattle behavior (Hernandez et al., 1999).

It is well accepted that not all natural behaviours improve welfare, for instance natural behaviours such as aggression and fear lower cattle welfare (Špinka, 2006). Nevertheless, many of the natural behaviours observed in feral populations of cattle can explain or indicate where our modern husbandry systems are failing (Špinka, 2006). It is well documented that cattle are social animals (Boissou et al., 2001); an early study done on calves kept in isolation expressed more abnormal behaviour than those kept in groups (Veissier et al., 1998). Since then, social isolation in calves has been linked to negative effects on learning, cognition, and social interactions later in life (Costa et al., 2016).

Play behaviour has also been used to identify positive welfare states in calves, which also reflects on affective state (Jensen et al., 2015), however play behaviour is still a fairly new measure in animal welfare science. Play behaviour in animals has been generally accepted as a sign of the absence of bad welfare, or the presence of good welfare, but it has also been expressed during times of stress (Held and Špinka, 2011). It is, therefore, a measure that requires further study to decipher.

An alternative method to measure dairy cow welfare in the context of natural behaviour is to study a cow’s motivation. Researchers have used motivation tests as an indicator of natural behaviours (Špinka, 2006), and also of affective state (Duncan, 2005), and have assumed that if a cow is prevented from performing these strongly motivated behaviours this could negatively affect her welfare (Fraser, 2003). This type of motivation test was used by Veissier (2008) who determined that cows were strongly motivated to walk. This motivation is hindered when cows are kept tethered, thereby negatively affecting their welfare. Similar deprivation studies have been performed to determine the motivation for rest in cattle (Metz, 1985; Munksgaard et al.,
In these studies, cows were deprived of lying for varying lengths of time and it was found that cows would compensate for that deprivation. One study even showed that cows deprived both of rest and feed would prioritize rest over feeding when both were once again made available (Metz, 1985). Another study evaluated how strongly motivated cows were to reach a comfortable resting area through the use of weighted push gates (Tucker et al., 2018). Though this approach yielded moderate success, with significant individual variation in cows’ willingness to “pay” for access to comfortable resting space. Researchers did find a rebound affect where cows that were not willing to push the gate spent in excess of 17h/d lying when finally given access to resting space. This demonstrates a strong motivation for rest; preventing a cow from resting would therefore compromise her welfare.

Rest, or lying behaviour, is a natural behaviour in dairy cattle that has commonly been used in the dairy industry as an indicator to assess welfare (Ito et al., 2009, 2010). Lying behaviour remains a challenging measure to use on its own, as factors such as severe lameness can increase lying time, whilst factors such as high stocking densities can reduce lying time in cows (Fregonesi et al., 2007; Ito et al., 2010). Lying time is, therefore, an animal-based measure that needs to be used in combination with other factors and interpreted relative to context in order to be used to assess welfare.

Measures of biological functioning

Compared to measures of natural living, measures of good or bad biological functioning are fairly straightforward to identify but present their challenges in commercial settings, as described below. Measures of biological functioning include measures of health and production, including aspects of reproduction. Whether these measures are in turn all good measures of cow welfare remains a point of discussion (Duncan, 2005; Curtis, 2007).
Health. Starting with health disorder, these include issues like lameness, metabolic disorders, injuries, mastitis, etc. Assessment of lameness, disease, and health records were among the top five most useful animal-based measures to assess dairy cow welfare as decided by a panel of animal-welfare experts (Whay et al., 2003). However, one of the concerns with using these as welfare indicators is the high variation in the reports of their incidence and prevalence (Rushen et al., 2008; Kelton et al., 2010). This is caused in part by the variable case definition of health issues, in addition to the tendency for producers not to record disease events consistently (Kelton et al., 2010). Lack of recording by producers could be related to producers underestimating the prevalence of health issues on the farm. A number of researchers have reported that producers underestimate lameness, perhaps falling victim to “barn blindness” which describes the phenomenon where issues seen on a daily basis start becoming normalized (Espejo et al., 2006; Croyle et al., 2019). Lameness in particular can be quite a subjective measure, requiring training to assess consistency (Croyle et al., 2018). Another concern with using disease as a welfare indicator is the difficulty in determining its effect on the cow, particularly when sub-clinical. One of the most practical ways to determine the effect of health problems on a cow is to assess the length and strength of the symptoms (Rushen et al., 2008). In the case of dairy cattle, common symptoms amongst most health problems are milk loss and reduced feed intake. Records of these symptoms were surveyed for an extensive list of health problems and it was reported that hock injuries, systemic mastitis, and lameness were amongst the health problems with the longest and strongest negative effects on milk loss and feed intake (Bareille et al., 2003). However, does a reduction in milk production and feed intake reflect animal welfare? Wells et al. (1998) stated that health problems relate to welfare when they lead to animal suffering. This will be further
discussed in the next section, however, being able to reliably measure animals suffering remains a challenge. The most practical ways to measure the effect of disease on a dairy cow remains assessing the effect on her “normal state”, in this case feeding behaviour, production, and overt signs of illness such as diarrhea, purulent discharge or bleeding.

Disease has also been linked to changes in body condition. Body condition has been commonly used to assess welfare, with both underweight and overweight animals at risk for negative health outcomes (Roche et al., 2009). Body condition scoring remains a subjective measure that requires training (Croyle et al., 2018).

Lastly, indicators of heat stress are important measures of dairy cow welfare. Dairy cows are susceptible to heat stress, making its early identification key to maximizing dairy cow welfare. Animal-based indicators of heat stress include elevated respiration (noted through the speed of movement of a cow’s sides), panting, increased saliva production and increased standing (Gaughan et al., 2000; Tucker and Schütz, 2009).

**Production.** A biological measure commonly used as an indicator of animal welfare on its own: production. This is one of the most controversial measures of animal welfare used in practice (Rushen et al., 2008). Milk production was considered of little use in the assessment of dairy cow welfare by a panel of animal-welfare experts (Whay et al., 2003), however producers and veterinarians still commonly use it. Variations in long-term milk production can be associated with a number of factors including genetics and nutrition and so is difficult to associate with welfare directly. However, some researchers have shown that acute stress can lead to a short-term decrease in milk production in dairy cattle, such as severe injury (Rushen et al., 2001). Short-term changes in milk production could, therefore, be useful in indicating a welfare
problem, as long as this has been associated with disease and stress. Conversely long-term milk production records have not been shown to be a reliable indicator of dairy cow welfare.

Poor cow hygiene has also been linked with production, where cows with contaminated udders, legs, and flanks have been found to have increased SCCs and a higher risk for mastitis (Sant’Anna and Paranhos da Costa, 2011). Cow hygiene can also be reflective of the cleanliness of the environment the cows are housed in (Hultgren and Bergsten, 2001; Cook, 2002). Both these factors lead to hygiene being an indicator of dairy cow welfare.

Lastly, reproduction must be considered. Little work has been done to assess potential associations between poor reproductive performance and welfare, though some evidence exists that stress can interfere with the reproductive cycle (Dobson and Smith, 2000). This effect is also associated with other health problems like lameness and mastitis (Rushen et al., 2008; Walker et al., 2008, 2010). These associated health problems could, therefore, potentially be more direct indicators of poor welfare than reproductive success on its own.

Measures of affective state

Measures of affective state are regarded as the only true measures of animal welfare by some animal welfare scientists; it considers the emotional state of the animal including feelings of suffering, fear and pain (Fraser, 2003). Duncan (2006) has argued that animal sentience is the base of animal welfare science, that is to say that aspects of natural behaviour and biological functioning relate to animal welfare only when affecting the affective state of the animal. For example, if a cow is diagnosed with an illness, this illness affects her welfare only if it causes her pain or discomfort.

Unfortunately, indicators of affective state have also been some of the most challenging to decipher. These welfare indicators most commonly revolve around 4 major negative emotional
states: pain, suffering, frustration, and fear. These states of emotion have often been associated with the concept of stress. The term ‘stress’ has been adopted to describe how sentient beings perceive and respond to challenges from both their internal and external environments, as well as the consequences of the exposure to those challenges or “stressors” (Moberg and Mench, 2000). These stressors can be associated with negative affective states (such as pain in the case of injury), or potentially to positive affective states (such as pleasure during copulation for males), making the interpretation of its physiological impacts challenging.

A number of physiological indicators of stress have been discovered, some indicating acute stress while others indicating chronic stress (Rushen et al., 2008). The most commonly used physiological indicator of acute stress is blood cortisol concentration. Baseline values in cattle for this hormone in blood ranges from 4 to 6 ng/ml (Ladewig and Smidt, 1989). During acute periods of stress, such as in short-term social isolation or novel environments, blood cortisol levels in dairy cattle can reach 25 ng/ml (Rushen et al., 1999). However, to use blood cortisol concentration to reliably assess stress levels, regular blood samples must be taken; this in itself can become a stressor thereby affecting the results (Rushen et al., 2008). Care must, therefore, be taken when determining sampling method and timing between samples. To circumvent this difficulty, researchers have looked at using cortisol concentrations or their metabolites in other bodily fluids such as saliva, milk and urine (Mormede et al., 2007). These types of samples are much less intrusive to collect and therefore less stressful on the animals, minimizing the potential effect of collection on cortisol levels. Unfortunately, cortisol concentrations in these fluids are much lower than in blood, lowering their sensitivity in being able to indicate stress (Mormede et al., 2007). The use of blood cortisol concentration as an indicator of stress also becomes problematic when considering situations of chronic stress. Cortisol levels will adapt to chronic
stress over time and return to almost basal levels (Ladewig and Smidt, 1989). Besides the difficulty in interpreting these hormones, they also remain a fairly impractical measure to use on commercial dairy farms.

Behavioural indicators of individual affective states such as fear and pain have also been studied. An example of one such indicator is vocal behaviour, or vocalization. Researchers have looked at vocalization in cattle when exposed to presumed painful or fear-provoking situations and only some of the animals responded vocally (Watts and Stookey, 1999, 2001). This may be explained by the work done by Watts and Stookey (2001) who demonstrated a genetic effect on vocalization. In a study examining behavioural changes of calves during castration and dehorning, the calves going through the procedures vocalized significantly more than the controls, however both groups vocalized. Vocal behaviour, therefore, remains a relatively unreliable assessment of fear and pain in cattle, and may require further research to establish thresholds beyond which pain is evident.

A method used to validate measures of pain includes the use of analgesics and observing consequent behavioural changes. A study looking at lameness administered lidocaine injections to the injured legs of lame cows and subsequently observed a significant improvement in their gait (Rushen et al., 2007). This demonstrated that lameness was painful. A similar study was undertaken for mastitis, in which cows responded less negatively to pressure on infected quarters when treated with an NSAID (Fitzpatrick et al., 2013). This allows researchers to determine which health issues cause pain, and so should be measured to assess welfare. Along this line, the presence of surface injuries such hock, knee, and neck injuries in dairy cows can be assumed to be painful and are commonly used indicators of welfare on commercial dairy farms (Zaffino Heyerhoff et al., 2014). Though measuring injuries on dairy cows appears fairly simple,
categorizing their severity remains inconsistent throughout the dairy industry, with a wide variety of scoring systems being used (Zaffino Heyerhoff et al., 2014). Other injuries such as broken tails and injured hips and backs can also be reflective of poor handling or a less than ideal environment, however little to no research exists on these.

Frustration has been a more difficult feeling to measure and assess in animals, and stereotypic behaviour has been used as a key indicator (Mason and Rushen, 2006). The presence of stereotypic behaviour in animals has been widely accepted as an indication of poor or inadequate resources (Olsson et al., 2011). However, its variable expression in individual animals, its tendency to become a habit in some animals even after the original stressor has been resolved, and its potential function in being a coping mechanism leading to improved welfare make stereotypic behaviour a difficult measure to use to assess an animals immediate state (Mason and Latham, 2004). Commonly observed stereotypic behaviours in cattle are oral stereotypies, including tongue rolling and bar-biting. These have been linked to limit-feeding (Redbo et al., 1996) and tethering (Redbo, 1992). Nose-pressing has also been observed, though less common than oral stereotypies. Nose pressing has been theorized to be associated to a poor stall environment (Anderson, 2008), however, others have postulated that it is more directly linked to pain mitigation (Broom and Fraser, 2007).

Preference testing has become a popular method to assess how animals feel about certain things such as housing or feed (Duncan, 1992). Duncan described this field of research as allowing animals to “vote with their feet” and is often followed by motivation testing. Unlike previously mentioned measures, preference testing moves beyond the sole measurement of negative welfare states, into including aspects of positive welfare. Preference research has been undertaken in dairy cows to assess preferences of resources such as different stall dimensions.
(Tucker et al., 2004), stall surfaces (Tucker et al., 2003; Tucker and Weary, 2004) and feed (Matthews and Temple, 1979). Though much can be learned from this type of research, preference testing is limited by the potential short-term gain vs. long-term pain trade-off, where animals may prefer something in the short-term that may reduce their welfare in the long-term, such as excessive amounts of high-energy grain (Fraser and Nicol, 2011). Additionally, exposure to highly rewarding resources may affect an animal’s motivation for these resources over time, and therefore may make it difficult to assess inherent welfare needs (Mason and Burn, 2011).

Another measure used to assess the affective state of cows is aversion, opposite to preference. Aversion learning is a technique that was developed to assess what animals find aversive, meaning what they find potentially unpleasant, painful, scary, etc. In studies done by Pajor et al. (2000; 2003), aversion learning techniques were used to determine whether cattle found certain handling practices aversive. They found that cattle would avoid choosing or attempt to delay their exposure to more abrasive handling techniques, demonstrating that they find them aversive. On the subject of animal handling, the assessment of flight distance can also be a helpful indicator of welfare, reflective of the fear cows have towards their caretakers and so quality of handling, with additional limited associations on production and fertility (Hemsworth et al., 2000).

As mentioned previously, measures of positive affective state, such as the pretense of play behaviour, are few and far between. That being said, providing dairy cows the opportunity to partake in behaviours they are motivated to perform as described earlier falls in line with reaching a positive welfare state (Held and Śpinka, 2011). Additionally, the use of enrichment tools such as mechanical cow brushes can be indicative of positive welfare (DeVries et al., 2007).
This overview makes it clear that no single measure used today can fully measure or assess the level of welfare of a dairy cow.

**In practice**

Not all the measures covered above are practical to gather on commercial dairy farms. Commercial dairy welfare assessment programs therefore limit their inclusion of animal-based measures to those considered direct outcome measures, such as lameness, injuries, BCS and hygiene (FARM program, proAction Animal Care program, Dean Foods Dairy Well Audit). These will be the predominant focus in this thesis.

**MOTIVATING THE IMPROVEMENT OF DAIRY COW WELFARE**

Though defining and assessing dairy cow welfare are components required to improve it, the gatekeeper to its improvement on commercial farms remains the producer. Motivating producers to improve dairy cow welfare requires examining their personal motivations and limitations.

Motivators and barriers to improving agriculture have been studied since the 1940s (Ryan and Gross, 1943), though limited work has been to investigate these in the context of animal welfare. Factors such as the attitude, knowledge, perception and motivators of producers in relation to the change required have all been shown to affect the implementation of new practices (Barkema et al., 1999; Leeuwis, 2004; Ritter et al., 2017).

**Attitude**

Motivating adoption is, not surprisingly, more difficult among producers who show little interest in change (Mee, 2007). Kielland et al. (2010) found a link between producers’ attitude towards animal welfare, and the level of welfare of their cows: producers who disagreed with the
statement that animals felt pain were more likely to have cows with leg injuries. Attitude is, therefore, a significant factor when motivating a producer to improve animal welfare.

**Knowledge**

Sharing knowledge is the basis for many extension efforts in agriculture through meetings, pamphlets, and webinars. Though knowledge is a key component in motivating change, it is rarely sufficient, with other extrinsic and intrinsic factors contributing to the decision to making a change (Ellis-Iversen et al., 2010). An example of this is a study done on foot health in dairy cattle, in which it was reported that producers believed they had enough knowledge to make improvements, but their motivation was moderate due to their perception of the severity of the problem (Bruijnis et al., 2013). This may in part explain why after years of research on dairy welfare issues such as lameness and injuries, the commercial dairy industry is still faced with high levels of both of these conditions (von Keyserlingk et al., 2012; Zaffino Heyerhoff et al., 2014).

**Perception**

Different from attitude, perception involves how a producer perceives his or her external environment and its impact when making a change. Perception is an important factor in animal welfare, due to its strong link to societal pressure and relative subjectivity. How a producer perceives the severity of a problem, the complexity in making a change to address it and perceives external pressure to make such a change will all impact the motivation to make that change. Producers have consistently been found to underestimate the level of lameness in their herds (Espejo et al., 2006; Croyle et al., 2019), this perception may prevent them from making changes to improve lameness on their farms. Conversely, the perceived societal pressure to
improve animal welfare may motivate producers to implement changes on their farms related to housing and management.

**Motivators and barriers**

Motivators and barriers of change can be internal or external. External motivators are motivators that either promote a positive external outcome, such as financial gain, or prevent a negative external outcome, such as financial loss. Incentive and penalty structures have been studied in dairy in the context of milk quality, where both premium programs and penalty programs have been established for many years (Nightingale et al., 2008; Sargeant et al., 2010). Though both types of programs motivate producers to implement changes, these types of motivators only work as long as these programs exist. Intrinsic motivators are those that lead to either a positive internal outcome, such as happiness, or prevent a negative internal outcome, such as sadness. These motivators are more challenging to study, with little research being done to investigate them.

**Extension efforts**

Extension efforts in dairy cow welfare have been undertaken in various capacities, from meetings, to websites, to on-farm interventions, however the level of success these efforts have achieved often remain unknown.

Benchmarking has been an extension tool used to motivate change in both dairy cow and calf welfare with success (von Keyserlingk et al., 2012; Sumner et al., 2018). This type of on-farm intervention allows producers to compare themselves to their peers and plays on the intrinsic motivator to be the best, or to not be the worst. These benchmarking exercises also allow producers to receive an assessment of the level of welfare of their cows, which in and of
itself may be motivating change, depending on other factors mentioned previously. This is reinforced by a study by Vasseur et al. (2010) in which researchers developed an advisory tool to improve calf welfare. This tool first involved doing an assessment of the level of calf welfare on a farm, comparing that farm’s results to welfare targets developed from existing scientific knowledge and presenting this information to the producer. Upon 6 month follow-up, researchers found improvements in a variety of calf welfare measures.

Mandatory animal welfare assurance programs and requirements have also become more and more prevalent in dairy industries around the world. Some of these programs are industry mandated, such as the proAction Animal Care program in Canada, and others are retailer driven, with retailers such as McDonalds and Dean Foods developing their own animal welfare requirements. The success of these programs at improving dairy cow welfare remains debated, with no research, to the authors knowledge, examining the difference in animal welfare before and after implementation of these program in the dairy industry.

CONCLUSION

It can be concluded that defining and measuring dairy cow welfare is a complex and challenging task. The definition of animal welfare includes a diverse array of opinions and beliefs amongst its experts (Rushen et al., 2008); this has led to numerous measured of animal welfare being developed and applied, some useful and others perhaps less so. Measures of naturalness and biological functioning remain debated measures of animal welfare science, but the difficulty in reliably measuring affective state in animals has made these measures some of the most common and practical indicators of welfare available today to commercial dairy farms. Motivating producers to implement changes to improve animal welfare requires considering all factors that
contribute to a decision to make a change, with our understanding of the success of existing extension efforts being quite limited.

**THESIS RATIONALE**

Though research in dairy cow welfare has been taking place since well before the turn of the century, until recently, the level of dairy cow welfare on Canadian dairy farms was largely unknown. Furthermore, dairy cow welfare science has traditionally been focused on the animals themselves, rather than on their human caretakers. It was not known how well extensions efforts related to improving dairy cow welfare on farms were motivating producers to implement changes on farms in Canada, nor was it clear what kind of barrier may be present in producers that may be preventing the implementation of changes to improve dairy cow welfare on Canadian dairy farms. Moreover, the level of difficulty for producers to implement changes to dairy cow welfare had been assumed but had never been formally assessed. There also appeared to be a certain level of disagreement between dairy stakeholders working within the dairy industry on how to define and assess dairy cow welfare, leading to a level of confusion preventing dairy producers from implementing improvements on their farms. Additionally, animal welfare assurance programs and policies in Canada have focused on minimum requirements, rather than “gold standards”, potentially leading to a level of complacency within the industry. The work in this thesis aimed at improving our knowledge and understanding in all of these areas, and in attempting to do so uncovered both expected, and unexpected results.
RESEARCH OBJECTIVES

The overall objective of this thesis was to expand our understanding and knowledge of dairy cow welfare in Canada. This was done through the following individual research objectives:

(1) Measure the prevalence of hock and knee injuries in dairy cows housed in tiestall systems in Canada. (Chapter 2)

(2) Identify animal- and farm-based risk factors associated with hock and knee injuries in dairy cows housed in tiestall systems in Canada. (Chapter 2)

(3) Assess the difficulty of implementing changes to improve dairy cow welfare on farm. (Chapter 3)

(4) Determine how successful an on-farm intervention was at motivating producers to make changes to improve animal welfare on their farms, by categorizing them based on the types of changes that they made relative to their areas of strength and weakness and assessing how producers in each category differed. (Chapter 3)

(5) Examine barriers to implementing changes to improve dairy cow welfare on Canadian dairy farms. (Chapter 3)

(6) Come to a consensus among Canadian dairy experts on the factors to include in the definition and measurement of dairy cow welfare. (Chapter 4)

(7) Assess the importance Canadian dairy experts place on reaching targets for identified animal-based measures to attain a herd with optimal health, production or welfare. (Chapter 4)

(8) Come to a consensus among Canadian dairy experts on a set of animal-based targets for a herd of dairy cows with optimal welfare. (Chapter 4)
REFERENCES


CHAPTER 2

Prevalence of, and risk factors for, hock and knee injuries on dairy cows in tiestall housing in Canada

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ABSTRACT

Leg injuries on dairy cows are a common and highly visible welfare concern on commercial dairy farms. With greater attention being placed on food animal welfare and limited research being conducted on tiestall farms, this study aimed to identify prevalence and risk factors for hock and knee injuries on dairy cows housed in tiestall barns in Ontario (n = 40) and Quebec (n = 60). A sample of 40 cows was purposively selected per farm, and several animal- and farm-based measures were taken. Both hocks and both knees on each cow were scored as injured (presence of lesions or swelling) or not injured (no alterations or hair loss), and the highest score of each of the 2 knees and the 2 hocks was considered the cow’s hock or knee score. Possible animal- and farm-based risk factors were incorporated into 2 separate multivariable logistic models for hock injuries and knee injuries respectively at the cow level. Mean (±SD) percentage of cow with hock injuries per farm was found to be 56 ± 18% and mean percent- age of knee injuries per farm was found to be 43 ± 23%. Animal-based factors found to be associated with a greater odds of hock injuries at the cow level were increased days in milk (DIM), lower body condition score (BCS), lameness, higher parity, higher cow width, median lying bout duration, and median number of lying bouts. Environmental factors found to be associated with hock
injuries at the cow level were province, stall width, tie rail position, stall base, chain length, and age of stall base. Animal-based factors found to be associated with knee injuries at the cow level were DIM, BCS, and median lying time. Environmental factors found to be associated with knee injuries at the cow level were stall width, chain length, province, stall base, and bed length. Quadratic and interaction terms were also identified between these variables in both the hock and knee models. This study demonstrates that hock and knee injuries are still a common problem on tiestall dairy farms in Canada. Several animal- and farm-based factors contribute to their presence. Further research to confirm causal relationships between these factors would help identify the cause of knee and hock injuries and determine how to best reduce the incidence of injuries in cows on commercial tiestall dairy farms in Canada.

**Key words:** dairy cow, Canada, hock injury, knee injury, tiestall

**INTRODUCTION**

Leg injuries on dairy cows are a common problem in commercial dairy herds. Injuries are most commonly seen on the tarsus (hock) and carpus (knee) joints of the cow (Laven and Livesey, 2011). These types of injuries are widely accepted as a welfare concern for dairy cattle (Whay et al., 2003) and efforts to reduce them have been addressed in the Code of Practice for the Care and Handling of Dairy Cattle in Canada (National Farm Animal Care Council, 2009) and internationally with programs such as the Farmers Assuring Responsible Management (FARM) program in the United States (National Milk Producers Federation, 2015).

The average herd-level prevalence of hock and knee injuries for cows in freestall herds has been estimated to range from 23 to 73% in Canada and internationally (Veissier et al., 2004; Lombard et al., 2010; von Keyserlingk et al., 2012; Zaffino Heyerhoff et al., 2014). Some of this
variation can be explained by differences in scoring systems and region. However, limited research has been conducted on tiestall systems, even though this housing system makes up 72.4% of the farms in the Canadian dairy industry, housing an estimated 36% of the dairy cows in Canada (Canadian Dairy Information Center, 2014).

Hock and knee injuries have been found to be associated with several housing-, management-, and animal-based factors within Canada and internationally. The most commonly identified animal-based factors associated with leg injuries include early lactation (Busato et al., 2000; Kielland et al., 2009), high or low BCS (Busato et al., 2000; Lim et al., 2015), lameness (Brenninkmeyer et al., 2013; Burow et al., 2013), older age (Kielland et al., 2009; Potterton et al., 2011), and lower lying time (Rushen et al., 2007). The most commonly identified farm-based risk factors for injuries include hard stall surfaces (Livesey et al., 2002; Barrientos et al., 2013; Burow et al., 2013; de Vries et al., 2015), lack of bedding (Barrientos et al., 2013), long and short stalls (Regula et al., 2004; Kielland et al., 2009; Potterton et al., 2011), and no outdoor access (Keil et al., 2006; Barrientos et al., 2013; de Vries et al., 2015).

The objectives of this study were to provide an estimate of the prevalence of hock and knee injuries and identify risk factors for them among Holstein dairy cows housed on tiestall farms in Ontario and Quebec, Canada.

**MATERIALS AND METHODS**

All methods were approved by the respective University of Guelph and Laval University Animal Care Committee and Research Ethics Board (Guelph REB # 10DC021, AUP # 10R110; Laval CPAUL # 2010127). All standard operating procedures for this study can be found online on the Canadian Dairy Research Portal (2015).
Study Design

Data for this study were collected as part of a national cross-sectional study undertaken in 2011 (Vasseur et al., 2015). Tiestall farms (n = 100) were visited from January to December 2011 in the provinces of Ontario (n = 40) and Quebec (n = 60). Together these 2 provinces account for 95.3% of Canada’s tiestall dairy farms (Canadian Dairy Information Center, 2014). One hundred farms was the maximum number of farms that could be assessed within the budgetary and time limitations of the project.

Herd Selection

Eligible tiestall herds for this study were selected from those enrolled in a milk recording program through CanWest DHI in Ontario, and Valacta in Quebec (Vasseur et al., 2015). Participation in this study was voluntary, with no financial compensation provided to the herd owners. The number of eligible tiestall herds sent invitation letters was based on an expected response rate of 10% and totaled 1,319 letters. Producers who responded to their invitation letter with interest were interviewed by telephone to further determine whether they met all inclusion criteria, and if so, to schedule farm visits. The criteria were the milking herd did not have outdoor access within 2 mo of the time of the visit and mean milk production was ≥7,000 kg/cow per year. A minimum herd size of 40 milking Holstein cows was required, and the facilities housing the milking herd had to have been in use for at least 1 yr.

Cow Selection

Based on previous work determining sample sizes for accurately estimating lying time at the herd level (Ito et al., 2009; Vasseur et al., 2012), 40 focal cows per herd were purposively selected for observation. Cow selection was balanced for parity, whenever possible, to reflect the
proportion of primiparous and multiparous cows within the milking herd. Cows were purposively selected based on DIM, selecting cows 10 to 120 DIM whenever possible. This selection was done owing to the evidence that early lactation cows are at increased odds of having leg injuries (Kielland et al., 2009). Cows under 10 DIM were not selected because of a lack of opportunity for habituation to their environments post-calving. If a herd had fewer than 40 cows between 10 and 120 DIM, the selection window was extended beyond 120 DIM until the target sample size of 40 was reached. Based on the average size of tiestall herds in Ontario and Quebec (Canadian Dairy Information Center, 2014), a sample size of 40 cows per herd allowed us to sample an average of 70.5% of the adult dairy cows in each herd.

**Animal-Based Measures.**

**Injuries.** Hock and knee injuries were the 2 outcome variables of interest. Cows were scored for hock and knee injuries according to the criteria in Table 2.1. (adapted from Gibbons et al., 2012) while in their stalls. Both hocks and both knees on each animal were scored. Due to poor lighting in some barns, a headlamp was used to facilitate cow assessment.

**BCS.** Body condition score was recorded on a 5-point scale in 0.25 increments (Ferguson et al., 1994), using the procedure described in Vasseur et al. (2013).

**Lameness.** Lameness was assessed using in-stall lameness scores developed by Leach et al. (2009) and validated by Gibbons et al. (2014). Cows were individually video recorded using a Sony DCRSR88 camera (Sony, Tokyo, Japan) in their stalls from behind for 2.5 min. The 4 following behaviors were scored: resting a foot, shifting weight, placing a foot on edge of stall, and uneven weight bearing when moving side to side. A cow was considered lame if 2 or more of these behaviors were observed in her video recording. This novel method has a sensitivity of 0.63 and a specificity of 0.77 compared with locomotion scoring (Gibbons et al., 2014).
**Lying Time.** Lying time was recorded using an electronic data logger (Hobo Pendant G Accelerator Data Logger, Onset Computer Corporation, Pocasset, MA) attached to the lateral side of the metatarsus of one hind leg of each focal cow. Co-Flex vet wrap (Andover Healthcare Inc., Salisbury, MA) was used to attach a logger to the leg while a cow was in her stall, and the logger remained on the cow for a minimum of 96 h. The loggers recorded data at 1-min intervals starting at midnight of the day they were attached. Data on lying time (min/d), lying bout number, and individual lying bout duration were collected and averaged for each cow over 4 consecutive 24-h periods as validated by Ito et al. (2009) and Vasseur et al. (2012).

**Cow Height and Width.** The height of each focal cow was measured from the ground to the spine parallel to the hook bone, and the width was measured between the 2 widest points of the hook bones.

**Cow Hygiene.** Cows udders, flanks and lower legs were scored for hygiene using the 4-point scale developed for the Canadian Quality Milk Program (Canadian Dairy Research Portal, 2015). Cows with a score of 3 or 4 were considered “dirty”.

**Parity, DIM, and milk production.** Parity, DIM and milk production data for the focal cows were extracted through CanWest DHI and Valacta databases from the most recent milk recording visits on each farm. Days in milk on day of the visit were extrapolated from the milk recording date. To more easily illustrate associations, DIM was categorized in 10-d increments. Parity was categorized in 4 categories (1, 2, 3, and 4+) based on the distribution of the data. Our sample included a large number of cows within parity 1, 2, and 3, but fewer in parities 4 or greater; therefore, parities 4 or greater were grouped.

**Training.** Research teams in Quebec (n = 3) and Ontario (n = 2), each consisting of 2 people, followed an intensive 2-wk training program on all animal and farm measures. Regular inter- and
intra-observer repeatability checks were performed for injury, lameness, BCS, and cleanliness scoring throughout the data collection period using the methodology described in Gibbons et al. (2012) and Vasseur et al. (2013). Repeatability between observers and the trainers was tested using a weighted Kappa coefficient as described in Gibbons et al. (2012) and Vasseur et al. (2013). Only observers who achieved and maintained a weighted kappa coefficient of \( \geq 0.6 \) during training were used to assess injuries and other animal-based measures on farm, to align with previous work (Gibbons et al., 2012). If an observer demonstrated weak repeatability for a certain measure, they were paired with an observer who demonstrated strong repeatability for that measure to help record that data.

Farm-Based Measures

**Individual Stall Measurements.** The following measures were taken on every stall occupied by a focal cow. The type of tiestall, including tie rail and chain, stanchions, chain, 2-bar stalls, and 6-bar stalls, was recorded. These types are illustrated in Figure 2.1. The width from the inside of one stall divider to the inside of the next divider was measured. For those stall designs with a chain to tether the cow, the chain length was measured. Lunge space ahead of each focal cow was scored as “no obstruction” if no obstruction was present within 76 cm ahead of the center top of the manger curb and to a 45° angle to the left and right (National Farm Animal Care Council, 2009). Electric trainer position above each focal cow was scored as “low” if less than 10 cm or acceptable if higher than 10 cm from the highest point of the cow (National Farm Animal Care Council, 2009).

**Averaged Stall Measurements.** To maximize time efficiency on farm and gather necessary data, the following measures were interpolated from a sample of stalls. A diagram of how the measurements were taken on the stall is provided in Figure 2.2. The length of the stall beds (a),
the manger curb height (c), the height of the tie rail (d), and the position of the tie rail relative to the manger curb (b) were based on the length, height, and tie rail position of the stalls on either end of each row containing focal cows. A linear interpolation between the values of the stalls on each end was then performed to calculate the respective dimensions for each stall that housed a focal animal.

Bedding depth and cleanliness were assessed for 2 stalls per row of cows. Stalls on either side of the center stall of each row housing focal cows were scored. Bedding depth was evaluated as “none” (insufficient quantity to allow bedding to be raked), <2 cm (once raked evenly), or ≥2 cm (once raked evenly). Two centimeters was selected as the cutoff for bedding depth because this depth would be the minimum bedding required to cover the stall base leaving no bare spots. Stall cleanliness was evaluated qualitatively on the back one-quarter of the stall bed length after the cleaning routine had been performed. Cleanliness was categorized as either clean, little manure or visible wet areas, the manure-free area was larger than the contaminated area, the contaminated area was larger than the manure-free area, or the entire area contaminated with manure or urine. Bedding wetness was tested using a paper towel technique (Canadian Dairy Research Portal, 2015). Bedding was considered dry, wet, or very wet. Farms were attributed a bedding wetness, cleanliness, and depth score based on the worst stall score they received during the farm visit in each row, as well as attributed a mean bedding wetness, cleanliness, and depth score for all stalls.

Because some farms had more than one type of housing accommodations for cows, only the predominant (>50%) tie rail type, stall base, and bedding type were recorded on each farm.

**Feed Management.** Presence of feed in the manger was recorded on 4 separate occasions during the visit, with a minimum of 60 min between each observation. Presence of feed was scored as
present if more than 90% of cows had some feed in front of them at the time of the assessment. Producers were asked how frequently they push up feed and this was recorded as 2 to 3 times per day, 1 time per day, or not applicable if cows were provided a sunken manger.

**Data Handling**

The data were entered into a relational database by observers (Microsoft Access 2010; Microsoft Corp., Redmond, WA). Data entry was evaluated 3 times by different individuals to minimize the risk of errors. These checks were done by comparing the data from the on-farm data sheets, to the data entered electronically. The data were exported into SAS 9.3 (SAS Institute Inc., Cary, NC) for analysis. Cows missing or who only had 1 score for hock or knee were excluded from analysis.

**Statistical Analysis**

Descriptive statistics (mean, standard deviation, minimum, and maximum) were generated using Proc Freq and Proc Means functions in SAS 9.3 to describe herd and cow characteristics.

Two generalized liner mixed models with logit link function were built for hock and knee injury outcome variables using Proc GLIMMIX in SAS 9.3 with a binomial distribution. Farm nested within province was included in both models as a random effect to account for the fact that cows within a farm and farms within a province might not be independent. Predictor variables were tested for collinearity and if found to be highly correlated (correlation coefficient \( \geq 0.8 \)), the most significant variable when tested at the univariable level with the outcome of interest was retained for analysis in the model. All variables were included in the full multivariable model. All nonsignificant variables (\( P > 0.05 \)) were removed from the model in a
manual backward step-wise fashion. If the removal of any variable resulted in a greater than 20% change in the estimate of a remaining variable, the removed variable was considered a confounder and retained in the model. Continuous variables were tested for linearity by testing their quadratic form. Biologically plausible interactions between variables and quadratics were then tested and retained if $P \leq 0.05$ in addition to the significant main effects.

**RESULTS**

Of the 1,319 randomly selected tiestall farms that were sent invitations to participate in the study, 250 replied and agreed to participate, giving us a response rate of 19%. Mean milk yield per year in the herds in our sample was 9,570 kg and mean herd size was 66. In total, 303 cows were excluded from the hock analysis due to a missing hock score, and 92 cows were excluded from the knee analysis due to a missing knee score. Of the cows included in the analysis, 56.3% had a hock injury and 42.5% had a knee injury overall (scores 2 or 3); the distribution of hock and knee scores is described in Table 2.2. At the farm level, mean percentage (±SD) of cows with a hock injury was 56 ± 18% and knee injury was 43 ± 23%. In Ontario, mean percentage (±SD) of cows with a hock injury was 45 ± 18% and knee injury was 26 ± 15% at the farm level. In Quebec, mean percentage (±SD) of cows with a hock injury was 64 ± 18% and knee injury was 53 ± 21% at the farm level. The distribution of potential explanatory variables is presented in Table 2.3. for cow-level variables and Table 2.4. for herd-level variables. Age of stall base was assessed on 96 farms; mean age was 7.7 years with a SD of 5 yr and a range from 1 to 28 yr.

*Factors Associated with Hock Injuries*

The factors associated with hock injuries in the multivariable model are presented in
Table 2.5. The proportion of random variation that occurred at the herd level was 25% in this model.

**Animal-Based Measures.** The odds of hock injury increased by 1.02 times with every 10-d increase in DIM ($P = 0.001$) and by 1.39 times with every 0.25-point decrease in body condition ($P = 0.002$). Median lying bout duration and median number of lying bouts had significant quadratic terms in the hock injury model ($P = 0.002$ and $P < 0.001$, respectively). The probability of hock injury increased when median lying bout duration was less than 110 min or more than 200 min. The probability of hock injury was lowest in cows with median number of lying bouts between 13 and 18. An interaction was also discovered between lameness and parity ($P = 0.02$). Cows in parity 4 or greater were more likely to have hock injuries if lame than if not lame ($P = 0.009$) as illustrated in Figure 2.3. All other parities showed no difference when lame or not lame. A second interaction was found between number of lying bouts and parity ($P = 0.04$) seen in Figure 2.4. Cows in parity 2 and 4 or greater were less likely to have hock injuries with fewer lying bouts than cows in parity 1 and 3. This relationship is reversed after 14 lying bouts per day, with cows in parity 2 and 4 or greater having higher probability of hock injuries than cows in parity 1 and 3. Finally, as illustrated in Figure 2.5., for narrower cows (<80 cm), increasing stall width lowered the probability of hock injury ($P = 0.01$). Whereas for wider cows (≥80 cm), increasing stall width increased the probability of hock injury. At a stall width of 127 cm, the probability of hock injury was the same for all cow widths. After this point, the probability of injury for narrower cows becomes lower than the probability of injury for wider cows.

**Farm-Based Measures.** The odds of hock injury decreased by 1.03 times for every 1-yr increase in the age of the stall base ($P = 0.02$) and by 1.01 for every 1-cm reduction in chain length ($P =
Additionally, the odds of hock injury were 1.44 times greater on rubber mats \((P = 0.01)\) and 2.64 times greater on concrete \((P = 0.15)\) compared with mattresses.

Last, an interaction was found between tie rail position and province \((P = 0.03)\) illustrated in Figure 2.6. The further forward the tie rail was positioned, the greater the probability of hock injury. Tie rail position only went from −36 to 35 cm in Quebec and 0 to 67 cm in Ontario. The probability of hock injuries was consistently higher in Quebec; however, the slope of the probability was greater in Ontario.

**Factors Associated with Knee Injuries**

Factors associated with knee injuries at the multivariable level are presented in Table 2.6. The proportion of random variation that occurred at the herd level was 31\% in this model.

**Animal-Based Measures.** The probability of knee injury was found to decrease with increasing DIM within the distribution of our data \((P = 0.005)\). In addition, an interaction was identified between BCS and DIM \((P = 0.009)\). As illustrated in Figure 2.7., for cows with a BCS of 2, the probability of knee injury decreased with increased DIM. For cows with a BCS of 3, the probability of knee injury dropped until 200 DIM, and then began to rise. For cows with a BCS of 4, the probability of knee injury increased with increasing DIM. Lastly, lying time was found to have a quadratic association with injuries: the probability of knee injury decreased with increasing lying time until cows were lying 12 h a day, at which point the probability of knee injuries began to rise with increasing lying time \((P < 0.001)\).

**Farm-Based Measures.** The odds of knee injuries were found to increase by 1.10 times with every 10-cm decrease in chain length \((P = 0.001)\), increased by 1.10 times with every 5-cm decrease in bed length \((P = 0.01)\), and decreased with increasing stall width \((P = 0.001)\). Additionally, the odds of knee injury were 2.90 times greater in Quebec than in Ontario \((P < \)
The odds of knee injury were also 2.01 times greater on rubber mats \((P<0.001)\) and 3.01 times greater on concrete \((P=0.01)\) compared with mattresses.

**DISCUSSION**

To our knowledge, this project was the most comprehensive on-farm cow comfort study of its kind in Canada, assessing 3,868 cows on 100 tiestall farms across Ontario and Quebec. Through this study, we identified that hock and knee injuries are a common problem on Canadian tiestall farms. The mean milk yield per year in the herds in our sample was 9,570 kg and mean herd size was 66 cows. These values are slightly higher than the provincial means of 8,673 kg and 57 cows in Ontario and 8,696 kg and 55 cows in Quebec (Canadian Dairy Information Center, 2014). The differences were likely because of our selection criteria for production and herd size. On average, 56% of our sample of each herd had hock injuries and 43% had knee injuries. This level of hock injury was higher than the 47% reported on cows in freestall systems in Canada (Zaffino Heyerhoff et al., 2014). The level of knee injuries identified was also higher than the 27% reported in freestall systems (Zaffino Heyerhoff et al., 2014). This finding is possibly because of the greater prevalence of cement- and rubber mat-based systems in tiestall systems compared with freestall housing, thus leading to higher impacts on cows’ joints. We also identified tiestall herds with levels of hock injuries as low as 5.7% and knee injuries as low as 0%, indicating that it is possible to minimize the odds of injuries on dairy cows in tiestall housing systems.

The levels of hock and knee injuries were both higher on farms in Quebec. This finding can be explained in part by the interaction we identified between stall design and province described earlier. The design and material make-up of the manger wall may have also
contributed to the difference in knee injuries. Though this factor was not measured, manger walls may be more likely to have been made of cement or other abrasive surfaces in Quebec than in Ontario. Furthermore, it is possible that the suppliers of stall bases in Quebec and Ontario differ: mattresses or rubber mats offered in Quebec may be more abrasive than those offered in Ontario, thereby causing a greater number of hock and knee injuries in Quebec.

**Factors Associated with Hock Injuries**

The proportion of random variation that occurred at the herd level was 25% in this model. As expected, the outcome was clustered within herd likely due to herd level variables. However, 75% of variation occurred at the cow level, making cow-level analysis appropriate.

**Animal-Based Measures.** The odds of hock injuries increased with increasing DIM, which agrees with previous research (Potterton et al., 2011; Burow et al., 2013; Zaffino Heyerhoff et al., 2014). This association could be explained by cows with higher DIM being exposed to the stall surface for a longer period and this prolonged exposure causing the injury.

Additionally, a higher probability of hock injuries was found for thin cows. This association was also reported by Lim et al. (2015). It is hypothesized that thinner cows have less of a fat pad on their hocks to protect the joint, therefore putting them at greater odds of injuring the hock. Lameness was also identified as having an association with hock injuries, depending on parity. Older cows that were also lame had the greatest odds of having hock injuries, and lameness increased these odds compared with older non-lame cows. This finding supports previous research that identified older cows as being at higher risk of injury, as well as lameness being an additional risk factor (Rutherford et al., 2008; Potterton et al., 2011; Lim et al., 2015). Lying time was found to be associated with increased odds of hock injuries. Cows with low (<8) or high (>20) number of lying bouts and low (<60 min) or high (>240 min) lying bout durations
had increased odds of having hock injuries. This association between lying behavior and hock injuries is still unclear in the literature; however, a study by Ito et al. (2010) demonstrated that severe lameness was associated with cows with longer lying bout durations. It is possible that cows with mild hock injuries are uncomfortable and therefore have shorter lying bouts, whereas cows with more severe injuries are high-risk cows that may be so uncomfortable that they get up and down less and stay down once lying, which would explain the fewer, longer lying bouts.

**Farm Measurements.** Older stall bases were negatively correlated with hock injuries. Potterton et al. (2011) found a similar association: stall surfaces may become less abrasive through rubbing and being worn over time. Is it also hypothesized that farms with older stall bases compensate for aging stall bases through other housing and management factors such as bedding. Our measures were likely not sensitive enough to account for this compensation effect.

Stall width was found to be associated with hock injuries, though it was dependent on the width of the cow. Wider stall was hypothesized to lower the probability of hock injury, and this relationship was the case for narrower and average cows in our study. However, wider cows had increased odds of hock injury when in wider stalls. This outcome could be due to confounding factors related to management. Perhaps producers purposely provided their larger cows wider stalls and may have especially done so for those wide cows that had already sustained an injury. Additionally, wider cows may also be heavier, therefore placing more weight and pressure on their knees when lying and rising.

Finally, tie rail position played a role in the probability of hock injury, with forward tie rails increasing the probability of injuries. This finding could be explained by the further forward the tie rail, the further forward the cow is placed in the stall, and so the cow may not have as much flexibility to move her hocks when lying down and getting up. This effect varied between
the 2 provinces, with the probability of injury rising much more quickly as the tie rail moves forward in Ontario than in Quebec. However, the overall probability of hock injury was consistently greater in Quebec. This interaction could be explained by tie rail positions in Ontario being further forward, whereas herds in Quebec had tie rails further back from the manger curb.

**Factors Associated with Knee Injuries**

Knee injuries had different risk factors than hock injuries. This finding agrees with research demonstrating that hock and knee injuries do not necessarily correlate with each other (Brenninkmeyer et al., 2016). The proportion of random variation that occurred at the herd level was 31% in this model. Again, as expected, the outcome was clustered within herd likely because of herd-level variables. However, 69% of the variation occurred at the cow level, making cow-level analysis appropriate.

**Cow Measurements.** In this study, body condition interacted with DIM: cows with higher BCS had a higher probability of knee injuries with increasing DIM than cows with low or average BCS. This finding may be because cows with higher BCS tend to be heavier and are thereby putting more pressure on their knees. Additionally, cows within a median lying time range of between 10 and 14 h were found to have the lowest probability of knee injuries. This finding supports previous research demonstrating this range as being optimal for cow comfort (Ito et al., 2010).

**Farm Measurements.** The odds of knee injuries were increased with shorter chain length. This outcome is perhaps due to cows having less free space to rise and lie down with shorter chains and causing them to struggle on their knees. Knee injuries were also more common in Quebec than Ontario, which could be explained by the difference in stall designs observed between the 2
provinces. This difference in tie rail position is demonstrated in Figure 2.6., where tie rail positions range much further back in the stall on farms in Quebec than they do on farms in Ontario. Stall base was also found to be associated with knee injuries, as reported by others (Rushen et al., 2007; Zaffino Heyerhoff et al., 2014). Harder stall surfaces such as concrete and simple rubber mats provide higher odds of knee injuries possibly because of lower compressibility of concrete and rubber mats compared with mattresses (Fulwider and Palmer, 2004). Lastly, the odds of knee injuries increased in narrower and shorter stalls. This increase may have been due to lack of adequate space to rise and lie down, forcing the cow to fall more harshly to her knees when lying down than if she had more room and causing friction when rising to stand. She would also be more likely to rub against the manger wall in this scenario.

**LIMITATIONS**

Several limitations exist in this study that should be addressed with future research. This study was voluntary; therefore, nonresponse bias may be present. Even though our sample size reflects national mean milk yield and herd size for tiestall herds, the individuals who responded may be different from our target population regarding interest, knowledge, and application of on-farm cow welfare issues. Farms with serious injury problems may have chosen not to participate out of concern that they might be judged. Therefore, our sample may have lower levels of injuries than our target population. Unfortunately, this bias is an unavoidable limitation in voluntary studies. Given that this study had a cross-sectional design, cause and effect could not be established, especially between animal-based measures. Additionally, because of our large sample size and large number of variables, spurious results may have been identified that may not truly reflect the nature of these relationships. Further longitudinal study is required to
understand the causal relationship among these factors. With regard to the study design, it would be wise in future studies to record housing and management of heifers and dry cows on farms. Some of the factors measured on fresh cows may have been a consequence of the heifer or dry housing and management they were exposed to and not the milking cow housing and management.

Furthermore, our measures of cow cleanliness, bedding depth, and stall cleanliness may not have been sensitive enough to pick up associations with hock injuries. A more detailed scoring system may have been more successful. Lastly, little variation was seen among the lunge space, bedding types, stall types, and trainer position, and so few analyses were performed, and no significant results were found. This outcome does not preclude that other variations of these measures could have significant impacts on hock and knee injuries if they are present.

CONCLUSION

Reducing or eliminating hock and knee injuries on dairy cows is generally accepted to improve animal well-being. This study found that hock and knee injuries were common on tiestall dairy farms in Canada. An effort should be made to reduce such injuries. Several stall-based factors were found to contribute to injuries. This study provides a starting benchmark to track changes in the level of hock and knee injuries on tiestall farms over time with the improvement of these contributing factors, including age and type of stall base, chain length, and tie rail position for hock injuries, and bed length, bed width, and chain length for knee injuries. Producers should aim to provide adequate space for cows to stand up and lie down and a comfortable base to lie on to reduce the odds of hock and knee injuries. Animal-based factors such as a lying time, age, BCS, and DIM were also found to be associated with injuries; however,
the direction of these associations are impossible to identify in a cross-sectional study. Additional longitudinal studies should be performed to better understand the causal relationships between these factors.

ACKNOWLEDGMENTS

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REFERENCES


<table>
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<th>Area of interest</th>
<th>Score 0</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
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</thead>
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<tr>
<td>Hock (tarsus)</td>
<td>No Swelling. No hair is missing or broken hair</td>
<td>Bald area on hock with no swelling or swelling &lt; 1 cm high.</td>
<td>Swelling, 1-2.5 cm high, and/or broken skin/scab on bald area</td>
<td>Swelling, &gt; 2.5 cm high. May have bald area/broken skin/scab</td>
</tr>
<tr>
<td>Knee (carpus)</td>
<td>No swelling. No hair is missing or slight hair loss or broken hair</td>
<td>No swelling. Bald area</td>
<td>Broken skin or scab and/or swelling (&lt; 2.5 cm high). May have bald area</td>
<td>Swelling ≥ 2.5 cm high. May have bald area/lesion</td>
</tr>
</tbody>
</table>
Table 2. Distribution of hock and knee injuries scores on 3,868 cows from 100 tiestall farms overall and by province

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall, n(^1)(%)</th>
<th>Quebec, n(%)</th>
<th>Ontario, n(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hock injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>804 (21)</td>
<td>366 (17)</td>
<td>438 (30)</td>
</tr>
<tr>
<td>1</td>
<td>779 (20)</td>
<td>407 (19)</td>
<td>372 (25)</td>
</tr>
<tr>
<td>2</td>
<td>1912 (49)</td>
<td>1308 (60)</td>
<td>604 (42)</td>
</tr>
<tr>
<td>3</td>
<td>130 (3)</td>
<td>83 (4)</td>
<td>47 (3)</td>
</tr>
<tr>
<td>Knee injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1374 (36)</td>
<td>599 (26)</td>
<td>775 (49)</td>
</tr>
<tr>
<td>1</td>
<td>831 (22)</td>
<td>440 (19)</td>
<td>391 (25)</td>
</tr>
<tr>
<td>2</td>
<td>1575 (41)</td>
<td>1182 (53)</td>
<td>393 (25)</td>
</tr>
<tr>
<td>3</td>
<td>69 (2)</td>
<td>53 (2)</td>
<td>16 (1)</td>
</tr>
</tbody>
</table>

\(^1\)Does not always equal 3,868 (or 100%) due to missing data
Table 2. 3. Distribution of all cow-level explanatory variables hypothesized to be associated with hock and knee injuries measured on 3,868 cows from 100 tiestall farms in Canada

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cows, n1(%)</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>Univariable P-value hock</th>
<th>Univariable P-value knee</th>
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</thead>
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<tr>
<td>Cow variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cow</td>
<td>3868 (100)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg hygiene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dirty</td>
<td>160 (4)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.97</td>
<td>0.58</td>
</tr>
<tr>
<td>Not dirty</td>
<td>3703 (96)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Udder hygiene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dirty</td>
<td>153 (4)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.68</td>
<td>0.61</td>
</tr>
<tr>
<td>Not dirty</td>
<td>3710 (96)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Flank hygiene</td>
<td></td>
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<td></td>
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<tr>
<td>Dirty</td>
<td>411 (11)</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>0.074</td>
<td>0.042</td>
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<tr>
<td>Not dirty</td>
<td>3457 (89)</td>
<td>-</td>
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<tr>
<td>Lameness</td>
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<td>0.0001</td>
<td>0.028</td>
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<tr>
<td>Lame</td>
<td>914 (24)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
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</tr>
<tr>
<td>Not lame</td>
<td>2837 (73)</td>
<td>-</td>
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<td></td>
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<tr>
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<td>0.78</td>
<td>0.56</td>
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<tr>
<td>1</td>
<td>1394 (36)</td>
<td>-</td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>994 (26)</td>
<td>-</td>
<td>-</td>
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<td>628 (16)</td>
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<tr>
<td>≥ 4</td>
<td>850 (22)</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>Days in milk (days)</td>
<td>3868 (100)</td>
<td>156</td>
<td>94.5</td>
<td>12</td>
<td>500</td>
<td>0.084</td>
<td>0.16</td>
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<tr>
<td>Cow height (cm)</td>
<td>3868 (100)</td>
<td>150.4</td>
<td>4.3</td>
<td>137</td>
<td>159</td>
<td>0.77</td>
<td>0.23</td>
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<tr>
<td>Cow width (cm)</td>
<td>3785 (98)</td>
<td>66.4</td>
<td>4.3</td>
<td>52</td>
<td>76</td>
<td>0.84</td>
<td>0.59</td>
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<tr>
<td>BCS</td>
<td>3940 (100)</td>
<td>2.75</td>
<td>0.5</td>
<td>1</td>
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<td>0.06</td>
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<tr>
<td>Average lying time (min)</td>
<td>3788 (98)</td>
<td>747</td>
<td>142</td>
<td>373</td>
<td>1092</td>
<td>&lt;0.0001</td>
<td>0.22</td>
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<tr>
<td>Average lying bout duration (min)</td>
<td>3788 (98)</td>
<td>73</td>
<td>25</td>
<td>27</td>
<td>170.8</td>
<td>0.62</td>
<td>0.93</td>
</tr>
<tr>
<td>Average number of lying bouts</td>
<td>3788 (98)</td>
<td>11.3</td>
<td>3.7</td>
<td>2.3</td>
<td>21.5</td>
<td>0.35</td>
<td>0.52</td>
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<tr>
<td>Median lying time (min)</td>
<td>3788 (98)</td>
<td>748</td>
<td>143</td>
<td>400</td>
<td>1087</td>
<td>&lt;0.0001</td>
<td>0.18</td>
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<tr>
<td>Median lying bout duration (min)</td>
<td>3788 (98)</td>
<td>72.5</td>
<td>25</td>
<td>27.2</td>
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<td>0.79</td>
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<tr>
<td>Median number of lying bout</td>
<td>3788 (98)</td>
<td>11.3</td>
<td>3.6</td>
<td>2</td>
<td>23</td>
<td>0.37</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Housing and management variables
| Stall width (cm) | 3788 (98) | 126.6 | 11.1 | 99 | 154 | 0.15 | 0.75 |
| Bed length (cm) | 3787 (98) | 178.1 | 8.5 | 157 | 200 | 0.90 | 0.044 |
| Manger height (cm) | 3787 (98) | 20.4 | 8.5 | 0 | 39 | 0.16 | 0.35 |
| Chain length (cm) | 3709 (96) | 69.4 | 21.6 | 25 | 130 | 0.11 | 0.0003 |
| Tie rail height (cm) | 3476 (90) | 109.9 | 12.2 | 78 | 134 | 0.51 | 0.16 |
| Tie rail position (cm) | 3122 (81) | 15.6 | 16.3 | -36 | 67 | 0.04 | <0.0001 |
| Trainer position | Adjusted | 3167 (82) | - | - | - | - |
| | Not adjusted | 134 (3) | - | - | - | - |
| Lunge space | Yes | 3699 (96) | - | - | - | - |
| | No | 88 (2) | - | - | - | - |

1 Does not always equal 3,868 (or 100%) because of missing data.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Herds, n²(%)</th>
<th>Univariable P-value hock</th>
<th>Univariable P-value knee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd</td>
<td>100 (100)</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
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<td>Province</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ontario</td>
<td>40 (40)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quebec</td>
<td>60 (60)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stall base</td>
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<td>Mattress</td>
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<tr>
<td>Rubber mat</td>
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</tr>
<tr>
<td>Concrete</td>
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</tr>
<tr>
<td>Bedding type</td>
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<tr>
<td>None</td>
<td>3 (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4 (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shavings</td>
<td>1 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sawdust</td>
<td>1 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straw</td>
<td>92 (92)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stall type</td>
<td></td>
<td>0.0010</td>
<td>0.18</td>
</tr>
<tr>
<td>Tie rail and chain</td>
<td>89 (89)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stanchion</td>
<td>1 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 bar stall</td>
<td>5 (5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 bar stall</td>
<td>3 (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min bedding depth</td>
<td></td>
<td>0.15</td>
<td>0.40</td>
</tr>
<tr>
<td>None</td>
<td>1 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 2cm</td>
<td>57 (57)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 2cm</td>
<td>40 (40)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean bedding depth</td>
<td></td>
<td>0.01</td>
<td>0.13</td>
</tr>
<tr>
<td>0.5</td>
<td>1 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>39 (39)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>18 (18)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>40 (40)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum bedding wetness</td>
<td></td>
<td>0.47</td>
<td>0.28</td>
</tr>
<tr>
<td>Dry</td>
<td>68 (68)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet</td>
<td>25 (25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very wet</td>
<td>5 (5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean bedding wetness</td>
<td></td>
<td>0.10</td>
<td>0.21</td>
</tr>
<tr>
<td>0</td>
<td>68 (68)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>22 (22)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>8 (8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum manure contamination</td>
<td></td>
<td>0.32</td>
<td>0.28</td>
</tr>
<tr>
<td>Clean</td>
<td>31 (31)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little</td>
<td>52 (52)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean &gt; 50%</td>
<td>11 (11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dirty &gt; 50%</td>
<td>4 (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completely dirty</td>
<td>0 (0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean manure</td>
<td>0.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>contamination</td>
<td>0.14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>0</th>
<th>31 (31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>37 (37)</td>
</tr>
<tr>
<td>1</td>
<td>19 (19)</td>
</tr>
<tr>
<td>1.5</td>
<td>6 (6)</td>
</tr>
<tr>
<td>2</td>
<td>4 (4)</td>
</tr>
<tr>
<td>2.5</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Feed access</td>
<td>0.15</td>
</tr>
<tr>
<td>Yes</td>
<td>51 (51)</td>
</tr>
<tr>
<td>No</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Feed pushup</td>
<td>0.14</td>
</tr>
<tr>
<td>2-3 times per day</td>
<td>46 (46)</td>
</tr>
<tr>
<td>1 time per day</td>
<td>4 (4)</td>
</tr>
<tr>
<td>N/A</td>
<td>3 (3)</td>
</tr>
</tbody>
</table>

1Does not always equal 100 (or 100%) because of missing data
Table 2.5. Factors associated with hock injuries on 87 farms in the final logistic regression model with a binomial distribution, not injured (no response) \( n = 1,438 \) and injured (response) \( n = 1,275 \)

<table>
<thead>
<tr>
<th>Fixed effect</th>
<th>Coefficient</th>
<th>SE</th>
<th>DF</th>
<th>OR</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days in milk per 10 days</td>
<td>0.016</td>
<td>0.0049</td>
<td>2780</td>
<td>1.02</td>
<td>1.01-1.03</td>
<td>0.001</td>
</tr>
<tr>
<td>BCS</td>
<td>-0.33</td>
<td>0.10</td>
<td>2780</td>
<td>1.39</td>
<td>1.14-1.70</td>
<td>0.002</td>
</tr>
<tr>
<td>Age of stall base per 1 year</td>
<td>-0.033</td>
<td>0.014</td>
<td>2780</td>
<td>1.03</td>
<td>1.01-1.06</td>
<td>0.02</td>
</tr>
<tr>
<td>Chain length per cm</td>
<td>-0.0063</td>
<td>0.0029</td>
<td>2780</td>
<td>1.01</td>
<td>1.00-1.01</td>
<td>0.03</td>
</tr>
<tr>
<td>Lameness</td>
<td>-0.73</td>
<td>0.18</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Lame</td>
<td>Referent</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Parity</td>
<td>0.67</td>
<td>0.43</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td>0.06</td>
</tr>
<tr>
<td>1</td>
<td>0.21</td>
<td>0.44</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.40</td>
<td>0.46</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>≥ 4</td>
<td>Referent</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Lameness * Parity</td>
<td>-</td>
<td>-</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td>0.02</td>
</tr>
<tr>
<td>Province</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ontario</td>
<td>-1.34</td>
<td>0.34</td>
<td>82</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Quebec</td>
<td>Referent</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tie forward position per cm</td>
<td>0.0036</td>
<td>0.0066</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td>0.003</td>
</tr>
<tr>
<td>Tie forward * province</td>
<td>-</td>
<td>-</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td>0.03</td>
</tr>
<tr>
<td>Stall base</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.03</td>
</tr>
<tr>
<td>Concrete</td>
<td>0.97</td>
<td>0.67</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Rubber mat</td>
<td>0.37</td>
<td>0.15</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Mattress</td>
<td>Referent</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Cow width per cm</td>
<td>-0.27</td>
<td>0.11</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td>0.01</td>
</tr>
<tr>
<td>Stall width per 5 cm</td>
<td>-0.78</td>
<td>0.28</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td>0.006</td>
</tr>
<tr>
<td>Stall width * cow width</td>
<td>0.011</td>
<td>0.0042</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td>0.01</td>
</tr>
<tr>
<td>Median bout duration per min</td>
<td>-0.36</td>
<td>0.082</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Bout duration squared</td>
<td>0.012</td>
<td>0.0038</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td>0.001</td>
</tr>
<tr>
<td>Median number bouts</td>
<td>-0.26</td>
<td>0.068</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Bout number squared</td>
<td>0.0092</td>
<td>0.0024</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Bouts * parity</td>
<td>-</td>
<td>-</td>
<td>2780</td>
<td>-</td>
<td>-</td>
<td>0.04</td>
</tr>
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</table>
Table 2.6. Factors associated with knee injuries on 97 farms in the final logistic regression model with a binomial distribution, not injured (no response; n = 2,309) and injured (response; n = 711)

<table>
<thead>
<tr>
<th>Fixed effect</th>
<th>Coefficient</th>
<th>SE</th>
<th>DF</th>
<th>OR</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chain length per cm</td>
<td>-0.072</td>
<td>0.028</td>
<td>3477</td>
<td>1.07</td>
<td>1.02-1.14</td>
<td>0.01</td>
</tr>
<tr>
<td>Bed length</td>
<td>-0.097</td>
<td>0.037</td>
<td>3477</td>
<td>1.10</td>
<td>1.02-1.19</td>
<td>0.009</td>
</tr>
<tr>
<td>Days in milk per 10 days</td>
<td>-0.11</td>
<td>0.027</td>
<td>3477</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>DIM squared</td>
<td>0.00093</td>
<td>0.00033</td>
<td>3477</td>
<td></td>
<td></td>
<td>0.005</td>
</tr>
<tr>
<td>BCS</td>
<td>-0.60</td>
<td>0.19</td>
<td>3477</td>
<td></td>
<td></td>
<td>0.001</td>
</tr>
<tr>
<td>DIM * BCS</td>
<td>0.024</td>
<td>-0.0094</td>
<td>3477</td>
<td></td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Median lying time per min</td>
<td>-0.0058</td>
<td>0.0017</td>
<td>3477</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Lying time squared</td>
<td>0.0000040</td>
<td>0.0000012</td>
<td>3477</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stall width per 5cm</td>
<td>-0.44</td>
<td>0.17</td>
<td>3477</td>
<td></td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Stall width squared</td>
<td>0.0081</td>
<td>0.0032</td>
<td>3477</td>
<td></td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Province</td>
<td>-</td>
<td>-</td>
<td>3477</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ontario</td>
<td>-1.21</td>
<td>0.17</td>
<td>93</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quebec</td>
<td>Referent</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stall base</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Concrete</td>
<td>1.092</td>
<td>0.46</td>
<td>3477</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber mat</td>
<td>0.66</td>
<td>0.16</td>
<td>3477</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mattress</td>
<td>Referent</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 2.1. Diagram of observed stall configurations: (a) tie rail and chain, (b) stanchion, (c) chain, (d) 2-bar, and (e) 6-bar.
Figure 2.2. Diagram of stall measures taken on farm: (a) bed length, (b) tie rail position, (c) manger curb height, and (d) tie rail height.
Figure 2.3. Mean level of hock injury by parity and lameness. Error bars indicate 95% CI.
Figure 2.4. Probability of hock injury by median number of lying bouts per cow per day and parity.
Figure 2.5. Probability of hock injury of cows of different widths by increasing stall width.
Figure 2.6. Probability of hock injury by tie rail position in relation to the front edge of the manger curb for Ontario and Quebec.
Figure 2.7. Probability of knee injury in different cow BCS by increasing DIM.
CHAPTER 3

A survey of practices implemented to improve cow comfort following an initial assessment on Canadian dairy farms

Published in the Canadian Journal of Animal Science:

ABSTRACT

The objectives of this study were to determine the difficulty of implementing changes to improve cow comfort on Canadian dairy farms, to determine if any changes were implemented to improve dairy cow comfort following an initial cow comfort assessment, to categorize producers based on types of changes they made, to compare how producers in these categories differed, and to identify barriers to implementing these changes. The most difficult type of change to implement was changing stall design (including building a new barn) with a mean difficulty score of 3.3 (out of 5) scored by a panel of dairy researchers. Overall, 3 of 118 (2.5%) interviewed producers were categorized as innovators, 62 (52.5%) as effective adopters, 20 (17%) as ineffective adopters, and 33 (28.0%) as non-adopters. The most common types of changes made were to stall management (37.3%). Participants were asked to identify all barriers to further improvement of cow comfort. The most commonly reported barriers were lack of funds (52.9%), lack of time (38.7%), and being satisfied with the level of cow comfort (31.1%). This survey study demonstrates that a cow comfort assessment can influence dairy producers to implement changes to improve cow comfort; however, certain barriers exist to implementation.

Key words: dairy, welfare, cattle, survey, adoption
INTRODUCTION

Scientific knowledge regarding dairy cattle housing and management continues to grow. However, it is unclear whether this knowledge is being implemented on commercial dairy farms in Canada. The motivators and barriers to the implementation of new technologies in agriculture have been studied since the 1940s (Ryan and Gross 1943), though limited work has been done to examine the adoption of technologies that improve animal welfare in animal production systems. Some extension efforts to improve lameness have been undertaken in Europe, showing limited success (Barker et al., 2012; Main et al., 2012. To attempt to develop a wholistic approach to improve dairy cow welfare, a dairy cow welfare extension and communication study, titled the Dairy Cluster I Welfare Study (DCIWS), was undertaken from 2010 to 2012 to benchmark cow comfort on Canadian dairy farms (Vasseur et al., 2015). One of the study objectives was to help Canadian dairy producers gauge how well they met certain standards in the Code of Practice for the Care and Handling of Dairy Cattle (DFC-NFACC 2009), and how they compared to their peers. Two hundred and forty commercial farms, both free-stall and tie-stall, were assessed, with animal, management, and housing related measures taken (Zaffino Heyerhoff et al., 2014; Nash et al., 2016).

The DCIWS formed the basis for a top-down approach to agricultural extension, also called the Diffusion of Innovations model (Rogers 1963), in which researchers provide information and knowledge to producers to incite change. This model was first described by Rogers (1963) and assumed that the information and knowledge provided would be first taken up by more progressive producers and that these would then motivate other producers to gradually follow suit. Rogers (1963) categorized producers with the following labels, based on timeline of implementation: innovators (first to implement: risk takers), early adopters (next to implement:
think more critically than innovators), early majority (implement sometime after contact with early adopters), late majority (implement later than average) and laggards (last to implement). The current study adapted these categories to determine the level of implementation of new practices following the DCIWS: rather than categorizing producers based on how long it took them to implement a change, this study categorized them based on whether or not the changes made addressed an existing weakness.

Knowledge and information of a new practice is, however, not the only factor that determines its implementation. Factors such as the attitude, perception, motivators, and objectives of producers in relation to the change have also been shown to affect the implementation of new practices (Barkema et al., 1999; Leeuwis, 2004; Ritter et al., 2017). Motivating adoption is, not surprisingly, more difficult among producers who show little interest in change (Mee, 2007). Jansen et al. (2010) categorized producers based on some of these determining factors, to develop a program to improve mastitis control on dairy farms in the Netherlands. Those researchers demonstrated that the adoption of practices cannot be done using a “one-size-fits-all” strategy. This demonstrates the importance of examining the various determinants of adoption to develop more specialized tools and strategies to improve adoption (Rehman et al., 2007). More recently, motivators and barriers to the adoption of new practices in the dairy industry specific to Johne’s disease control have been investigated (Roche, 2014); however, these areas have not yet been fully explored in the context of animal welfare in the Canadian dairy industry. Limited research currently exists to assess the difficulty of making individual changes to improve cow comfort on farm, with most studies again focusing on lameness and foot health (Leach et al., 2010; Bruijnis et al., 2013).

The objectives of this follow up study were to: 1) assess the perceived difficulty with
implementation of new cow comfort practices, 2) determine whether changes to improve previously identified cow comfort problems were implemented by commercial free-stall and tie-stall Canadian dairy producers in Alberta, Ontario, and Quebec following DCIWS, 3) categorize these producers based on whether they implemented changes and, if they did, whether they addressed the weaknesses identified by DCIWS, 4) determine how farmers within these different categories differed, and 5) examine other factors that may have been barriers to implementation of changes to improve cow comfort on these dairy farms.

**MATERIALS AND METHODS**

All methods used in this study were approved by Institutional human research ethics boards at the University of Guelph (REB# 10DC021), Université Laval (CPAUL# 2010127) and the University of Calgary (#13-0046).

**Dairy Cluster I Welfare Study**

One hundred and thirty-five Canadian tie-stall and 135 free-stall dairy herds were assessed in Ontario, Alberta and Quebec using the cow comfort assessment described in detail by Vasseur et al. (2015). In Alberta, 90 free-stall herds were assessed, in Quebec 90 tie-stall herds were assessed and in Ontario 45 free-stalls, and 45 tie-stalls were assessed. Sample size was selected to maximize power while staying within time and financial limitations.

Eligible herds had to meet the following criteria: minimum herd size of 40 milking Holstein dairy cows, the dairy herd must have lived in the current housing system for at least one year and must not have has access to outdoor exercise areas or pasture. All components of the assessment are accessible on the Canadian Dairy Research Portal at:

https://www.dairyresearch.ca/animal-comfort-tool.php
Briefly, the farm assessment addressed 13 critical areas of dairy cow comfort, including: accommodation and housing (stall dimensions, space allowance at stalls, space allowance at feeders, stall management, pen management, milking parlor and transfer alleys), feed and water (body condition scoring, nutrition), and health and welfare (injuries, lameness, lying time and hoof health). In that study, the focus was placed on stall design (which included injuries, lying time and stall dimensions), stall management, and hoof health (which included trimming frequency and maintaining records). Targets of good practice were identified from the Requirements and Recommended Practices in the Code of Practice for the Care and Handling of Dairy Cattle (DFC-NFACC, 2009). Each farm was presented a score for the 13 critical areas, ranging from 0 (target not reached) to 100 (target reached). These scores were developed by a panel of 16 dairy experts in Canada, further detail on the scoring is provided by Vasseur et al. (2015). The original study included 12 assessors and inter- and intra-observer reliability was assessed periodically and maintained at a minimum weighted Kappa of 0.6 (Gibbons et al., 2012). An evaluation report was provided and discussed with each producer at the end of the assessment by the DCIWS investigators, identifying strengths and areas for improvement that could benefit cow comfort on their farm.

**Difficulty Scoring**

To better understand the difficulty of improving cow comfort on-farm, an online survey, completed by 13 government or university-based dairy cattle researchers in Canada, was also administered to determine their professional opinion on the level of difficulty for producers to make each of these changes to improve cow comfort on commercial dairy farms. The researchers had expertise in animal behavior, veterinary medicine, animal welfare, and health management, and each had at least 10 years of experience working in the dairy industry. All researchers agreed
to participate. They were selected based on their extensive experience working directly with producers on improving the health and welfare of their herds. The researchers were asked to take into account cost, labour, and effort required when scoring each of the changes. Each type of change was scored (stall design, stall management, and hoof health), and each of 12 individual changes included within those types (e.g. changing neck-rail height, bedding more frequently or trimming more regularly) on a scale of 1 to 5 (1 being very easy to 5 being very difficult). The survey is included as Appendix I.i.

**Follow-up Interviews**

Eight to twelve months after the initial DCIWS cow comfort assessment, provincial initiatives were launched by principal investigators within each province to follow-up with producers on whether or not they made any changes related to cow comfort since being part of the DCIWS. Phone interviews with provincial government and industry representatives were done to identify regional objectives in addition to those of our study; these included identifying the level of adherence to the Code of Practice in Alberta and whether or not producers perceived cow comfort as valuable to their business in Quebec and Ontario. Due to slightly differing objectives within each province, the questionnaires were tailored by province. Thirteen common questions remained consistent between provinces regarding demographics, types of changes made, and barriers to change. In Quebec, the interviews were conducted in French and were made up of close-ended questions. In Alberta and Ontario, the interviews were conducted in English and included both open- and close-ended questions to gain a deeper understanding of their perspectives. Each of the adapted questionnaires were pre-tested in person on a sub-sample of non-participating dairy producers within each province: 3 in Ontario, 3 in Alberta and 3 in
Quebec. The full questionnaires are available as supplemental data: cjas-2018-0012suppl and as Appendices I.ii, I.iii and I.iv.

The investigators attempted to contact the 270 dairy producers involved in DCIWS who had tie-stall or free-stall parlour facilities. A total of 118 (43%) producers, 53 (59%) in Quebec, 42 (47%) in Ontario, and 23 (26%) in Alberta, were willing and able to participate in this follow-up study. Five close-ended demographic questions were common in all 3 provinces: herd type (freestall, tiestall, etc), age of the producer, herd size, number of employees on the farm, and education of the producer. A close-ended question on what barriers prevented the producer from making cow comfort changes was asked, as was a question asking whether or not the DCIWS played an important role in their decision about whether or not to make changes. Questions on types of changes made were also included. Three types of changes were commonly considered in all 3 provinces: stall design, stall management, and hoof health. Additionally, those producers who reported they made no changes to these categories were asked to identify what barriers prevented them from making changes, while those producers who did make changes were asked to identify what barriers prevented them from making additional changes. Producers were provided a list of barriers and asked to pick out whichever ones applied. Barriers identified in addition to those included in the survey were grouped as “other”.

**Data Handling**

Demographic data were categorized as follows, based on the distribution of the data: Age was categorized into 3 groups: under 35, between 35 and 55, or above 55 years of age due to some producers preferring to state a category rather than their true age. Herd size was categorized into 4 groups based on quartiles of the 270 herds to capture variation in herd size within each farm type: under 60, 60 to 100, 101 to 150 or over 151 milking cows. Number of
employees and full-time equivalents were categorized into 3 groups: 1, 2 to 3, or ≥4 employees. Education, defined as having any kind of post-secondary schooling, was categorized as yes or no.

Types of changes, common to both tie-stall and free-stall systems, that were implemented to improve cow comfort, were grouped into 3 categories: stall design, stall management, and hoof health. These 3 categories were selected among the original 13 categories assessed in the DCIWS because they impacted cow comfort for all housing types, and because producers could directly implement changes to improve them. Stall design included any changes related to the permanent physical structures such as the stall dimensions, stall base, and lunge space to more closely meet recommendations in the Code of Practice for the Care and Handling of Dairy Cattle (DFC-NFACC, 2009). Stall management included any changes related to bedding and cleanliness to more closely meet recommendations in the Code of Practice for the Care and Handling of Dairy Cattle (DFC-NFACC, 2009). Hoof health included any changes related to lameness and hoof trimming to more closely meet recommendations in the Code of Practice for the Care and Handling of Dairy Cattle (DFC-NFACC, 2009). For each of the 118 farms, the scores they received in each of the 3 critical areas of the assessment were combined with the changes that each farm adopted after the assessment, to characterize farms into 4 types. A score of 80% or greater was selected to determine whether or not a farm met recommendations, as it captured the best 25% of farms within the sample for each category. ‘Innovators’ were those producers who had already adopted the management practices that met the recommendations in the Code, given they scored over 80% in all 3 categories. Adopters, those producers who scored under 80% in any one of the 3 categories, but reported they did make changes, were split in 2 groups. ‘Effective adopters’ were producers who reported they made a change related to an area
where they received a low score, and ‘ineffective adopters’ were producers who reported they made a change unrelated to an area with a low score. ‘Non-adopters’ were those producers who scored under 80% in one or more areas and reported they did not make any changes to improve their score in any of these 3 areas.

**Statistical Analysis**

Difficulty scores collected from the dairy researchers were entered into Microsoft Excel 2010 (Microsoft Corp.). The data were calculated using mean and median scores for each of the 3 categories (stall design, stall management, and hoof health), and were also calculated for specific changes identified within each category.

The interview responses were recorded by hand and entered into Microsoft Excel 2010 (Microsoft Corp.). The data were then exported into SAS (version 9.3, SAS Institute Inc., Cary, NC, USA). Descriptive statistics were generated using the PROC FREQ, and exact chi-square analyses were undertaken by adopter type for all variables of interest. These included types of changes made, barriers to adoption and all demographic variables. Significance was considered at $P \leq 0.05$.

**RESULTS**

**Difficulty Scoring**

Results for the difficulty survey conducted with dairy cow welfare researchers are presented in Table 3.1. The most difficult category of change was identified as stall design, with a mean score of 3.3. The most difficult types of changes identified were building a new barn and changing stall dimensions, with scores of 4.9 and 4.2, respectively. Variation between those
surveyed was low, with the highest standard deviations found in hoof health, from 0.69 to 0.96.

Type of Adopters

Of the 118 farms interviewed, we identified 3 (2.5%) innovators, 62 (52.5%) effective adopters, 20 (16.9%) ineffective adopters, and 33 (28.0%) non-adopters. Demographic results are described by adopter type and farm type in Table 3.2. There were no significant differences in demographics between adopter types.

Types of Changes

Of the 118 producers interviewed, 85 (72.0%) reported they implemented one or more changes in stall design, stall management, or hoof health related to cow comfort, including 2 of the 3 innovators. Of these 85 producers, 60 (70.6%) identified the DCIWS report and discussion as having played a significant role in helping them make that change. Other factors they reported played a role were having made the decision to make the change before the study (12.6%) and consulting with other farm advisors, such as a veterinarian or nutritionist (16%).

When looking at different categories of changes implemented, 34 of 118 (28.8%) producers reported they implemented changes to stall design, 44 (37.3%) to stall management, and 32 (27.1%) to hoof health. These results are further separated into more specific kinds of changes, by adopter type, in Table 3.3. Forty of the 118 farms (33.9%) adopted changes in 2 categories, and 9 (7.6%) adopted changes in all 3 categories. Twenty-four producers of the 118 (20.3%) who reported they made changes unrelated to the 3 critical areas studied in this paper; however, these changes were free-stall-specific and, therefore, excluded from analysis. These additional changes included addition of cooling systems, reducing parlor holding times, and improved cleanliness and traction of flooring. When looking at the difference in types of changes
by adopter type, effective adopters were more likely to have made hoof health changes ($P < 0.01$) compared to ineffective adopters. Specifically, effective adopters were more likely to have increased trimming frequency compared to ineffective adopters ($P = 0.01$).

**Barriers to Change**

The list of barriers identified during the interviews, separated by adopter type, is presented in Figure 3.1. The “other” category included planning on building a new barn (3.4% of producers), successorship considerations (2.5%), and the inconvenience of making changes (3.4%). The most commonly reported barriers overall were: lack of funds (52.9%), lack of time (38.7%), and already being satisfied with the cow comfort provided by their farm (31.1%).

**Province**

Comparisons were made between provinces to account for provincial differences, as well as to address differences in interview structure and interviewers in each province. The free-stall producers in Alberta and Ontario were compared. Producers in Ontario were more likely to identify being satisfied with their current level of cow comfort ($P = 0.03$) as a barrier to change compared to producers in Alberta. The tie-stall producers in Quebec and Ontario were also compared, and producers in Quebec were found to be more likely to have post-secondary education ($P < 0.01$) and have more employees ($P < 0.01$) than producers in Ontario, despite farms in Ontario being larger than in Quebec ($P = 0.03$). No other differences between provinces were identified.

**DISCUSSION**

The results of this study demonstrate that a majority of producers reported voluntarily
making changes related to cow comfort in the year following the DCIWS assessment, and a majority of those indicated the DCIWS assessment report and associated discussion, played an important role in making those decisions.

**Difficulty Scoring**

The difficulty survey was included as part of this study due to the lack of research understanding the difficulty of implementing certain changes on farm to improve cow comfort. The results of this survey were a preliminary attempt to better understand why producers may or may not have implemented each type of change. As expected, stall design changes were identified as the most difficult changes to make, with the exception of moving the neck rail. Stall management and hoof health changes were considered easier, possibly because they were viewed as less expensive or less complex to implement. This is supported by a recent focus group study of dairy producers in Canada, who highlighted the difficulty of changing stall design and infrastructure (Croyle et al., manuscript in preparation). They claimed that increasing the amount of bedding was an easier short-term change compared to building a new barn or changing the stalls (Croyle et al., manuscript in preparation).

**Types of Adopters**

Unsurprisingly, when looking at the adopter type breakdown, we had few progressive innovators, with the majority of producers being either adopters or non-adopters. We found that a majority of farms were effective adopters, meaning they reported making one or more changes to an identified area of weakness. It is worth noting that 16.9% of the producers interviewed were ineffective adopters, meaning they adopted changes that did not directly address the weaknesses identified in the DCIWS assessment report. Ineffective adopters were less likely to report to
make changes to hoof health: changes generally identified to be easier by our expert panel. These changes may not have been prioritized over making a change that were perhaps viewed by ineffective adopters as more directly addressing cow comfort, such as changes to stall management or stall design. This is supported by a survey-based study of 500 Dutch dairy producers that found that producers did not associate their intentions to improve subclinical foot health with cow welfare (Bruijnis et al., 2013).

We identified a total of 33 (28.0%) non-adopters. These producers, along with the ineffective adopters, may benefit from a different type of extension strategy. A strategy with additional producer engagement may be more successful at reaching these producers, such as the one used by Whay et al. (2012) to control lameness.

**Types of Changes**

Stall management changes (including increasing quantity of bedding, modifying the type of bedding or base, and increasing cleaning frequency) were the most common changes reported. These types of changes may be viewed as more directly related to improving of cow comfort, especially given the recent attention being paid to the importance of longer lying times (Ito et al., 2009; Vasseur et al., 2012; von Keyserlingk et al., 2012), which is directly affected by bedding quality (Fregonesi et al., 2007). Additionally, bedding amount and cleaning frequency were considered by our expert panel as relatively “easy” changes to make without requiring large financial and time inputs. However, these changes may not have directly addressed the weaknesses identified by DCIWS on those farms. Additional extension efforts are needed for Canadian producers to help promote the importance of other types of changes which may be more challenging but may offer more significant improvements to the level of comfort on their farms.
**Barriers to Change**

The 3 most commonly identified barriers to change were lack of funds, lack of time, and satisfaction with their current level of cow comfort. Lack of funds and lack of time have also been previously reported as barriers to improve priority issues in the dairy industry such as mastitis (Barkema et al., 1999; Jansen et al., 2009), lameness (Leach et al., 2010) and Johne’s disease (Roche, 2014). Further research to help identify how producers prioritize their funds and time would allow a better understanding of how to address these barriers. The complexity of recommendations was also identified as a barrier by 24 producers and could be addressed through improved research, extension and teamwork of the advisory group on the farm.

**Province**

Most of the questions were similar between the interview guides and comparisons revealed only a few differences between provinces. That being said, it must be acknowledged that the format was different for some questions and so may prevent us from teasing apart further differences between provinces.

The difference between Alberta and Ontario free-stall producers with respect to their satisfaction regarding the level of cow comfort could be explained by farms in Alberta having generally newer facilities (Alberta Milk, Edmonton, AB, personal communication), an unmeasured variable in this study. Meanwhile, for tie-stall producers in Quebec and Ontario, the differences were in education and number of employees. The greater proportion of educated producers in Quebec may be explained by the CEGEP program, a secondary school program which provides more tailored training to late high school students with an interest in agriculture but is only available in Quebec. The greater number of employees on Quebec farms could be explained by a different farming style in Quebec, where family members may play a larger role
as employees on the farm (Université Laval, Québec, QC, personal communication). This is speculative, further research is needed to understand these provincial differences.

**LIMITATIONS**

The data collected for this follow-up study were based on interviews. We made the assumption that the responses are honest and accurate, although the possibility for social desirability bias may exist given the nature of the topic. It must also be noted that no control group was included, limiting the interpretation of the effect DCIWS had on motivating change. Additionally, 8 to 12 months may not have been enough time to allow producers to make major changes to their facility, and from this study we cannot determine whether the changes reported did in fact improve the level of cow comfort on those farms. It must also be noted that producers were only categorized based on the 3 areas of focus of this paper: stall design, stall management and hoof health. It is very possible they made changes in other areas that were not assessed in this study. Lastly, only a subset of the 210 herds assessed for the DCIWS were interviewed. Those producers that could not be reached may be less likely to have adopted changes and so non-adopters may be under-represented in our sample.

**CONCLUSION**

This is the first study, to our knowledge, to attempt to score the difficulty of making changes to improve cow comfort. Stall design changes were generally scored as more difficult than stall management and hoof health changes, however further, more detailed, research is required to better understand these differences.

This is also the first study in Canada to explore the success of a cow comfort assessment.
with a discussed report at motivating the adoption of practices to improve dairy cow welfare, and to examine barriers to further change. This work demonstrated that the assessment, report, and discussion on the areas of strength and weakness in cow comfort on a farm were generally successful at motivating change in stall design, stall management, and hoof health on the majority of farms that were reached. However, further study on this and other extensions strategies is necessary to better understand how to motivate those producers that did not implement effective changes to address weaknesses on their farm. We identified that lack of funds, lack of time, and perceived satisfaction with the current level of cow comfort of the dairy herd were barriers to further improvement of cow comfort on a number of Canadian dairy farms.

ACKNOWLEDGMENTS

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REFERENCES


Université Laval. 2017. Personal communication. Québec, QC, Canada.


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<tr>
<th>Type of Change</th>
<th>Mean score</th>
<th>Max Score</th>
<th>Min Score</th>
<th>Median Score</th>
<th>Standard Deviation</th>
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<td>3</td>
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<td>4</td>
<td>4</td>
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<td>2</td>
<td>0.78</td>
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Note: Data collected through an online survey of 13 dairy welfare researchers
Table 3.2. Demographic results for 118 interviewed dairy producers by innovator, effective adopter, ineffective adopter and non-adopter

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<tr>
<th>Variable</th>
<th>Class</th>
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<th>Innovator</th>
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<td>Tie-stall</td>
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<td>60-100</td>
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<td>8</td>
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<td># employees(^a)</td>
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<td>16</td>
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Note: Data collected through phone interviews related to implementation of cow comfort practices
\(^a\)Employees or full time equivalent
Table 3.3 | Types of changes identified by 85 dairy producers by innovator, effective adopter, ineffective adopter and non-adopter

<table>
<thead>
<tr>
<th>Type of Change</th>
<th>Total</th>
<th>Innovator</th>
<th>Effective Adopter</th>
<th>Ineffective Adopter</th>
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<tr>
<td></td>
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<td>Stall design</td>
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<td>Increased stall</td>
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<td>dimensions</td>
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</tbody>
</table>

**Note:** Data collected through phone interviews related to implementation of cow comfort practices. Numbers within a row not sharing a lowercased italic differ significantly at the $P \leq 0.05$ level.
These factors were mentioned within “other” category.

Figure 3.1 | Histogram of types of barriers to adoption of cow comfort practices, identified by 118 interviewed dairy producers, by adopter type (effective adopters, ineffective adopters, non-adopters, and innovators)
CHAPTER 4

Building consensus on defining, measuring and achieving optimal dairy cow welfare – A Delphi approach

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ABSTRACT

The objectives of this study were to: 1) assess how dairy stakeholders in Canada define dairy cow welfare, 2) investigate which measures dairy stakeholders would use to assess dairy cow welfare, 3) assess how those stakeholders would score the importance of identified animal-based measures to assess dairy cow welfare and finally, 4) have dairy stakeholders come to a consensus on a set of realistic animal-based targets for optimal dairy cow welfare. Delphi methodology was used, including 3 rounds of online, iterative surveys. One-hundred and twenty-six novel participants opened at least one of the 3 survey rounds. Of these, 31 completed all 3 rounds. Participants ranged in age from 19 to 69 years old and represented a variety of dairy professions, including veterinarians, academics, industry support (e.g. sales, nutritionists.) and producers. A majority (72%) of participants from survey round 1 identified they would include a combination health, affective state, natural living, and production in their definition of dairy cow welfare. All participants responded that they would use animal-based measures to assess dairy cow welfare, with a majority (67%) including them in combination with resource- and management-based
measures. Twenty-eight different animal-based measures were identified, with lameness and BCS being the most frequently mentioned (74% and 71% of participants, respectively). Lameness, injuries, and broken tails were considered more important to achieve optimal welfare than to achieve optimal health or optimal production, and participants scored lameness and injuries as more important than other measures when targeting a herd with optimal welfare.

Consensus was achieved for 16 of 21 animal-based measures for a herd with realistically optimal dairy cow welfare. This study demonstrates that there is some cohesive understanding of dairy cow welfare among dairy stakeholders in Canada, and consensus can be achieved on animal-based gold standards for dairy cow welfare.

**Key words:** dairy cow, consensus, animal welfare, gold standard

**INTRODUCTION**

Animal welfare, and its assessment, has become a priority in dairy industries worldwide (Caporale et al., 2005; Mench, 2008; Ventura et al., 2014). The improvement in animal welfare on farm is becoming an increasingly strong driver for innovation in animal agriculture, yet the industry continues to struggle with addressing common welfare issues, such as lameness and injuries in dairy cows (Zaffino Heyerhoff et al., 2014; Solano et al., 2015; Nash et al., 2016). This struggle has spawned several animal welfare assessment and certification programs through government, industry and private sectors around the world (Mench, 2008; Botreau et al., 2009). These programs usually include minimum requirements or standards and recommended best practices. Depending on the purpose and ownership of the program, they can be associated with penalty or incentive structures for dairy farmers. Consensus on the definition of animal welfare, and how to best measure it on commercial farms, remains a debated subject among dairy
stakeholders, potentially limiting the benefit of these programs and the improvement of animal welfare overall (Mason and Mendl, 1993; Hewson, 2003a; Fisher, 2009). These differing viewpoints are captured within 3 categories that embody the value framework of animal welfare, first identified by Fraser et al. (1997): naturalness, biological functioning, and affective state.

Though these assessment initiatives may reduce the risk of serious animal welfare concerns on farm, they may also create complacency once farms achieve minimum standards. Recommended best practices are often included in welfare programs to help farmers go above and beyond the minimum requirements, but they tend to focus on resource and management factors rather than the animals themselves. Few incentive structures exist that focus farmers on achieving optimal animal welfare. The reason for this may again be that there is no clear consensus within the industry on what a herd with optimal welfare looks like. Two studies have recently explored stakeholders’ views on what an “ideal herd” would look like, with one study focusing on the views of stakeholders not directly involved in the dairy industry, such as consumers (Cardoso et al., 2016), and the other being inclusive of Brazilian farmers, farm advisors and lay citizen, but focusing on what the ideal dairy farm looks like in general, without specifically focusing on animal welfare (Cardoso et al., 2018). Animal welfare was reported to be a central theme in both of these studies. Whay et al., (2003) and Lievaart and Noordhuizen (2011) both used expert opinion to identify and prioritize measures of cattle welfare assessment, but no studies have been designed to build consensus around a set of realistic animal-based targets (or “gold standards”) that describe a dairy farm with optimal welfare.

The objectives of this study were to reach a broad array of dairy stakeholders in Canada to: 1) investigate how dairy stakeholders define dairy cow welfare, 2) identify which measures dairy stakeholders would use to assess dairy cow welfare, 3) score the importance of the animal-
based measures identified by participants to assess dairy cow welfare, and 4) come to a consensus on a set of realistic animal-based targets describing a herd with optimal dairy cow welfare.

MATERIALS AND METHODS

All methods and surveys used in this study were approved by the Institutional Human Research Ethics Boards at the University of Guelph (REB #13MY045).

Design

To reach the objectives of this study, the Delphi technique was implemented. The Delphi technique is a widely used and accepted method for utilizing the knowledge and building consensus amongst a group of industry experts (Linstone and Turoff, 1976). It involves using an iterative survey process where participants are provided with some background material related to the questions being asked, and after each round, participants are provided the anonymized results of the previous round before responding to the next. This allows participants to adjust their response based on other participants’ responses, eventually coming to a consensus (Hsu and Sandford, 2007).

Recruitment

A list of 248 dairy stakeholders known to be working within the Canadian dairy industry was collated by the authors. Stakeholders were defined as anyone working within the dairy industry for more than two years, this included veterinarians, dairy farmers, extension agents, researchers, nutritionists, dairy equipment sales representatives, etc. These contacts were sent an
e-mail outlining the purpose of the study and a link to a LimeSurvey page (https://www.limesurvey.org; accessed 2013) hosting the first online survey. Participants could opt not to answer any question and could go back to change the answer to a previous question; however, the survey had to be completed in one sitting. These professionals were also encouraged to distribute the link to anyone they knew who was working within the dairy industry.

The survey was also advertised in four industry publications across Canada: Progressive Dairymen, Milk Producer Magazine, Ontario Farmer, and Le Producteur de Lait Québécois, and at two large dairy expositions: Canada’s Outdoor Farmshow 2013 and Canadian Dairy XPO 2013.

Survey round 1

Survey round 1 was written in English, then translated to French. The translation was validated through back translation by an independent, fluently bilingual volunteer. This survey was available in French or English from September 5th to November 11th, 2013 (68 days). The first part of the survey consisted of 15 close-ended demographic questions relating to: name, gender, province, age, education, years of experience, expertise, and profession. This was followed by a close-ended question on which categories of biological functioning (separated into health and production), affective state, and natural living they would choose to include in their definition of dairy cow welfare, adapted from Fraser (2003). Participants were then asked close-ended questions on which types of measures they would use to assess dairy cow welfare from among animal-, resource- or management-based measures. Participants were given the option to elaborate on both of these questions in an open text box, with no character limit. They were then asked the following open-ended question: When considering only animal-based measures (e.g.
production, BCS, lying time, lameness, injuries), what would a herd of milking dairy cows with realistically optimal welfare look like? This portion of the study focused on animal-based measures because they are the most direct measurement of animal welfare (Hewson, 2003b; Whay et al., 2003). Participants were made aware that the purpose of this study was to develop a set of realistically optimal targets using animal-based measures in the preamble of each survey round, however it was not specifically mentioned that the goal was to come to a consensus. See Appendix II.i and II.ii for the full survey in French and English, including reference materials.

Survey round 2

All individuals on the recruitment list generated for survey round 1, along with all participants from survey round 1, were sent a link to a second survey on LimeSurvey (https://www.limesurvey.org; accessed 2014) via email. This survey was open from July 7th to August 26th, 2014 (51 days). Because only 4 French participants from survey round 1 stated they would not be able to complete a Survey in English, it was decided to only provide survey round 2 in English. This allowed for better consistency in responses as translation was not needed.

Responses from the question related to animal-based measures and the question related to the optimal dairy herd in survey round 1 were collated and summarized by individual animal-based measures identified. All animal-based measures identified by more than 5 participants were retained for survey round 2. The measure of broken tails was added, due to the lack of literature around this topic. Survey round 2 consisted of 65 questions, each related to a specific animal-based measure. For each animal-based measure, graphs of the corresponding herd-level industry distributions of the measure (such as a graph representing the distribution of lameness in Canadian herds) was presented if available from the academic literature or from industry publications. For those measures with historical prevalence and distributions available in the
literature, they were split into ranges based on their standard deviations. Responses from survey round 1 were then superimposed onto these graphs. An example of this is shown in Figure 4.1 for lameness.

For each animal-based measure, participants were presented with the related figure, including the responses from survey round 1 and industry data. Participants were then asked to indicate what their target would be for this measure for each of a herd with optimal welfare, then for a herd with optimal health, and finally for a herd with optimal production. For each of these animal-based measures, they were also asked to score the importance they would place on reaching this target using a Likert scale of 1 being very important to 5 being not important at all to meet their definition of a herd with optimal welfare, a herd with optimal health and a herd with optimal production, respectively. Upon completion of survey round 2, results were collated and summarized in graphical format using the same reference materials from the literature or industry publications as used in survey round 2. See Appendix II.iii for the full survey, including reference materials.

Survey round 3

All individuals from the recruitment list generated for survey round 1, along with all participants from survey rounds 1 and 2 were sent a link to survey round 3 on LimeSurvey by e-mail. This Survey was available for 50 days, from January 7th to February 26th 2015. For each animal-based measure, participants were presented with the related figure including the responses from survey round 2 (an example is included as Figure 4.2) and asked to indicate what their target would be for this measure. Unlike survey round 2, each question was close-ended, forcing participants to pick one of the ranges used to graphically represent the data.

All three surveys are available in the appendices for review and were pilot-tested on a
convenience sample of 5 individuals: 1 veterinarian, 2 dairy farmers, and 2 dairy researchers. See Appendix II.iv for the full survey, including reference materials.

**Data handling**

Data were downloaded from LimeSurvey as Excel 2010 files. Survey responses were only kept if the participant completed all three surveys. If the survey was completed twice by the same participant, only the first response was kept in the dataset. Open-ended responses to questions about animal-based measures for optimal herds in survey rounds 1 and 2 were converted into the categories used in survey round 3 (see Figures 4.6 to 4.9).

**Analysis**

The survey responses were imported into Microsoft Excel 2010 (Microsoft Corp., Washington, USA). The data were then exported into SAS (version 9.4, SAS Institute Inc., Cary, NC, USA). Results for the question related to the definition of animal welfare, and the question related to types of measures used were analysed for differences by age, profession, and gender using Fishers Exact test with associated odds ratios if in a 2x2 comparison or using the Pearson’s chi-square test if greater than a 2x2 comparison. If the Pearson chi-square test was significant, the comparison was broken down into smaller 2x2 tables and the Fishers Exact test was used. Means of the importance scores provided for each measure in survey round 2 were calculated and compared using the Wilcoxon signed-rank test. Differences in scores by profession and gender were tested first using the Kruskal-Wallis test using the Monte Carlo exact test function with 50,000 repetitions. If this test was significant, pairwise comparisons were done using the Wilcoxon Mann-Whitney 2 sample rank test with exact p-values. Consensus was deemed to have been achieved if 80% or more of participants fell within 2 adjacent ranges (Ulschack, 1983; Hsu
and Sandford, 2007). Variance was calculated for each measure in survey rounds 2 and 3 by assigning each category a number in order (e.g. 1-6% = 1, 7-15% = 2, 16-25% = 3 etc.). Variance was not calculated for survey round 1 due to the open-ended nature of the questions and variable responses, leading to too much missing data. Responses from round 3 were analyzed for differences by profession and gender first using the Kruskal-Wallis test using the Monte Carlo exact test function with 50,000 repetitions. If this test was significant, pairwise comparisons were done using the Wilcoxon Mann-Whitney 2 sample rank test with exact p-values. Significance was set at p ≤ 0.05 for all analyses.

The comments left by participants who opted to elaborate on their answers for the question related to the definition of dairy cow welfare and the measures used to assess dairy cow welfare in survey round 1 were imported into Microsoft Excel 2010 (Microsoft Corp., Washington, USA). Comments were read carefully, and codes were used to label different ideas and concepts. These codes were organized into topics based on the concepts represented and the frequency of their appearance. The quotes presented in the discussion section were selected to provide further evidence and explanations for the topics addressed and for the quantitative results of the survey and enable the voice of the participants to be heard.

RESULTS

Due to the methods used for survey distribution, it was not possible to calculate a percentage of response. However, 126 novel participants opened at least one of the 3 surveys. Of these, 31 completed all 3 rounds, which equates to a percent completion of 25%. Table 4.1 presents demographic results for participants in each round and for those who completed all 3 rounds.
**Definition of dairy cow welfare**

Figure 4.3 displays the results for the question related to the definition of dairy cow welfare. Consensus was achieved in survey round 1 with 125 participants. Eighty two percent of participants agreed on including natural living, health, and affective state in their definition of welfare but not production, and 72% of participants indicated that they would include a combination of all 4 categories of natural living, health, production, and affective state to define dairy cow welfare. Though consensus was achieved with a combination of factors, health was the most commonly included, and production the least. The only significant association identified between these responses and profession or gender were that men were 3.6 times more likely to include production in their definition than woman \((P=0.02)\). Due to the consensus achieved in round 1, this question was not retained in survey rounds 2 and 3.

Of the 125 participants who completed survey round 1, 39 opted to elaborate on their responses to the question related to the definition of dairy cow welfare. Table 4.2 presents the main topics described in these comments. The most frequently mentioned topic (10% of participants) was the concept that production is not a good indicator of welfare.

**Measures to assess dairy cow welfare**

Figure 4.4 demonstrates that consensus was also achieved in round 1 on which types of measures participants would use to assess dairy cow welfare. All participants agreed on using animal-based measures to assess dairy cow welfare. Of these, most participants (67%) indicated that they would use a combination of animal, resource and management-based measures to assess dairy cow welfare, with another 21% indicating they would only use animal-based measures. No differences were found among the responses by age or profession. Due to the consensus achieved in round 1, this question was not retained in survey rounds 2 and 3. Figure
4.5 illustrates the frequency of animal-based measures mentioned in survey round 1. Twenty-eight separate measures were identified, with lameness and BCS being mentioned the most frequently (74% and 71% of participants, respectively). Only the measures listed by 5 or more respondents were included in survey rounds 2 and 3 to minimize the length of the 2nd and 3rd surveys and thereby maximize response rate.

Of the 125 participants who completed survey round 1, 19 opted to elaborate on their responses to the question related to the definition of dairy cow welfare. Table 4.3 presents the main topics described in these comments. The most frequently mentioned topics (6% of participants) were the concepts that animal-based measures are the gold standard for measuring welfare, and that resource- and management-based measures are reflective of the cause of a problem and make good backup measures.

**Scoring the importance of each measure of welfare, production and health**

Targets identified by participants for optimal health and optimal production in survey 2 are not included in this manuscript due to excessive missing or incoherent data. Table 4.4 presents results for how participants scored the importance of animal-based measures when considering a herd with optimal welfare, health and production respectively. Lameness, injuries, and broken tails were considered more important for welfare than for health and production. SCC and calving age were considered more important for health than for welfare or production. Milk production and 21-day pregnancy rate were considered more important for production than for welfare or health. Finally, culling was considered less important for production than for welfare and health.

Participants scored lameness and injuries as more important to consider when trying to achieve a herd with optimal welfare compared to other measures, and milk production, 21-day
pregnancy rate and calving age as less important. They scored lameness as more important to consider when trying to achieve a herd with production compared to other measures, and broken tails as less important. Finally, participants scored lameness, SCC, morbidity, and injuries as more important to consider when trying to achieve a herd with optimal health, and again broken tails as less important.

When broken down by profession, only a few differences were identified. Veterinarians scored injuries on average 1.2 points lower than dairy farmers when considering optimal production on a scale of 1 to 5 ($P=0.05$). Veterinarians also scored hygiene on average 1.6 points lower than dairy farmers when considering optimal production ($p=0.04$). Dairy farmers scored longevity on average 1.0 point higher than academics and those from the support industry (industry) when considering optimal health ($P=0.03$). Somatic cell count (SCC) was scored on average 1.4 points lower by veterinarians and academics than by farmers and industry when considering optimal welfare ($P=0.03$) and was scored on average 1.2 points lower by veterinarians than by the rest when considering production ($P<0.01$). Culling was scored on average 1.5 points higher by industry than by the other professions when considering optimal production ($P=0.01$). Finally, industry scored broken tails an average of 0.7 points higher than the other professions when considering optimal welfare ($P=0.05$). No differences were identified for lameness, BCS, lying time, calving age, 21-day pregnancy rate, milk production or morbidity. No gender differences were identified.

**Developing a set of optimal targets for dairy cow welfare**

To develop targets, morbidity was broken down into mastitis, metabolic disease, reproductive disease, and foot disease. Injury was broken down into hock, knee, and neck injury. Cleanliness was broken down into leg, flank, and udder hygiene, and mortality was broken down
into voluntary and involuntary culling to account for all responses. Table 4.5 presents the definitions included for each of the 21 measures captured in survey rounds 2 and 3. Consensus was achieved for all but 5 measures. Figures 4.6 to 4.9 illustrate that according to participants, a herd with optimal welfare should have less than 20% lameness (100% of respondents agreed on this), less than 15% of their cows injured (90%, 94% and 87% agreed for hocks, knees and necks respectively), less than 36% of their cows under a body condition of 2.5/5 (87%), a herd average lying time of between 11.6 and 13.5 hours/day (90%), SCC less than 168 000 cells/mL (81%), an average herd lactation of 2.3 or more (90%), less than 15% of the cows dirty (84%, 96% and 97% agreed for leg, flank and udder respectively), an average milk production of over 31 l/cow/day (84%), an average calving age of between 20 and 25 months (90%), a voluntary culling rate between 6 and 25% (87%), an involuntary culling rate of less than 15% (87%) and fewer than 2% of their cows with broken tails (84%). Consensus was not achieved for 21-day pregnancy rate and for morbidity measures: reproductive, mastitis, metabolic and foot disease. These results are summarized in Table 4.6.

The results for variance in survey rounds 2 and 3 are presented in Table 4.6. Overall, variances were low, with all but 5 measures having a variance of <1.00 in survey round 3. The variance decreased, and so consensus improved from rounds 2 to 3 for hock injuries, BCS, lying time, SCC, leg cleanliness, flank cleanliness, calving age, reproductive disease, udder disease, metabolic disease, longevity, and broken tails. Variance increased, and so consensus decreased from rounds 2 to 3 for knee injuries, neck injuries, udder cleanliness, milk production, 21-day pregnancy rate, culling, and foot disease.

Responses from round 3 were assessed by profession and gender. The results broken down by profession are shown in Figures 4.10 and 4.11. Almost all females chose a range of 0-
5% knee injuries, while males were more variable \((P<0.01)\). Academics and veterinarians chose a range between 0-15% for neck injuries, while dairy farmers and industry personnel were more variable \((P=0.04)\). Almost all veterinarians, farmers and males agreed on a range of 6-36% for cow scoring under 2.5 BCS, while industry, academics and females showed less consensus, sometimes opting for a higher range \((P<0.01)\). Almost all academics agreed on a range of 0-5% for dirty flanks, whereas the other professions chose 0-15% \((P<0.01)\). Most academics chose the range 0-5% for dirty udders, whereas industry and farmers chose ranges between 0-15% and veterinarians were more variable \((P<0.01)\). Females achieved stronger consensus on a range from 2.3-2.6+ lactations for longevity, whereas males ranged from 1.9-2.6+ lactations \((P=0.04)\). Farmers chose ranges between 20-25 months for first calving age, industry chose 20-23 months and veterinarians and academics were more variable \((P<0.01)\). Most females agreed on a range of 0-5% for metabolic disease, whereas males were more variable \((P=0.02)\). All industry participants agreed on a range of 6-10% for foot disease, whereas the other professions were more variable \((P<0.01)\). Veterinarians were more variable in their ranges for voluntary culling than the rest of the professions \((P<0.01)\). Finally, all industry and veterinarians and most females chose a range of 0-2% for broken tails, and the rest ranged between 0-5% \((P<0.01)\). No significant differences were found for lameness, hock injuries, lying time, leg cleanliness, milk production, 21-day pregnancy rate, SCC, involuntary culling, reproductive disease, and mastitis.

**DISCUSSION**

The participants who responded to all three survey rounds represented a broad array of dairy industry stakeholders, including participants aged 19-69 years old, from western, central and eastern Canada, of each of 4 major professional categories: veterinarians, academics,
industry support personnel (e.g. nutritionists, salespeople, milk board employees), and dairy farmers.

This iterative survey-based study yielded some surprising results. The level of consensus achieved for both the definition of dairy cow welfare, and the types of measures used were surprising: lack of consensus around animal welfare is commonly highlighted as a limiting factor to improving animal welfare (Mason and Mendl, 1993; Hewson, 2003a). It appears that stakeholders in Canada chose to apply pieces from multiple categories or “schools of thought” (Duncan, 2005) related to animal welfare, including pieces from natural living, production and health (also known as biological functioning) and affective state (or “feelings”). This was best reflected by a comment left by a participant which was grouped in the topic “All categories should be included”:

“It’s a combination of all of these categories to define a cow with good welfare, you just can’t have one category without the others. Ex. By having good environments we improve the welfare, which makes a healthier, more productive cow. Unfortunately, barns can have some good producing cows, but fail in the environment provided, which makes her have poorer welfare, just because she’s producing, doesn’t mean she is living in a welfare-friendly world.”

Though consensus was achieved with a combination of factors, health was the most commonly included, and production the least, particularly by women. This may be associated with women being more empathetic towards livestock than men, and therefore more likely to prioritize health and welfare over production (Hill, 1993; Raussi, 2003). The concept of production not being a good indicator of welfare was also the most common concept presented in the comments section. Below are some quotes that illustrate why some participants opted for more than one factor.

“Production is not really related to welfare - high producing cows are often at greatest risk from production diseases like mastitis”
“A healthy dairy cow will be a productive dairy cow”

“Production only in the manner that if there is well below average production measures, and other welfare issues, I would include it as support of poor welfare. Affective states more as absence of pain rather than presence of joy.”

This last quote raises an interesting point. The concept of “joy” or positive welfare states have been increasingly discussed in animal welfare research (Broom, 1988; Mellor, 2015). Mellor and Beausoleil (2015) stated that more emphasis should be placed on incorporating positive welfare states when discussing animal welfare. Example of behaviours linked to positive welfare states include play, maternal care, sexual release, and positive social interactions (Yeates and Main, 2008; Held and Špinka, 2011; Mellor, 2015). None of these behaviours or any other measures directly related to positive welfare state were mentioned by participants in this study. Participants focused on minimizing negative welfare states, such as reducing lameness or illness, illustrating perhaps that the industry has not yet switched focus from the “minimum requirement” mentality for animal welfare.

The topic of subjectivity was also broached in the comments, explaining why some participants did not include affective state and natural living in their definitions:

“All of the above are associated with animal welfare, but it can only be measured by production and health response, as they are not subjective.”

When moving on to the types of measures identified by participants for assessing dairy cow welfare, the consensus achieved was also surprising. All participants stated they would use animal-based measures, even though these can be difficult to use (Hewson, 2003b). Below are some quotes illustrating the topic of animal-based measures as the gold standard for assessing dairy cow welfare:
“The cows don't lie - if management-based measures are appropriate then the results will show in the cows.”

“Welfare evaluation should be based on animal criteria. Facility and management decisions will be reflected in animal specific evaluation criteria, and should go to informing the industry of which methods and resources promote better (or worse) animal welfare.”

A majority of participants included animal-based measures in combination with other types of measures to best assess dairy cow welfare. This was reflected by the topic identified in the comments where participants stated that resource- and management-based measures are reflective of the cause of the problem and can make good backup measures to animal-based measures. The quote below illustrated this topic:

“The animal-based measures are the gold standard, but design type measures (facility and management) can be useful where the animal-based measures are difficult to collect and where the causal inferences are clear. For example, it is best to measure hock lesions directly, but in cases where this is impractical simply knowing if the farm uses deep bedding will explain a great deal of variation in lesion scores.”

These results suggest that participants prioritized the direct measurement of dairy cow welfare and validated the decision to focus on animal-based measures for developing a set of optimal targets for dairy cow welfare.

Lameness and BCS were the most frequently mentioned animal-based measures for assessing dairy cow welfare, similar to results found by Whay et al. (2003). This may be due in part to the fact that they were included in the example provided to help explain the question, however, lameness also received the highest mean importance score for welfare. Lameness was also identified as the leading disease issue by Canadian dairy producers who participated in the National Dairy Study undertaken between 2014 and 2015 (Bauman et al., 2016). Lameness and BCS were followed by injury, production and lying time measures, which were also in the top 20
measures identified by Whay et al. (2003). All five of these measures are commonly used measures of dairy cow comfort in on-farm assessment tools (von Keyserlingk et al., 2012; Vasseur et al., 2014).

The importance scores revealed some interesting results. The lowest mean scores received were for broken tails relative to health and production. This was the only measure that was forced into the survey due to the very limited research addressing it, which may explain this result. Broken tails and flight zone were the only measures included in the results that are a direct reflection of animal handling. Only 2 participants identified flight zone in survey round 1, and none identified broken tails. This may be because most participants did not consider the use of animal-based measures to assess handling, or that handling was not seen as a priority. This would be surprising considering the well-publicized Code of Practice for the Care and Handling of Dairy Cattle includes the term “Handling” in its title (DFC-NFACC, 2009). Another interesting result was that veterinarians scored injuries, hygiene, and SCC lower in importance for production than all other professions. It is well known that hygiene and SCC impact udder health, which impacts milk production (Harmon, 2010), so why veterinarians scored these factors as lower importance to production is unclear and warrants further investigation. Veterinarians are considered one of the most important advisors on farm for udder health, and have been found to struggle to communicate the economic impacts of udder health to farmers, making this result even more concerning (Lam et al., 2011).

Consensus was achieved for all measures except for 21-day pregnancy rate and morbidity measures: reproductive, mastitis, metabolic, and foot disease. This may be explained by the sheer variety of diseases and disorders that participants might include in these categories, making coming to a consensus near impossible. It must be noted that because we considered having
achieved consensus to be when 80% or more of participants fell within 2 back to back ranges, it is possible that some participants would not agree to the other range included. It must also be noted that this study did not capture the perspective of external stakeholders such as consumers and retailers. These targets are subject to the acceptance of these external stakeholders, and so further research including these groups would be beneficial as was done by Cardoso et al. (2016) but related to developing targets.

The ideal targets identified for measures such as injuries and lameness are not being met by most dairy producers today, however some are able to meet some of these individual targets (Zaffino Heyerhoff et al., 2014; Solano et al., 2015; Nash et al., 2016). This may demonstrate that the industry is in a point of transition, where internal dairy stakeholders are placing more importance on improving animal welfare, but the industry still has a way to go.

This study was subject to limitations common to survey-based research designs including non-response and voluntary response bias. The sample size was limited, only considering Canadian participants, and it was difficult to measure the level of non-response bias and voluntary bias. This may limit extrapolation of these results beyond the participants. Additionally, due to the sensitive subject matter, response, or social desirability bias may also be present, especially when considering the lack of anonymity required for this iterative survey process. Further extension work may be necessary to help the industry evolve its thinking around animal welfare. Further qualitative analysis may also allow for a deeper understanding of these expert perspectives, which was only gleamed in the present study.

CONCLUSION

Overall, this study achieved all 3 of its objectives, and demonstrated that stakeholders in
the Canadian dairy industry can achieve consensus on important dairy cow welfare issues: definition, assessment measurements, and optimal targets. Some differences existed between targets for optimal welfare, production and health, and between professional groups, but these differences were minimal and should not prevent the industry from moving forward to simultaneously optimize welfare, health and production. The results of this study highlighted that the dairy industry in Canada still emphasizes minimizing negative welfare states, rather than focusing on positive welfare states.

ACKNOWLEDGEMENTS

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REFERENCES


Table 4.1. Demographic results for participants in Survey rounds 1, 2 and 3.

<table>
<thead>
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<th># Participants</th>
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<th>Survey 3 (n=58)</th>
<th>Completed all 3 (n=31)</th>
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<td></td>
</tr>
<tr>
<td>19-29</td>
<td>22</td>
<td>6</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>30-39</td>
<td>44</td>
<td>16</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>40-49</td>
<td>21</td>
<td>11</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>50-59</td>
<td>36</td>
<td>18</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>60-69</td>
<td>12</td>
<td>8</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>95</td>
<td>46</td>
<td>42</td>
<td>24</td>
</tr>
<tr>
<td>Female</td>
<td>40</td>
<td>13</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>Province</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ontario</td>
<td>78</td>
<td>37</td>
<td>37</td>
<td>17</td>
</tr>
<tr>
<td>Quebec</td>
<td>21</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Alberta</td>
<td>7</td>
<td>2</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>10</td>
<td>7</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Manitoba</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>BC</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Maritimes</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Topic</td>
<td>Number of comments</td>
<td>Definition of welfare comments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>--------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production is not a good indicator of welfare</td>
<td>12</td>
<td>“An animal may have adequate welfare, and no &quot;production&quot;; conversely production is not a true measure of welfare. Child labourers may be very &quot;productive&quot; though their welfare is compromised”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific indicators are important for welfare</td>
<td>9</td>
<td>“From my many years of experiencing the industry on the different farms I have worked on I tend to see Nutrition as the major factor that effects and affects all of the above.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All categories should be included</td>
<td>7</td>
<td>“I believe a combination of those is important in order for the animal to have good welfare.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural living is an ambiguous concept</td>
<td>7</td>
<td>“Natural living is definitely an area of concern, but I am not confident that we truly understand what the needs or natural behaviours of dairy cattle are.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal don’t have human feelings</td>
<td>6</td>
<td>“To me there is nothing emotional about pain . . . it is very much a physical thing to be avoided in the provision of welfare. To call fear an &quot;emotion&quot; is also a bit of a stretch. I believe animals fear pain and avoid it if they can, but I hesitate to attribute emotions to dairy cattle. I doubt they love and hate and I am not convinced they have the mental capacity to decide about happiness and unhappiness etc. Sp &quot;affective state&quot; yes . . . &quot;feelings and emotions&quot; no!”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production is a good indicator of welfare</td>
<td>5</td>
<td>“Good production is an outcome, and key indicator, of having good animal welfare on-farm.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subjectivity should be taken into account</td>
<td>5</td>
<td>“All of the above are associated with animal welfare, but it can only be measured by production and health response, as they are not subjective.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfortable, healthy cows equal higher production</td>
<td>4</td>
<td>“the more comfortable and healthy the cow is, the better she will produce for you”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimizing pain is important for welfare</td>
<td>3</td>
<td>“The most important in my mind is absence of pain.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comment</td>
<td>Frequency</td>
<td>Quote</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-----------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health is a good indicator of welfare</td>
<td>3</td>
<td>“A farm with good dairy cow welfare will have minimal disease, below industry average treatment rates, morbidity and mortality rates and above average production.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time matters: short term vs long term</td>
<td>2</td>
<td>“I think there is also a time component related to it, were as for a short period of time one or more of those component cannot be reached for whatever reason but if it is on the improving path then ok.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health is not a good indicator of welfare</td>
<td>2</td>
<td>“I see production/health as separate issues that only serve to distract the welfarist.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous comments</td>
<td>6</td>
<td>“If we are to use the 5 freedoms as a guide for the determination of welfare, then the 4 states above reflect this accurately. I believe the 5 freedoms are a effective proxy for animal welfare.”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.3. Topics raised by participants when they elaborated on the question related to the measures they would select to assess dairy cow welfare in survey round 1 (n=19)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Number of comments</th>
<th>Example quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal-based measures are the gold standard</td>
<td>8</td>
<td>“The cows don't lie - if management-based measures are appropriate then the results will show in the cows.”</td>
</tr>
<tr>
<td>Resource- and management-based measures reflect the cause of the problem and are good backup measures</td>
<td>7</td>
<td>“Welfare evaluation should be based on animal criteria. Facility and management decisions will be reflected in animal specific evaluation criteria, and should go to informing the industry of which methods and resources promote better (or worse) animal welfare.”</td>
</tr>
<tr>
<td>Measures of human interaction are important</td>
<td>4</td>
<td>“human interaction: herds people should work with cows in a quiet, calm manner. Cows should not display fear of people.”</td>
</tr>
<tr>
<td>Many variables should be used</td>
<td>3</td>
<td>“Many more things to look at/record”</td>
</tr>
<tr>
<td>Other factors</td>
<td>3</td>
<td>“smaller herds tend to be better assessed for welfare and are easier to perform measurements on as stated above. Very large herds can also be monitored well, but it takes more people.”</td>
</tr>
<tr>
<td>Miscellaneous comments</td>
<td>4</td>
<td>“You have to make clear if you are interested in animal welfare or animal abuse. If we assume that animal abuse is a small to non existing problem and that we have organisations to deal with that we can focus on animal welfare.”</td>
</tr>
</tbody>
</table>
Table 4.4 Table illustrating the mean importance score for each measure (from 1 being not important to 5 being very important) for a herd with optimal welfare, production or health in survey round 2 by participants who completed all 3 surveys (n=31)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Welfare</th>
<th>Health</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Lameness</td>
<td>4.7</td>
<td>3.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Injuries</td>
<td>4.7</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td>BCS ≤ 2.5</td>
<td></td>
<td>3.9</td>
<td>1.0</td>
</tr>
<tr>
<td>Lying time</td>
<td>4.2</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>SCC</td>
<td>3.7</td>
<td>2.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Longevity</td>
<td>3.8</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Cleanliness</td>
<td>3.8</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Milk Production</td>
<td>3.1</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Calving age</td>
<td>3.2</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>21-day preg rate</td>
<td>3.1</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Culling</td>
<td>3.9</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Morbidity</td>
<td>4.2</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Broken tails</td>
<td>4.1</td>
<td>3.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

X Indicates significant difference between measures for each of welfare, health and production (comparison within column)

X Indicates significant difference between welfare, health and production for each measure (comparison within row)
Table 4.5 | Definitions provided for each of the 21 animal-based measures included in survey rounds 2 and 3

<table>
<thead>
<tr>
<th>Measure</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lameness</td>
<td>Percentage of the herd that is lame (identified through locomotion scoring)</td>
</tr>
<tr>
<td>Hock injuries</td>
<td>Percentage of the herd that is injured (defined as moderate to severe swelling, and/or lesion)</td>
</tr>
<tr>
<td>Knee injuries</td>
<td>Percentage of the herd that is injured (defined as moderate to severe swelling, and/or lesion)</td>
</tr>
<tr>
<td>Neck injuries</td>
<td>Percentage of the herd that is injured (defined as moderate to severe swelling, and/or lesion)</td>
</tr>
<tr>
<td>BCS ≤ 2.5</td>
<td>Percentage of the herd with a body condition score of 2.5 or lower (scale of 1 to 5)</td>
</tr>
<tr>
<td>Lying time</td>
<td>Average herd lying time (h/d)</td>
</tr>
<tr>
<td>SCC</td>
<td>Average bulk tank SCC</td>
</tr>
<tr>
<td>Leg cleanliness</td>
<td>Percentage of the herd that is dirty (defined as 50% or more of the area being contaminated)</td>
</tr>
<tr>
<td>Flank cleanliness</td>
<td>Percentage of the herd that is dirty (defined as 50% or more of the area being contaminated)</td>
</tr>
<tr>
<td>Udder cleanliness</td>
<td>Percentage of the herd that is dirty (defined as 50% or more of the area being contaminated)</td>
</tr>
<tr>
<td>Average milk production</td>
<td>Herd average milk production in litres/cow/day</td>
</tr>
<tr>
<td>Calving age</td>
<td>Average age of first calving</td>
</tr>
<tr>
<td>21-day preg rate</td>
<td>Average 21-day pregnancy rate</td>
</tr>
<tr>
<td>Longevity</td>
<td>Average longevity (number of lactations)</td>
</tr>
<tr>
<td>Voluntary culling</td>
<td>Percentage of the herd voluntarily culled over 1 year</td>
</tr>
<tr>
<td>Involuntary culling</td>
<td>Percentage of the herd involuntarily culled over 1 year</td>
</tr>
<tr>
<td>Reproductive disease</td>
<td>Percentage of the herd diseased over 1 year</td>
</tr>
<tr>
<td>Mastitis</td>
<td>Percentage of the herd diseased over 1 year</td>
</tr>
<tr>
<td>Metabolic disease</td>
<td>Percentage of the herd diseased over 1 year</td>
</tr>
<tr>
<td>Foot disease</td>
<td>Percentage of the herd diseased over 1 year</td>
</tr>
<tr>
<td>Broken tails</td>
<td>Percentage of the herd with broken tails</td>
</tr>
</tbody>
</table>
Table 4.6: Variance within survey rounds 2 and 3, and summary of the ranges for which consensus was achieved in survey round 3 (n=31)

<table>
<thead>
<tr>
<th></th>
<th>Round 2</th>
<th>Round 3</th>
<th>Achieved Consensus (% of participants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lameness</td>
<td>0.16</td>
<td>0.17</td>
<td>&lt;20% (100%)</td>
</tr>
<tr>
<td>Hock injuries</td>
<td>0.90</td>
<td>0.44</td>
<td>&lt;15% (90%)</td>
</tr>
<tr>
<td>Knee injuries</td>
<td>0.52</td>
<td>0.37</td>
<td>&lt;15% (94%)</td>
</tr>
<tr>
<td>Neck injuries</td>
<td>0.17</td>
<td>0.43</td>
<td>&lt;15% (87%)</td>
</tr>
<tr>
<td>BCS ≤ 2.5</td>
<td>0.27</td>
<td>0.19</td>
<td>&lt;36% (87%)</td>
</tr>
<tr>
<td>Lying time</td>
<td>0.70</td>
<td>0.57</td>
<td>11.6-13.5h/d (90%)</td>
</tr>
<tr>
<td>SCC</td>
<td>1.08</td>
<td>0.94</td>
<td>&lt;168 000 (81%)</td>
</tr>
<tr>
<td>Leg cleanliness</td>
<td>0.84</td>
<td>0.58</td>
<td>&lt;15% (84%)</td>
</tr>
<tr>
<td>Flank cleanliness</td>
<td>0.73</td>
<td>0.38</td>
<td>&lt;15% (96%)</td>
</tr>
<tr>
<td>Udder cleanliness</td>
<td>0.55</td>
<td>0.50</td>
<td>&lt;15% (97%)</td>
</tr>
<tr>
<td>Average milk production</td>
<td>1.35</td>
<td>1.45</td>
<td>&gt;31 l/c/d (84%)</td>
</tr>
<tr>
<td>Calving age</td>
<td>0.83</td>
<td>0.52</td>
<td>20-25mo (90%)</td>
</tr>
<tr>
<td>21-day preg rate</td>
<td>0.69</td>
<td>1.05</td>
<td>-</td>
</tr>
<tr>
<td>Longevity</td>
<td>0.77</td>
<td>0.51</td>
<td>&gt;2.3 lact (90%)</td>
</tr>
<tr>
<td>Voluntary culling</td>
<td>0.31</td>
<td>0.51</td>
<td>6-25% (87%)</td>
</tr>
<tr>
<td>Involuntary culling</td>
<td>0.46</td>
<td>0.54</td>
<td>&lt;15% (87%)</td>
</tr>
<tr>
<td>Reproductive disease</td>
<td>1.84</td>
<td>1.04</td>
<td>-</td>
</tr>
<tr>
<td>Mastitis</td>
<td>1.65</td>
<td>0.97</td>
<td>-</td>
</tr>
<tr>
<td>Metabolic disease</td>
<td>1.80</td>
<td>1.31</td>
<td>-</td>
</tr>
<tr>
<td>Foot disease</td>
<td>2.69</td>
<td>1.72</td>
<td>-</td>
</tr>
<tr>
<td>Broken tails</td>
<td>0.36</td>
<td>0.1</td>
<td>&lt;2% (84%)</td>
</tr>
</tbody>
</table>
Figure 4. 1. Example of the figures presented to participants in survey round 2 to illustrate prevalence of lameness and responses from the previous round.
Figure 4.2. Example of the graphs presented to participants in survey round 3 to illustrate prevalence of lameness and responses from previous rounds 1 and 2.
Figure 4.3 Venn diagram showing which categories of natural living, health, production and affective state participants included when defining dairy cow welfare (n=125). Adapted from Appleby, M. C. (1999).
Figure 4.4 Venn diagram showing the types of measures participants identified they would use to assess dairy cow welfare in survey round 1 (n=125).
Figure 4.5. Animal-based measures identified to assess animal welfare mentioned by participants in survey round 1 (n=125)
Figure 4.6. Responses by participants for each of 3 rounds of surveys for injuries and hygiene (n=31)
Figure 4. 7. Responses by participants for each of 3 rounds of surveys for lameness, BCS, lying time, culling and broken tails (n=31)
Figure 4.8 Responses by participants for each of 3 rounds of surveys for milk production, SCC, longevity, calving age and pregnancy rate (n=31)
Figure 4.9: Responses by participants for each of 3 rounds of surveys for morbidity related measures (n=31)
Figure 4. 10. Responses by participants for each animal-based measure from survey round 3 by profession (n=31)
Figure 4.11. Responses by participants for each animal-based measure from survey round 3 by profession (n=31)
CHAPTER 5

Key findings, limitations and implications

Animal welfare within food production systems is of growing concern worldwide. Though the field of animal welfare science is expanding every year, we are just scratching the surface in understanding how to optimize the care and handling of farm animals.

The dairy industry has historically been under less scrutiny regarding animal welfare concerns compared to other livestock industries, such as swine and poultry (Stevenson, 2014). However, within the last 10 years, a number of animal rights groups have turned their attention to dairy production and have released video footage depicting dairy farms across North America and Europe undertaking less than ideal care and handling practices. The objective of this thesis was to expand our understanding of dairy cow welfare in Canada by assessing the level of care of dairy cows housed in tiestall systems in Canada, improving our understanding of the implementation of practices to improve dairy cow welfare on dairy farms in Canada, and building consensus among dairy industry stakeholders on the definition, assessment and targets for optimal dairy cow welfare.

KEY FINDINGS

The work described in Chapter 2 of this thesis demonstrated that hock and knee injuries were prevalent in dairy cows housed in tiestall systems in Canada (56% and 43% of cows in herds had these injuries, respectively). Certain housing and management
practices of dairy cattle in tiestall systems in Canada were associated with a greater probability of those cows having leg injuries. For hock injuries, those factors were wide stalls for wide cows (≥80cm) or narrow stalls for narrow cows (<80cm). Further, forward tie rail positions, harder stall bases, longer chain lengths, and older stall base were associated with greater prevalence of hock injuries. For knee injuries the associated factors were narrower stall width, shorter chain length, province, harder stall bases, and shorter bed length. Other researchers have demonstrated similar results for freestall housed dairy cattle in Canada (Zaffino Heyerhoff et al., 2014), the USA (Lombard et al., 2010; von Keyserlingk et al., 2012), the UK (Potterton et al., 2011) and Norway (Kielland et al., 2009). This body of research has allowed the dairy industry to come to certain conclusions regarding factors that likely impact dairy cow welfare: to minimize the occurrence of leg injuries: cows should be provided with a comfortable space to lay down, stand up and rest. The surface of this space should be soft, and the dimensions should be large enough to accommodate the size of the cow. The progression and healing time of leg injuries is unknown in dairy cattle, thus further work is needed in this area. Overall, this initial work made it clear that improvements could be made to reduce leg injuries on dairy cows housed in tiestall systems in Canada and improve overall dairy cow welfare.

The above study also included completing a thorough dairy cow welfare assessments of participating farms and providing a report to producers highlighting areas in which they met certain aspects of the Code of Practice for the Care and Handling of Dairy Cattle (2009), and areas where they fell short. The aim of this intervention was to motivate producers to improve areas in which they were assessed as weak. It was unclear
whether or not the feedback provided to producers in this study on the level of welfare of their cows was being used to make changes to improve dairy cow welfare on these farms. Nor was it clear how difficult it might be for producers to make changes to their existing management and housing practices to improve cow welfare.

The work described in Chapter 3 of this thesis was the first, to the authors’ knowledge, to explore these areas in the context of dairy cow welfare in Canada. Phone interviews were undertaken one year after the intervention to determine whether changes were made. At the same time, a survey of dairy experts was undertaken to gather their opinions regarding how difficult making some of these changes for producers might be. A majority (72%) of the 118 producers who took part in this follow-up study (Chapter 3) responded that they did make changes to improve cow welfare on their farms, and most noted that the intervention was a contributing factor to making these changes, though a control group was not included in this study, limiting the interpretation of this result. Of the 118 producers who took part in this follow-up, 17% made changes in areas they were already strong in, and not in areas in which they did not meet standards set out by the Code of Practice for the Care and Handling of Dairy Cattle. These were considered “ineffective adopters”, and they did not necessarily improve the welfare of their dairy cows.

The most common types of changes that were implemented were stall management changes. These types of changes were considered easier than stall design changes by a group of dairy experts made up of dairy veterinarians and dairy researchers. This may explain why they were the most commonly implemented. Furthermore, stall management (including bedding type, quantity and quality) have been a focus of dairy
welfare research over the years (e.g. Tucker and Weary, 2004; Drissler et al., 2005; Fregonesi et al., 2007; Norring et al., 2008, 2010; Boone et al., 2010; Husfeldt and Endres, 2012, etc.). This focus and subsequent presentation of related information at meetings and in farm press publications may have also influenced producers.

The barriers that were most frequently identified by producers in Chapter 3 to explain why further changes were not made were lack of funds, lack of time, and being satisfied with the level of welfare of their cows. Lack of funds and lack of time have also been reported as barriers to reducing mastitis (Jansen et al., 2009), lameness (Leach et al., 2010) and Johne’s disease (Roche, 2014) in dairy cattle. Already being satisfied with the level of welfare is a barrier that has not been well explored, however, this may be tied to a phenomenon termed “Barn Blindness” where producers who see their cows everyday may normalize some of their weak areas (Croyle et al., submitted). This is supported by the large difference between producer estimates and the observed prevalence of lameness reported by Espejo et al. (2006) and Croyle et al. (2019 - submitted), where producers underestimated the level of lameness in their herds. The fifth, sixth and seventh most commonly mentioned barriers were that changes were too complex, they were not profitable or there was no perceived benefit, respectively.

The lack of agreement in the industry around defining, measuring and optimizing animal welfare was explored in the final research chapter of this thesis. Chapter 4 described the iterative Delphi survey methodology used to build consensus amongst dairy stakeholders in Canada around the definition, measurement and gold standards for dairy cow welfare. We reported a surprising level of consensus around defining and measuring dairy cow welfare in the first survey round, with most participants (72%) including a
combination of natural living, affective state, production, and health factors in their definition of dairy cow welfare. Production was the least frequently selected, with 10% of participants stating it was not a good indicator of welfare. The subjectivity of measuring affective state and natural living was also mentioned, causing certain participants not to select these categories.

All participants stated they would use animal-based measures to assess dairy cow welfare, and 67% stated they would include these measures in combination with resource- and management-based measures. Some participants (6%) stated that animal-based measures were the gold standard for measuring dairy cow welfare, but that resource- and management-based measures could be used as backup measures.

Participants in Chapter 4 were able to reach consensus on 16 of the 21 animal-based targets identified for optimal dairy cow welfare. According to participants, a herd with optimal welfare should have less than 20% lameness (100% of respondents agreed on this), less than 15% of their cows injured (90%, 94% and 87% agreed for hocks, knees and necks, respectively), less than 36% of their cows under a body condition of 2.5/5 (87%), a herd average lying time of between 11.6 and 13.5 h/d (90%), SCC less than 168,000 cells/mL (81%), an average herd lactation of 2.3 or more (90%), less than 15% of the cows dirty (84%, 96% and 97% agreed for leg, flank and udder, respectively), an average milk production of over 31 L/cow/day (84%), an average calving age between 20 and 25 months (90%), a voluntary culling rate between 6 and 25% (87%), an involuntary culling rate of less than 15% (87%), and fewer than 2% of their cows with broken tails (84%). Consensus was not achieved for 21-day pregnancy rate or for morbidity measures: reproductive, mastitis, metabolic and foot disease. Interestingly, no participants identified
measures of positive welfare states such as play behaviours, and few identified potential indicators of poor handling such as flight distance. This may be reflective of a limited view of animal welfare assessment in the Canadian dairy industry, which will need to evolve to keep up with growing public interest and attention from animal rights groups, particularly in these areas of handling and positive welfare states.

LIMITATIONS AND FUTURE WORK

The research described in Chapter 2 was cross-sectional in design, limiting the ability to make conclusive statements about potential causal relationships, however these associations are supported by some longitudinal studies that more strongly support a causal effect of stall surfaces and stall dimensions on injuries in dairy cattle (Rushen et al., 2007; Norring et al., 2008). Further longitudinal research focusing on the progression and healing of dairy cow injuries would aid in our understanding of how to minimize their occurrence on farms in Canada.

Chapter 3 of this thesis is limited by biases common to survey-based research including non-response bias, voluntary response bias and social desirability bias. Social desirability bias is of particular concern given the sensitive nature of the subject of animal welfare. This study would benefit from an on-farm follow up to assess the implementation of these changes in person. It must also be noted that this study lacked a control group, which limits the interpretation of how well the intervention motivated the implementation of changes to improve dairy cow welfare on-farm.

The intervention described in Chapters 2 and assessed in Chapter 3 included 2 visits to the farm and a top-down approach to extension (also termed Diffusion of
Innovation Model), where researchers or experts provide information to producers to incite change (Rogers, 1963). This approach assumes that more progressive producers will adopt changes faster, and that these producers will eventually stimulate less progressive producers to change in time. This assumption has been challenged, particularly for complex issues such as disease reduction (Roche, 2014). This top-down approach has also been thought to widen the perceived social gap between academia and producers (Röling et al., 1976) and under-value the knowledge and experience that producers bring to the discussion (Chambers, 1984), which is theorized to limit the success of this approach. It also assumes that researchers or experts provide a cohesive view on the solution to a particular challenge, which is often not the case, particularly around animal welfare (Cantrell et al., 2013). A more successful approach to motivate effective changes to improve dairy cow welfare might therefore be to explore bottom-up extension efforts, also called “farmer first” or producer-centered extension (Chambers, 1984; Roche, 2014). This approach focuses on understanding the producers first, having them become part of the solution identification process and having them actively learn from each other, as was tested by Roche (2014) to improve management of Johne’s disease. The ineffective and non-adopters identified in Chapter 3 of this thesis may have more greatly benefited from this type of extension rather than the top-down approach that was used. I therefore suggest that further bottoms-up extension efforts be explored to understand which of these approaches best motivate producers and improve dairy cow welfare.

The Delphi study described in Chapter 4 of this thesis was also limited by biases common to survey-based research including non-response bias, voluntary response bias
and social desirability bias. This study was the first of its kind in Canada and was successful at identifying or building consensus, however our understanding of why participants responded in the way they did remains limited. The open-ended comments left by some participants and included in the Discussion of this chapter provided further insight into this area, however a deeper exploration of the perceptions of dairy stakeholders on the definition and assessment of dairy cow welfare, using qualitative methods such as focus groups and interviews may allow for a more thorough understanding in how and why dairy stakeholders perceptions do or don’t differ.

The Delphi study in this thesis was the first step in developing a set of gold standards for animal welfare. This study was limited to internal dairy stakeholders such as producers and veterinarians and did not include external dairy stakeholders such as consumers and retailers. A next step in this work would be to explore how the targets developed in this study hold up to scrutiny from these external stakeholder groups. Social license is an integral part of animal agriculture (Williams and Martin, 2011), and so without acceptance from external stakeholders (and therefore without social license), these animal welfare targets may be of limited use.

**IMPLICATIONS**

The research described in this thesis resulted in a number of tangible outcomes. First, the SOPs developed and validated for the study described in Chapter 2 were used as the basis for the SOPs used in the proAction Animal Care Assessment program (www.dairyfarmers.ca/proaction#animal-care), now mandatory for all dairy farms in Canada. Second, the results of this study informed the proAction Animal Care
committees on the level of injuries of cows housed in tiestall systems in Canada, aiding them in prioritizing which animal-based measures to assess within the program. The results of this study also reinforced the importance of providing cows with a comfortable place to rest.

The research presented in Chapter 3 of this thesis demonstrated that a majority of producers implemented changes to improve dairy cow welfare following an intervention, however some of these changes were not targeted to areas that needed improvement. This study was the first to categorize producers based on the types of changes that were made relative to their weaknesses, using the terms effective and ineffective adopters. This research also provided insights into some of the barriers producers perceived to further improvement. These results should be used to inform the industry on how to build extension efforts, tools, technologies and products that help producers make more effective improvement to animal welfare and reduce the barriers they perceive to do so.

Finally, the research presented in Chapter 4 demonstrated that internal dairy stakeholders can agree on how to define and measure dairy cow welfare and can come to a consensus on most animal-based targets for a herd with optimal welfare. However, this study also highlighted the focus these stakeholders place on minimizing negative welfare states, rather than providing opportunities for positive ones. This focus will need to shift if the industry wants to optimize animal welfare and keep up with growing public expectations.

In conclusion, the research covered in this research made it clear that the Canadian dairy industry is working through challenges in animal welfare, such as high levels of hock and knee injuries. However, a majority of producers made changes to try
and address these challenges once being made aware of them. This demonstrated that there is motivation to improve. A number of barriers were identified, which are preventing producers from making further changes, one being that recommendations were too complex. The final study in this thesis demonstrated that the industry is able to come to a consensus on animal welfare issues. Moving forward, the industry needs to use this knowledge to come to a consensus on how to best help producers improve animal welfare in a clear, simple way. The Canadian dairy industry would benefit from having more stakeholders with specialized training in animal welfare to help drive this process.
REFERENCES


Zaffino Heyerhoff, J. C., S. J. LeBlanc, T. J. DeVries, C. G. R. Nash, J. Gibbons, K.
# APPENDIX I

## I.i DIFFICULTY SURVEY FOR CHAPTER 3

Your Name:

Please provide a difficulty rating for each type of change, including the 3 overall categories of changes (stall design, stall management and hoof management). This rating should take into consideration cost, labour and effort to make the change.

<table>
<thead>
<tr>
<th>It is_______ to change…</th>
<th>Very easy</th>
<th>Easy</th>
<th>Moderately difficult</th>
<th>Difficult</th>
<th>Very difficult</th>
<th>COMMENTS (optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stall design (overall category)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck rail placement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stall dimensions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lunge space</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stall base</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building a new barn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stall management (overall category)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amount of bedding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of bedding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stall cleaning routine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoof management (overall category)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trimming frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Footbath frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lameness monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record keeping for foot health</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
I.ii ALBERTA QUESTIONNAIRE FOR CHAPTER 3

You are:  □ Full owner  □ Part owner  □ Employee responsible for herd
Are you the primary decision maker? □ Yes □ No
Age:  □ Under 35  □ 35 – 45  □ 46 – 56  □ Over 56  Gender:  □ Male □ Female
Education:  □ Less than high school  □ High school  □ College/University  □ Post Graduate
Years of study in agriculture:
No. of milking cows:  No. of dry cows:  Average production (kg/cow/day):
Milking frequency (free stalls only):  __________ times a day
Who milks the cows? □ Owner  □ Employee  □ Family

How many employees work at the farm?  __________ employees

1. Have you discussed the results you received from our original cow comfort report with your advisor?
   □ Yes  □ No

2. Did the cow comfort results you received for your herd correspond with your previous thoughts on the comfort of your herd?
   □ Yes  □ No

3. Did you find the original cow comfort report useful
   □ Yes. Why?
      ___ It helped me identify my strengths and weaknesses
      ___ It encouraged me to keep working
      ___ Other:

   □ No. Why?
      ___ I already had all the information you provided
      ___ I did not find the information very clear
      ___ Other:

   According to you, was the original report clear and easy to understand? □ Yes □ No
   If not, why?

5. What were the advantages of the original report that was provided to you?
   a □ It helped me identify my strengths and weaknesses
   b □ The information was clear and precise
   c □ The information was backed up by the Codes of Practice
   d □ None of the above
   e □ Other:

6. What were the disadvantages of the original report that was provided to you?
   a □ The information was not clear
b □ The results were clear, but I don’t know what to do to improve (recommendations were lacking or unclear)
c □ It did not do a good job of representing the level of cow comfort of my herd
d □ None of the above
e □ Other:

7. Overall, if you had to give the original report a mark out of 10, what would it be? ___ /10

8. Would you be willing to participate in a focus group (5-6 producers) on improving outreach/extension programs? □ Yes □ No

9 Now that we have given you the report on the 13 critical areas of cow comfort: have you made changes as a result of the assessment?

<table>
<thead>
<tr>
<th>SECTION 1 – ACCOMMODATION AND HOUSING</th>
<th>Aspect of cow comfort</th>
<th>Made changes</th>
<th>If yes, what changes were made? If no, why not?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a. Stall design (e.g., lying time, injuries and stall configuration)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Space allowance (FS only) (e.g., stocking density, feeding space)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Stall management (e.g., type, quantity and wetness of bedding/flooring, cleaning management)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Pen management (FS only) (e.g., standing on concrete, slipperiness and cleaning management)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. Milking parlor, holding pens and transfer alleys to the milking parlor (FS only)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>
10.) For the changes you made on your farm, was the report the only thing informing your decision?
   a □ Yes
   b □ No, the discussion with the researchers helped
   c □ No, the codes of practice helped
   d □ No. Other :

11. If you had made changes on your farm but not because of the assessment, what had most influenced you to make the changes?

12. There can be many reasons why you may not have made many of the recommended changes related to the cow comfort report from your farm. In the following list, please pick out which best represent your situation:
   a □ I don’t see the long-term benefits
   b □ The complexity of the recommendations was too high
   c □ Lack of working help
d  □ I was indifferent about the recommendations
e  □ The recommendations squelched my motivation
f  □ Lack of funds
g  □ The recommended changes would not make my farm more profitable
h  □ I am already satisfied with the level of comfort of my cows
i  □ I don’t know anyone else who follows those recommendations
j  □ Lack of time
k  □ Lack of information
l  □ I don’t remember the report or the weaknesses identified
m  □ None of the above
n  □ Other:

13. Are you planning on making any more changes in the future?
   □ Yes  □ No  □ I don’t know
If yes, what changes do you have planned
Hello, my name is Clem Nash from the University of Guelph – I am part of the cow comfort and longevity project you participated in last year. I’m calling to follow-up on the new benchmarking report we sent to you recently that compared your herd to the other herds visited in Ontario. Have you had a chance to look at it?

-If yes: Would you have 20 minutes to discuss your results and provide some feedback on the report?
-If no: I have the report here and can verbally present you with the results, or give you a call back once you’ve had the chance to look at the report…

Thank you very much for agreeing to chat with me.

This follow-up interview is designed to gain a better understanding of what farmers
thought of the project and of cow comfort in general. This interview should only take about 20 minutes to complete. I would like to highlight that there are no right or wrong answers; we are just trying to gather your thoughts.

With your permission, this interview will be recorded in order to make sure we don’t miss anything. We will only ask you for your first name during the recording in order to maximize confidentiality. All information collected from this session will remain strictly confidential and you have the right to decline any questions you do not feel comfortable answering.

If you agree to continue with this interview, we will now get started with a few general questions...1. **You are:**

- O Full owner
- O Part owner
- O Employee responsible for herd

2. **Your age**

3. **Your education**

4. **Years of study in agriculture:**

5. **Total number of cows (lactating + dry):**

6. **Average production (kg/cow):**

7. **How long have you had the farm?**

8. **Number of permanent employees (including family):**

9. **Do you currently have a successor identified for your farm?**

   - O Yes
   - O No
   - O Not sure

10. **Do you participate in dairy extension activities like tradeshows, conferences or provincial meetings?**
11. How do you perceive the short-term future of dairy farming?
- Very good
- Good
- Moderate, future uncertain
- Bad

12. How do you see your farm evolving in the next 10 years?
- It will grow
- It will stay the same
- It will shrink
- It may no longer be in operation

13. From the following statements, which best represents your view?

- Cow comfort represents part of the image my business portrays; therefore it is an obligation.
- Cow comfort means extra time and expense, therefore it is a constraint for my business.
- Cow comfort is an important and unavoidable concern for farmers, it is part of my moral and ethical values.
- Cow comfort is a way to increase the long-term marketability of my business

14. By order of importance, which are the 3 most important sources of information when it comes to your dairy herd? (1 to 3, 1 being the most important)
- Veterinarian
- Media (radio, TV, newspaper, magazines)
- Internet
- Other Producers
- Dairy advisors (please specify: ____________________)
- Feed companies
- Family and friends
15. Who is your principal dairy advisor?

- Canwest DHI
- OMAFRA
- Feed company
- Veterinarian
- Other: ____________________

16. We would like to know what kind of relationship you have with the advisor you just named. Here are 4 statements, please identify which corresponds best to your situation:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>A very good relationship, I put all my trust in him, and if at all possible I apply his advice to my farm</td>
<td></td>
</tr>
<tr>
<td>A good relationship, I trust him. However sometimes I disagree with his advice</td>
<td></td>
</tr>
<tr>
<td>A neutral relationship. I know my cows very well and I often opt for a more personal fix</td>
<td></td>
</tr>
<tr>
<td>An avoidance relationship, I only call for his assistance in urgent situations.</td>
<td></td>
</tr>
</tbody>
</table>

17. What are the key elements that ensure the comfort of the cows in your herd and you are very cautious to monitor?

- Facility design: ____________________________________________
- Management: _______________________________________________
- Health: ___________________________________________________
- Other: ____________________________________________________

18. Which elements do you think need to be currently improved on your farm to maximize the comfort of your cows?

- Facility design: ____________________________________________
- Management: _______________________________________________
- Health: ___________________________________________________
- Other: ____________________________________________________

19. What has prevented you from making these improvements?
I don’t see the long-term benefits

- Lack of working help
- Lack of funds
- They would not make my farm more profitable
- I’m already satisfied with the level of comfort of my cows
- Lack of time
- Lack of information (I don’t know how)
- Other: __________________________________________________________

I will now ask you a few questions about the original cow comfort report we provided you during our visit to your farm last year.

20. Have you discussed the results you received from our original cow comfort report with your advisor?
   - yes.
   - No

21. Did the cow comfort results you received for your herd correspond with your previous thoughts on the comfort of your herd?
   - Yes
   - No

21. Did you find the original cow comfort report useful?
   - Yes. Why?
     ___ It helped me identify my strengths and weaknesses
     ___ It encouraged me to keep working
   Other : _______________________________________________________________

   - No. Why?
     ___ I already had all the information you provided
     ___ I did not find the information very clear
   Other : _______________________________________________________________
22. According to you, was the original report clear and easy to understand?

- Yes
- No, why?

________________________________________________________________________

23. What were the advantages of the original report that was provided to you?

- It helped me identify my strengths and weaknesses
- The information was clear and precise
- The information was backed up by the Codes of Practice
- None
- Other: _________________________________________________________________

24. What were the disadvantages of the original report that was provided to you?

- The information was not clear
- The results were clear, but I don’t know what to do to improve (recommendations were lacking or unclear)
- It did not do a good job of representing the level of cow comfort of my herd
- None
- Other: __________________________________________________________________

25. Overall, if you had to give the original report a mark out of 10, what would it be?

________

26. Have you made any changes to your farm’s facilities or management related to cow comfort since our visit?

- Yes (see question __)
- No (See question __)
If yes, what have you changed?
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

27. For the changes you made on your farm, did your original cow comfort report play an important role in deciding on these changes related to cow comfort?

○ Yes
○ No

If yes, was the report the only thing informing your decision?

○ yes
○ No, the discussion with the researchers helped
○ No, the codes of practice helped
○ No, other : ________________________________

If not, what had most influenced you to make the change?

28. There can be many reasons why you may not have made many of the recommended changes related to the cow comfort report from your farm. In the following list, please pick out which best represent your situation:

○ A) I don’t see the long-term benefits
○ B) The complexity of the recommendations was too high
○ C) Lack of working help
○ D) I was indifferent about the recommendations
○ E) The recommendations squelched my motivation
○ F) Lack of funds
○ G) The recommended changes would not make my farm more profitable
○ H) I am already satisfied with the level of comfort of my cows
○ I) I don’t know anyone else who follows those recommendations
29. Are you planning on making any more changes in the future?

O yes, which ones?

_________________________________________________________________________
_________________________________________________________________________

O No

O I don’t know

Comments: _________________________________________________________________

I will now ask you a few questions about the new benchmarking report I sent you recently that compares you to the other herds we visited in Ontario.

30. Did you find the new benchmarking cow comfort report useful?

O Yes. Why?
   ___ It helped me identify my strengths and weaknesses
   ___ It encouraged me to keep working
Other: _________________________________________________________________

O No. Why?
   ___ I already had all the information you provided
   ___ I did not find the information very clear
Other: _________________________________________________________________

31. According to you, was the benchmarking report clear and easy to understand?

O Yes

O No, why?
32. What were the advantages of the benchmarking report that was provided to you?

- It helped me identify my strengths and weaknesses
- The information was clear and precise
- The information was backed up by the Codes of Practice
- None
- Other: _________________________________________________________________

33. What were the disadvantages of the benchmarking report that was provided to you?

- The information was not clear
- The results were clear, but I don’t know what to do to improve (recommendations were lacking or unclear)
- It did not do a good job of representing the level of cow comfort of my herd
- None
- Other: ________________________________________________________________

34. Overall, if you had to give the benchmarking report a mark out of 10, what would it be?

____________________________________________________

35. Would you be interested in having a more detailed conversation about this in-person at a location of your choice? If so, I will be in touch to organize a meeting.

- Yes. Details____________________________________
- No

36. Do you have any final comments about any of the things that we have discussed?

- Yes. Details____________________________________
- No

Thank you very much for your time, if you think of anymore questions feel free to contact me via e-mail or phone at dairy01@uoguelph.ca or 519.824.4120 ext. (54595)
We may be contacting you again in the next year for a potential follow-up project.
Have a great day!
QUESTIONNAIRE D’ENQUÊTE
SUIVI DU DIAGNOSTIC SUR L’ADOPTION DES PRATIQUES DE CONFORT CHEZ LES FERMES LAITIÈRES À STABULATIONS ENTRAVÉES

Projet confort - Section adoption des pratiques

HIVER 2012

Rapport d’enquête

----------------------------------- Remplir avant l’entrevue téléphonique -------------------

| Nom de la personne enquêtée : ____________________________________ |
| Nom de la ferme : ________________________________________________ |
| Tél : ____________________________________________________________ |
| N° d’identification de l’exploitation agricole : ________________ |
| Notes : Santé des ongles_____ Gestion des stalles ______ Configuration des stalles |

Entourez la cote : A   B   C   D

| Pas de réponse | ______ | Rappeler | Date : | Heure : |
| Pas disponible | ______ | Rappeler | Date : | Heure : |
| Refus : ______ |

| Nom de l’enquêteur : ____________________________________________ |
| Date de l’entrevue : ____________________________________________ |
| Début de l’entrevue : _________ Fin de l’entrevue : ____________ |

Commentaires :
________________________________________________________________________

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PRÉSENTATION DE LA RECHERCHE

1. Demandez un des propriétaires de la ferme.

2. S’il n’est pas disponible, demandez à quel moment vous pouvez la rejoindre.

3. S’il est là, présentez-vous et indiquez le but de votre appel en vous inspirant du texte suivant :

Bonjour Monsieur ou Madame, mon nom est _____________________, de l’Université Laval. Vous avez déjà accepté de participer à une recherche sur les pratiques de confort de vos vaches. Des étudiants ont visité votre ferme en ______2011. J’ai été mandaté(e) pour faire le suivi du projet. Nous voulons donc recueillir vos commentaires, je ne prendrais que 15 à 20 minutes de votre temps. Acceptez-vous de répondre à mes questions ?

Nous aimerions donc avoir votre point de vue sur l’efficacité de l’outil de diagnostic qui vous a été fourni l’an dernier. Nous aimerions savoir s’il y a eu des changements dans vos pratiques depuis votre notation.

Si la personne refuse, remerciez-la.

Si la personne accepte, remerciez-la et indiquez-lui que toutes les informations qu’elle fournira demeureront anonymes et débutez la section I.

Pour débuter, je vais vous poser quelques questions visant à mieux connaître votre situation.
SECTION I – INFORMATIONS GÉNÉRALES

1. Vous êtes :
   ○ Actionnaire principal
   ○ Actionnaire minoritaire
   ○ Employé responsable du troupeau

2. Votre âge _________

3. Votre degré de scolarité ________________________________

4. Nombre d’année d’étude en agriculture : __________________________

5. Nombre total de vaches (lactation + tarie) : __________

6. Moyenne de production (kg/vache) : __________

7. Depuis quand la ferme est en votre possession ? __________

8. Nombre d’employés permanents (incluant la famille) : __________

9. Pour l’instant, est-ce qu’il y aura une relève identifiée pour votre entreprise ?
   ○ Oui
   ○ Je suis la relève
   ○ Non
   ○ Incertain

10. Participez-vous souvent, parfois ou jamais aux activités suivantes :

    Réunion de l’UPA ___________________ __ Souvent __ Parfois __ Jamais
Salons et expositions agricoles  | __ Souvent  | __ Parfois  | __ Jamais
Réunion de la Coopérative ou de la meunerie  | __ Souvent  | __ Parfois  | __ Jamais
Réunion de la fédération des producteurs de lait  | __ Souvent  | __ Parfois  | __ Jamais
Club Holstein  | __ Souvent  | __ Parfois  | __ Jamais
Journée-conférence en gestion  | __ Souvent  | __ Parfois  | __ Jamais
Journée-conférence en production laitière  | __ Souvent  | __ Parfois  | __ Jamais
Sessions de formation Valacta  | __ Souvent  | __ Parfois  | __ Jamais

11. Par ordre d’importance, quelles sont les 3 sources d’informations les plus influentes en ce qui concerne votre troupeau laitier ? (1 à 3, 1 étant la source la plus importante)

___ Agronomes, techniciens du MAPAQ, médecin vétérinaire
___ Médias (radio, télé, journaux, revues)
___ Internet
___ Autres producteurs
___ Représentant de Valacta
___ Meuneries privées ou coopératives
___ Famille et amis
___ Autres :

_____________________________________________________________________

Nous allons maintenant passer aux questions concernant l’étude en cours
SECTION II – CATÉGORISATION

(Si les trois notes sont plus élevées que 85%) Suite à votre évaluation, malgré vos très bons résultats, depuis notre visite, avez-vous tout de même effectué certains changements concernant l’une des catégories suivantes :
la taille des onglons ____ et/ou
la gestion de vos stalles____ et/ou
la configuration de vos stalles ____ ?

- Oui
- Non → NON-ADOPTANT 1 avec possibilité d’améliorations faibles
  (Aller à la question #12)

(Si une des trois notes inférieures à 85%) Après avoir pris connaissance des résultats de votre évaluation, depuis notre visite, avez-vous effectué certains changements concernant l’une des catégories suivantes :
la taille des onglons ____ et/ou
la gestion de vos stalles____ et/ou
la configuration de vos stalles ____ ?

- Oui → ADOPTANT
  (Aller à la question #28)
- Non → NON-ADOPTANT 2 avec possibilité d’améliorations moyenne ou forte
  (Aller à la question #16)

SECTION III – NON-ADOPTANT 1

12. Vous avez obtenu de très bons résultats en matière de confort lors de l’évaluation de l’été 2011. Considérez-vous que l’outil de diagnostic a tout de même été utile ?

- Oui, pourquoi ?
  ___ Cela m’a aidé à identifier mes points forts et faibles
  ___ Cela m’a encouragé à continuer
  Autres :
  [Space]:

- Non, pourquoi ?
J’avais déjà le diagnostic sur mes pratiques de confort
Je ne le trouvais pas très clair
Autres :
_________________________________________________________________

13. Somme toute, si vous aviez à donner une note sur 10 sur l’utilité de l’outil de diagnostic, quelle serait-elle?

__________

14. Croyez-vous que cet outil peut être utile pour les producteurs qui, contrairement à vous, doivent améliorer leurs pratiques de confort ?

Oui, pourquoi ?  
_________________________________________________________________

Non, pourquoi ?  
_________________________________________________________________

15. Si des changements avaient dû être faits sur votre ferme, l’outil de diagnostic aurait-il joué un rôle important dans votre décision d’effectuer ces modifications en lien avec le confort de vos animaux ?

○ Oui
   Si oui, cet outil aurait-il été le seul à jouer ce rôle ?
      ○ Oui
      ○ Non, la discussion avec les chercheurs m’aurait aidé
      ○ Non, le « Code de pratique » m’aurait aidé
      ○ Non, autres :

   ○ Non
      Sinon, quelles sources vous ont influencé ?

   (ALLEZ À LA QUESTION 38)
SECTION IV – NON-ADOPTANT

Les questions qui suivent tenteront de déterminer les facteurs ayant contribué à la non-adoption des pratiques permettant l’augmentation de votre note de confort.

16. Suite aux visites en ferme, à l’évaluation ainsi faites et à la remise du « Code de pratique pour le soin et la manipulation des bovins laitiers », il peut y avoir plusieurs raisons qui font qu’un producteur n’ait pas jugé bon de faire des changements dans ses pratiques.

Parmi les raisons possibles, énumérées ci-dessous quelles sont celles qui concernent votre situation ?

- A) Je ne vois pas bien les impacts à long terme
- B) Le degré de complexité des recommandations est trop élevé
- C) Manque de main-d’œuvre
- D) Les recommandations m’ont laissé indifférent
- E) Les recommandations m’ont démotivé
- F) Manque de budget
- G) Je ne crois pas que ces pratiques augmenteront le rendement de l’entreprise
- H) Le niveau de confort de mes vaches me satisfait déjà
- I) Je ne connais personne adoptant de telles mesures
- J) Manque de temps
- K) Manque d’information
- L) Je ne me rappel pas de l’évaluation et des faiblesses identifiées

17. Parmi les raisons évoquées précédemment, laquelle est la plus importante concernant les catégories s’appliquant à vous ?

(Inscrire la lettre et cochez la/les catégorie(s) dont la note moyenne est inférieure à 85% et n’ayant pas eu d’amélioration)

- Santé des ongles _____
- Gestion des stalles _____
- Configuration des stalles _____

18. Comptez-vous adopter les recommandations ou faire les modifications à vos pratiques dans un futur proche ?

- Oui, quelles sont-elles ?
Taille des onglons
- Taille des onglons 2 fois par année
- Parage environ 2 mois avant le vêlage
- Établissement d’un registre

Gestion des stalles
- Augmentation de la propreté
- Nettoyage à chaque traite
- Augmentation de la litière
- Tapis

Configuration des stalles
- Repositionnement du dresseur électrique
- Distance entre le muret et la barre d’attache
- Longueur de la chaîne
- Hauteur du muret
- Longueur et largeur des stalles

- Non
- Je ne sais pas
  Commentaires :
  __________________________________________________________

19. Si vous aviez à donner une note sur 10 à l’utilité de l’outil de diagnostic qui vous a été fourni cet été, quelle serait-elle? ________

20. Selon vous, est-ce que l’outil de diagnostic était clair et facile à comprendre ?
- Oui
- Non

21. Quels sont les avantages de l’outil de diagnostic qui vous a été remis ?
- L’évaluation m’a permis de cibler mes forces et mes faiblesses
- L’information est claire et précise
- L’information était bonifiée par le « Code de pratiques »
- Aucun
- Autres :
  __________________________________________________________

22. Quels sont les inconvénients de cet outil de diagnostic ?
- L’information n’était pas claire
Les résultats sont clairs, mais je ne sais pas quoi faire pour m'améliorer (recommandations pas clairs ou absentes)
Il ne représente pas bien le niveau de confort de mon troupeau
Aucun
Autres : __________________________________________________________

23. Est-ce que le contenu du questionnaire d’évaluation était clair ?

Oui
Non

Sinon, qu’est-ce qui n’était pas clair pour vous ?
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________

24. Toujours concernant l’outil de diagnostic, avez-vous des améliorations à suggérer ?
__________________________________________________________________
__________________________________________________________________

25. Avez-vous discuté des résultats avec un conseiller (vétérinaire, Valacta, meunerie...)?

Oui
Non

26. Est-ce que le « Code de pratiques pour le soin et la manipulation des bovins laitiers » qui vous a été fourni lors du diagnostic est un outil de référence utile pour l’amélioration des pratiques de confort sur votre ferme ?

Oui
Non
Je ne sais pas, je ne l’ai pas lu
Je ne me souviens pas d’avoir eu ce document

27. Si vous aviez à donner une note sur 10, comment évaluez-vous l’utilité du Code de pratiques pour le soin et la manipulation des bovins laitiers ?

(ALLEZ À LA QUESTION 38)
SECTION V – ADOPTANT

Les questions qui suivent tenteront de déterminer les facteurs ayant contribué à l’adoption des pratiques permettant l’augmentation de votre note de confort.

28. Vous avez effectué des changements concernant :

○ Taille des onglons

Quels sont-ils ?

○ Taille des onglons 2 fois par année
○ Plus souvent qu’avant
○ Parage environ 2 mois avant le vêlage
○ Établissement d’un registre

○ Gestion des stalles

Quels sont-ils ?

○ Augmentation de la propreté
○ Nettoyage à chaque traite
○ Augmentation de la litière

○ Configuration des stalles

Quels sont-ils ?

○ Repositionnement du dresseur électrique
○ Distance entre le muret et la barre d’attache
○ Longueur de la chaîne
○ Hauteur du muret
○ Longueur et largeur des stalles

29. Suite aux visites en ferme, à l’évaluation ainsi faites et à la remise du « Code de pratique pour le soin et la manipulation des bovins laitier », il peut y avoir plusieurs raisons qui font qu’un producteur n’ait pas jugé bon de faire des changements dans ses pratiques.

Parmi les raisons possibles, énumérées ci-dessous quelles sont celles qui concernent votre situation ?

○ A) Je ne vois pas bien les impacts à long terme
○ B) Le degré de complexité des recommandations est trop élevé
30. Parmi les raisons évoquées précédemment, laquelle est la plus importante concernant les catégories s’appliquant à vous ?

(Inscrire la lettre et cochez la/les catégorie(s) dont la note moyenne est inférieur à 85% et n’ayant pas eu d’amélioration)

- Santé des ongles _____
- Gestion des stalles _____
- Configuration des stalles _____

31. Si vous aviez à donner une note sur 10 à l’utilité de l’outil de diagnostic qui vous a été fourni cet été, quelle serait-elle? __________

32. Selon vous, le fait que l’outil d’évaluation soit accompagné du « Code de pratiques pour le soin et la manipulation des bovins laitiers » a-t-il eu un effet?

- Oui
- Non
- Incertain

33. L’outil de diagnostic a t-il joué un rôle important dans votre décision d’effectuer certaines modifications en lien avec le confort de vos animaux ?

- Oui
  Si oui, cet outil a t’il été le seul à jouer ce rôle ?
    - Oui
    - Non, la discussion avec les chercheurs m’a aidé
    - Non, le « Code de pratique» m’a aidé
Non, autres :

Non, quelles sources vous ont influencé ?

34. Quels sont pour vous les avantages d’un tel outil ?

- L’évaluation m’a permis de cibler mes forces et mes faiblesses
- L’information est claire et précise
- L’information était bonifiée par le « Code de pratiques pour le soin et la manipulation des bovins laitiers »
- Aucun

35. Quels sont pour vous les inconvénients d’un tel outil ?

- L’information n’était pas claire
- Les résultats sont clairs, mais je ne sais pas quoi faire pour m’améliorer (recommandations pas clairs ou absentes)
- Selon vous, ne représente pas bien le niveau de confort de votre troupeau
- Aucun

36. Est-ce que le contenu du questionnaire était clair ?

- Oui
- Non

Sinon, qu’est-ce qui n’était pas clair pour vous ?

37. Toujours concernant l’outil de diagnostic, avez-vous des améliorations à suggérer ?
SECTION VI – ÉVALUATION DU CONFORT GÉNÉRAL, VISION DE L’AVENIR ET REPRÉSENTATION DU BIEN-ÊTRE
(TOUT LES REPONDANTS)

38. Par rapport aux évaluations du confort de vos animaux, quelle importance accordez-vous aux éléments suivant dans la démarche ?

<table>
<thead>
<tr>
<th>Forte</th>
<th>Faible</th>
<th>Moyenne</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistance d’un conseiller pour saisir les données</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Fréquences des évaluations</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Discuter des résultats finaux avec un conseiller</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Comparaison des résultats avec la moyenne des fermes</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

39. Est-ce que les résultats obtenus pour votre ferme correspondent à l’idée que vous avez du bien-être de vos vaches laitières ?

○ Oui
○ Non
Sinon, en quoi ne correspondent-ils pas ?

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
_____________________

40. Comment percevez-vous l’avenir à court ou moyen terme en production laitière ?

○ Très bonne
○ Bonne
○ Moyenne, avenir plutôt incertain
○ Mauvais
41. Comment voyez-vous votre ferme dans les 10 prochaines années ?
- Elle prendra de l’expansion
- Elle demeurera ce qu’elle est
- Elle sera plus petite
- Elle ne sera peut-être plus en opération

42. Êtes-vous en désaccord, ou plutôt en accord avec les affirmations suivantes ?

<table>
<thead>
<tr>
<th>Désaccord</th>
<th>Accord</th>
</tr>
</thead>
<tbody>
<tr>
<td>Le bien-être animal c’est une question d’image pour mon entreprise, donc une obligation et non une valeur</td>
<td></td>
</tr>
<tr>
<td>Le bien-être animal c’est des coûts et du temps supplémentaires, donc une contrainte pour mon entreprise</td>
<td></td>
</tr>
<tr>
<td>Le bien-être animal est une préoccupation importante et incontournable pour les éleveurs, c’est dans mes valeurs</td>
<td></td>
</tr>
<tr>
<td>Le bien-être animal est une façon d’augmenter la rentabilité de l’entreprise à long terme</td>
<td></td>
</tr>
<tr>
<td>Deux tailles des onglons par année ont une incidence directe sur les pertes et coûts de production</td>
<td></td>
</tr>
</tbody>
</table>

43. Quel est votre principal conseiller en production laitière ?
- Valacta
- MAPAQ
- Meuneries

44. Nous désirons savoir quelle type de relation vous avez avec le conseiller que vous venez de nommer ainsi qu’avec votre vétérinaire. Voici 4 catégories de relations, laquelle correspond à votre vétérinaire et laquelle à votre conseiller ? (Cochez les cases correspondantes)

<table>
<thead>
<tr>
<th>Vétérinaire</th>
<th>Conseiller en production laitière (Valacta, MAPAQ, meunerie...)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Une très bonne relation, il a toute ma confiance et dans la mesure du possible ses conseils sont mis en application.</td>
<td></td>
</tr>
<tr>
<td>2. Une bonne relation, je lui fais confiance. Cependant, à certains moments, ses recommandations ne sont pas dans la même optique que la mienne.</td>
<td></td>
</tr>
<tr>
<td>3. Une relation neutre, je connais très bien mes vaches et souvent j’opte pour une façon de faire plus personnelle.</td>
<td></td>
</tr>
</tbody>
</table>
4. Une relation d'évitement. Je fais appel à ses services seulement en cas d'urgences extrêmes.

45. Sur une note de 1 à 5 (1 étant le plus élevé), à combien évaluez-vous l'importance de ces pratiques pour le bien-être de vos vaches ?

____ Taille des onglons deux fois par année
____ Stalles de 180 cm (70 ‘’) de longueur et de 152 cm (60’’) de largeur en moyenne (Recommandé)
____ Stalles nettoyées à chaque traite
____ Taille des onglons deux mois avant le vêlage
____ Quantité de litière suffisante et sèche
____ Présence de tapis ou de matelas
____ Hauteur de la barre d’attache à plus de 115 cm (45’’) (Recommandé)

Remerciement

M. (ou Mme) _________________ je tiens à vous remercier sincèrement d’avoir bien voulu prendre quelques minutes de votre temps pour nous aider à compléter cette enquête.

Je vous souhaite une bonne fin de journée.
Dairy Survey

Thank you for taking the time to participate in this survey!

**English/Anglais:**
This research project aims to engage the knowledge of a wide range of key stakeholders within the Canadian dairy industry to develop ideal targets for the production, health and welfare of Canadian dairy cattle. Completion of this survey should take no more than 20 to 30 minutes. You will be able to monitor your progress. The following page contains further details regarding participation.

There are 55 questions in this survey.

**Language**

1. Please select your preferred language:
If you are capable of completing this survey in English we ask that you do so to simplify the validation process.

Please choose **only one** of the following:

- English/Anglais
- Français/French
Consent forms

2

CONSENT TO PARTICIPATE IN RESEARCH
Study title: Developing ideal targets for the production, health and welfare of Canadian dairy cattle
You are asked to participate in a research study conducted by Drs Derek Haley (Principal Investigator), David Kelton and Ms Clemence Nash (all from the Dept. Population Medicine, or Animal & Poultry Science at the University of Guelph). Data collected will contribute to the PhD thesis for Ms Nash.
If you have any questions or concerns about the research, please feel free to contact Clemence Nash by telephone: 519-824-4120, Ext. 54595, by email: nashc@uoguelph.ca, or by fax: 519-763-8621.

PURPOSE OF THE STUDY: Currently, the Dairy Farmers of Canada are developing an Animal Care Assessment Program with some minimum standards of care for dairy cattle in Canada, based on the Canadian code of practice for the care and handling of dairy cattle. It is anticipated that many dairy producers will already be meeting these minimum standards. The goal of this research project is to identify, through consultation with dairy experts, ideal targets to strive for to maximize the production, health and welfare of their dairy cattle. These targets will be developed with the help of this iterative survey process of key dairy experts in the industry.

PROCEDURES:
If you volunteer to participate in this study, we would ask you to do the following things:
Provide your opinion on the development of cow production, health and welfare targets for Canadian dairy cattle. As a participant in this study, you will be contacted to complete three rounds of consultation, each requiring 20 to 30 minutes of your time.

POTENTIAL RISKS AND DISCOMFORTS:
This study poses no physical risk to participants. All information provided by participants will be kept confidential and only available to the research group. We will do everything we can, including the encryption of data to keep the results of our study, and the data we have collected from you, secure from the public. Your identity will remain confidential and will not be associated with your responses.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY:
The participants, through the three sequential rounds of consultation, will receive the results from the previous rounds gathered from the other surveyed experts. This information will provide them with more free knowledge of the Canadian dairy industry’s views on cow production, health and welfare. The results of this process will be to develop ideal targets for the care and handling of dairy cattle, as agreed upon by all sectors of the dairy industry. From a society perspective, this study is then helping to ensure consumers that the Canadian dairy industry cares about their animals and that we are taking a systematic approach to improving their well-being and to caring for them in the best ways we know how.
PAYMENT FOR PARTICIPATION: Study participants are volunteers and will not
receive any monetary compensation for being involved in this study.

CONFIDENTIALITY: Every effort will be made to ensure confidentiality of any identifying information that is obtained in connection with this study. Participants will be asked to provide certain information about themselves (e.g. gender, age) and so will not be anonymous. However, they will be assigned an identification number and will, throughout all levels of data analysis be referenced by that number. The original file linking the study ID# and your name will be held in a password protected document by the Principle Investigator. Once data has been collected from you, the name and address will no longer be linked to the information in the analysis. The data will be retained on file for a period of 5 years following publication of the results. All identifiers will be stored in an encrypted coding.

PARTICIPATION AND WITHDRAWAL: You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may exercise the option of removing your data from the study. The investigator may withdraw you from this research if circumstances arise that warrant doing so.

RIGHTS OF RESEARCH PARTICIPANTS: You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. This study has been reviewed and received ethics clearance through the University of Guelph Research Ethics Board. If you have questions regarding your rights as a research participant, contact:

Director, Research Ethics
Telephone: 5198244120, ext. 56606
University of Guelph
Email: sauld@uoguelph.ca
437 University Centre
Fax: 519821523
Guelph, ON N1G 2W1

I have read the information provided for the study “Developing ideal targets for the production, health and welfare of Canadian dairy cattle” as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study by clicking accept on the following question.

Please choose only one of the following:

〇 Accept and continue
〇 Don't accept
Demographics

3
Please enter your name (first and last).

This will remain confidential and only be seen by survey administrators. Your survey be assigned a number and your name will no longer be attached to your results.

Please write your answer here: ____________________________

4
Please provide your most up to date email address below.

This will allow us to send you the overall results from this survey as well as invite you to participate in future rounds of consultation. It will not be used for any other purpose, nor will it be shared with any third party.

Please write your answer here: ____________________________

5
Gender:
Please choose only one of the following:

- Male
- Female
- Rather not say

6
Region(s) you currently work in:
Please choose all that apply:

- Ontario
- Quebec
- British Columbia
- Manitoba
- Saskatchewan
- Alberta
- Newfoundland/Labrador
- Prince Edward Island
- New Brunswick
- Nova Scotia
Other:__________________________________________________

Name of nearest city to your residence (please include city and province):

Please write your answer here:_____________________________________________

Education (please click all that you have COMPLETED)
Please add additional details of any specializations if applicable.

Please choose all that apply and provide a comment:

- None
  ________________________________________________________________

- High School
  ________________________________________________________________

- CEGEP Quebec (pre-university)
  ________________________________________________________________

- CEGEP Quebec (professional program)
  ________________________________________________________________

- 2 year College or University program
  ________________________________________________________________

- 4 year College or University program
  ________________________________________________________________

- DVM
  ________________________________________________________________

- DVSc
  ________________________________________________________________

- Masters
  ________________________________________________________________

- PhD
  ________________________________________________________________

- Other:_______________
  ________________________________________________________________

Education (Please click all you are IN THE PROCESS of completing):
Please add additional details of any specializations if applicable.

Please choose all that apply and provide a comment:
o None


o High School


o CEGEP Quebec (preuniversity)


o CEGEP Quebec (professional program)


o 2 year College or University program


o 4 year College or University program


o DVM


o DVSc


o Masters


o PhD


o Other:_____________


10
Profession (please provide details on field of work if necessary)
Please choose all that apply and provide a comment:

o Dairy Producer


o Veterinarian


o University (teaching)


o University (research)


o Government


o Support industry (equipment sales, genetics, pharmaceuticals, etc.)


o Other:________________________
11
If you own or work on a farm, what type of farm is it?
Please choose only one of the following:

○ Tie-stall
○ Free-stall with parlour
○ Free-stall with robot(s)
○ Bedded pack with parlour
○ Bedded pack with robot(s)
○ Other:_____________________________________

12
Is the farm certified Organic?
Please choose only one of the following:

○ Yes
○ No

13
Area of dairy expertise (if applicable):
Please choose all that apply:

○ Nutrition
○ Welfare
○ Production
○ Health
○ Milk quality and safety
○ Regulatory
○ Biosecurity
○ Other:_________________________________________
14
Age:
Please choose only one of the following:
- 19-29
- 30-39
- 40-49
- 50-59
- 60-69
- 70+

15
Please provide the name of the current organization, business, affiliation or farm you currently work in (optional):
This information will only be used to confirm we have placed you in the right profession category.

Please write your answer here:________________________________________________

16
How many years have you been working at this business?

Please write your answer here:______________

17
How many years have you been working within the dairy industry?

Please write your answer here:__________________________________
Definition of welfare

18

When trying to define the welfare of a herd of milking dairy cows on a working farm in Canada, one can consider the physical and/or mental wellbeing of the animals. This can include one or more of the following categories:

- **Production**
  - Milk quantity and quality
  - Reproductive performance
  An animal that produces well would be considered to have good welfare

- **Health**
  - Presence/absence of disease
  An animal with good health would be considered to have good welfare

- **Natural living**
  - Ability to live according to the "nature" of its species, including the ability to perform natural behaviours (including socializing, resting, etc.)
  An animal able to perform natural behaviours would be considered to have good welfare

- **Feelings or affective state**
  - Presence of positive emotional states (e.g. pleasure) and/or absence of negative emotional states (e.g. fear, pain)
  An animal experiencing pleasure and little to no pain would be considered to have good welfare

In your definition of dairy cow welfare, do you include any of the categories outlined above?

Please choose **all** that apply:

- ○ Production
- ○ Health
- ○ Natural Living
- ○ Feelings or affective state
- ○ Other:__________________________________

19

If you would like to expand on your answer to the above question, please do so here:
Measuring Welfare

20
When trying to assess the welfare of a herd of milking dairy cows, a number of measures can be used, such as:

- Resource based measures (facility design, stall design, feed, etc.)

- Management based measures (feeding frequency, cleaning routine, record keeping, etc.)

- Animal based measures (production, body condition score, lying time, lameness, injuries, etc.)

Which kinds of measures would you use to assess the welfare of a herd of dairy cows?

Please choose all that apply:

- [ ] Resource based measures
- [ ] Management based measures
- [ ] Animal based measures
- [ ] Other: ______________________________

21
Please specify the types of resource based measures you would use (facility design, stall design, feed, etc.):

Please write your answer here:

________________________________________________________________________

________________________________________________________________________

22
Please specify the types of management based measures you would use (feeding frequency, cleaning routine, record keeping, etc.):
23
Please specify the types of animal based measures you would use (production, body condition score, lying time, lameness, injuries, etc.):

Please write your answer here:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

24
If you have further comments about this question, please leave them here.

Please write your answer here:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Optimal herd
25
When considering only animal based measures (such as production, body condition score, lying time, lameness, injuries, etc), what would a herd of milking dairy cows with realistically optimal welfare look like?

Example answer: Less than 20% lameness, lying time of 13 hours/day, body condition score of 3.5, etc.

Please write your answer here:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Terminology

A wide range of terms have been used to describe dairy cattle care and handling in the dairy industry. In your opinion, do the terms “cow welfare”, “cow wellbeing” and “cow comfort” have different meanings?

Please choose only one of the following:

- Yes
- No
- Not sure

Please expand on your answer from the question above.

Please write your answer here:

________________________
________________________
________________________

Thank you! Merci!

Thank you so much for taking the time to participate in this survey! If you feel we've missed something, please leave a comment here. Otherwise, we look forward to sending you the overall results in the coming few weeks!
Feel free to contact us as dairy01@uoguelph.ca with any questions
If you have no further comments, please click "Submit" at the bottom of the page!
Merci de prendre le temps de participer à cette enquête!

Français/French:

Ce projet de recherche vise à engager la connaissance d'un large éventail d'intervenants clés au sein de l'industrie laitière canadienne pour développer des cibles idéales pour la production, la santé et le bien-être des bovins laitiers au Canada.

La réalisation de cette enquête ne devrait pas prendre plus de 20 à 30 minutes. Vous serez en mesure de suivre vos progrès. La page suivante contient d'autres détails concernant votre participation.

Langue

1
Veuillez choisir la langue du questionnaire que vous préférez:
Si vous êtes capable de remplir ce questionnaire en anglais, nous vous demandons de le faire pour simplifier le processus de validation.

Please choose only one of the following:
  - English/Anglais
  - Français/French

Round 2 language

2

Prenant en considération que le Canada est un pays bilingue, nous sommes heureux d'offrir cette première enquête en français et en anglais!

Toutefois, il est possible que nous ne serions pas en mesure d’offrir les questionnaires futurs en français car il sera difficile de traduire certains contextes scientifiques de l'anglais.

Considérant ceci, seriez-vous prêt à compléter les enquêtes futures en anglais?

Please choose only one of the following:
Consent Forms

3

Consentement à participer en recherche

Titre du projet : Développement de cibles idéales pour la production, la santé et le bien-être des vaches laitières au Canada

Vous êtes invités à participer à un projet de recherche mené par Dr. Derek Haley, Dr. David Kelton et Ms. Clémence Nash (tous du département de Population medicine à l’Université de Guelph). Les données recueillies contribueront à la thèse de Ms Nash.

Si vous avez des questions ou des préoccupations au sujet de la recherche, n'hésitez pas à contacter Clémence Nash par téléphone : 5198244120, Ext. 54595, par email: nashc@uoguelph.ca, ou par fax: 5197638621.

But de l'étude : Actuellement, les producteurs laitiers du Canada développent un programme d'évaluation pour le soin des animaux avec certaines exigences minimales de soins pour les vaches laitières au Canada, basées sur le Code de Pratiques pour le soin et la manipulation des bovins laitiers. On s'attend à ce que nombreux producteurs laitiers suivent déjà ces exigences. Le but de ce projet de recherche est d'identifier, en consultation avec les experts en produits laitiers, les cibles idéales à atteindre afin de maximiser la production, la santé et le bien-être des vaches laitières au Canada. Ces cibles seront développées avec l'aide d'un processus itératif d'enquête d'experts laitiers.

Procédures : Si vous vous portez volontaire pour participer à cette étude, nous vous demandons de faire les choses suivantes: Fournir votre opinion sur l'élaboration de cibles de production, de santé et de bien-être des vaches pour les bovins laitiers canadiens. En tant que participant à cette étude, vous serez contactés pour compléter une série de 3 consultations, chacune nécessitant 20 à 30 minutes de votre temps.

Risques potentiels : Cette étude ne pose aucun risque physique pour les participants. Tous les renseignements fournis par les participants seront gardés confidents et uniquement disponibles pour le groupe de recherche. Nous ferons tout notre possible, y compris le cryptage des données, pour conserver les résultats de notre étude, et les données que nous avons recueillies auprès de vous, confidentiels. Votre identité restera confidentielle, et ne sera pas associée à vos réponses.

Avantages potentiels pour les participants et/ou la société : Les participants, à travers les trois cycles séquentiels de consultation, recevront les résultats des tours précédents, recueillis auprès des autres experts interrogés. Cette information leur fournira plus de connaissances sur le point de vue de l'industrie laitière canadienne, sur la production, la santé et le bien-être des vaches laitières. Les résultats définitifs de ce processus développeront des cibles idéales pour le soin et la manipulation des bovins laitiers, tel que décidé par tous les secteurs de l'industrie laitière. Du point de vue de la société, cette étude va contribuer à garantir aux consommateurs de produit laitier que l'industrie laitière canadienne se soucie de leurs animaux et que...
nous adoptons une approche systématique visant à améliorer leur bien-être et à prendre soin d'eux de la meilleure façon possible.

Paiement pour participation : Les participants de l'étude sont bénévoles et ne reçoivent aucune compensation monétaire pour avoir participé à cette étude.

Confidentialité : Tous les efforts seront déployés pour assurer la confidentialité de toute information d'identification qui est obtenue dans le cadre de cette étude. Les participants seront invités à fournir certaines informations sur eux-mêmes (par exemple, sexe, âge) et ne seront donc pas complètement anonymes. Cependant, ils seront assignés à un numéro d'identification et seront, à tous les niveaux de l'analyse des données, référencées par ce numéro. Le fichier d'origine reliant l'ID de l'étude et votre nom sera tenu dans un document protégé par mot de passe par le chercheur principal. Une fois que les données ont été recueillies auprès de vous, le nom et l'adresse ne sera plus liée à l'information dans l'analyse. Les données seront conservées dans un dossier pour une période de 5 ans suivant la publication des résultats. Tous les identificateurs seront stockés dans un codage chiffré.

Participation et retrait: Vous avez le choix de participer à cette étude ou non. Si vous vous portez volontaire pour participer à cette étude, vous pouvez vous retirer à tout moment sans conséquences. Vous pouvez exercer l'option de supprimer vos données de l'étude. L'enquêteur peut vous retirer de la recherche si des circonstances surviennent qui justifie de le faire.

Droits des participants de recherché: Vous pouvez retirer votre consentement en tout temps et cesser de participer sans pénalité. Vous ne renoncez pas à toute réclamation juridique, ses droits et recours en raison de votre participation à cette étude. Cette étude a été examinée et reçu l'autorisation d'éthique à l'Université de Guelph « Research Ethics Board ». Si vous avez des questions concernant vos droits en tant que participant de recherche, communiquez avec:

Director, Research Ethics
University of Guelph
437 University Centre
Guelph, ON N1G 2W1
Telephone: 5198244120, ext. 56606
Email: sauld@uoguelph.ca
Fax: 5198215236

J'ai lu les informations fournies par l'étude « Développement de cibles idéales pour la production, la santé et le bien-être des vaches laitières au Canada ». Mes questions ont été répondues à ma satisfaction, et je suis d'accord pour participer à cette étude en cliquant "j'accepte" sur la question suivante.

Please choose only one of the following:

- J'accepte
- Je n'accepte pas
Demographic (Français)

4
Votre nom (et prénom):

(Cela restera confidentiel et ne peut être vu que par les administrateurs de l'enquête. Votre enquête sera attribuée un numéro et celui-ci remplacera votre nom dans vos résultats.)
Please write your answer here:

________________________________________

5
Votre adresse email la plus récente :

(Cela nous permettra de vous envoyer les résultats nationaux de cette enquête ainsi que vous invitez à participer lors des prochaines consultations. Votre adresse ne sera pas utilisée à d'autres fins, ni sera partagée avec une tierce partie).
Please write your answer here:

________________________________

6
Votre sexe:
Veuillez sélectionner une réponse cidessous.

Please choose only one of the following:
  o Homme
  o Femme
  o Je préfère ne pas dire

7
La/les région(s) où vous travaillez actuellement :
Cochez la ou les réponses

Please choose all that apply:
  o Ontario
  o Québec
  o Colombie Britannique
  o Manitoba
  o Saskatchewan
  o Alberta
  o Nouvelle Ecosse
  o Nouveau Brunswick
8
Nom de la ville la plus proche de votre résidence (inscrivez la ville et la province) :

Please write your answer here:

____________________________________

9
Éducation: (veuillez cliquer tout ce que vous avez COMPLETÉ)
Ajoutez des détails supplémentaires sur vos spécialisations si nécessaire.

Cochez la ou les réponses:

Please choose all that apply and provide a comment:

☐ Aucun
  __________________________________________________________

☐ École secondaire
  _________________________________________________________

☐ CEGEP Québec (préuniversitaire)
  ____________________________

☐ CEGEP Québec (programme professionnel)
  ____________________________

☐ Diplôme de 2 ans à l’Université
  __________________________________

☐ Diplôme de 4 ans à l’Université
  __________________________________

☐ DMV
  ________________________________

☐ DVSc
  ________________________________

☐ Maîtrise
  __________________________________

☐ Doctorat
  ________________________________
10
Éducation: (veuillez cliquer tout ce que vous êtes EN TRAIN de compléter). Ajoutez des détails supplémentaires sur vos spécialisations si nécessaire.

Cochez la ou les réponses:

Please choose all that apply and provide a comment:

- O Aucun

- École secondaire

- CEGEP Québec (préuniversitaire)

- CEGEP Québec (programme professionnel)

- Diplôme de 2 ans à l’Université

- Diplôme de 4 ans à l’Université

- DMV

- DVSc

- Maitrise

- Doctorat

- Other:__________________________

11
Profession (veuillez fournir des détails sur champ de travail si nécessaire)

Cochez la ou les réponses:

Please choose all that apply and provide a comment:
Si vous possédez ou travaillez dans une ferme laitière, quelle type de ferme est-elle?

Veuillez sélectionner une réponse ci-dessous:

Please choose only one of the following:

- Stabulation entravée
- Stabulation libre avec salle de traite
- Stabulation libre avec système robotisé
- Enclos à litière de paille accumulée avec salle de traite
- Enclos à litière de paille accumulée avec système robotisé
- Other: ________________________________

La ferme est-elle certifiée biologique?

Veuillez sélectionner une réponse ci-dessous:

Please choose only one of the following:
14
Domaine(s) d'expertise laitière (le cas échéant):

Cochez la ou les réponses:

Please choose all that apply:

○ Nutrition
○ Bien-être
○ Production
○ Santé
○ Qualité et quantité de lait
○ Règlementation
○ Biosécurité
○ Other: ____________________________________________

15
Votre âge:

Veuillez sélectionner une réponse cidessous:

Please choose only one of the following:

○ 19-29
○ 30-39
○ 40-49
○ 50-59
○ 60-69
○ 70+

16
Veuillez s'il vous plaît fournir le nom de l'organisation, l'entreprise, l'affiliation ou de la ferme où vous travaillez actuellement (optionnel):

Cette information ne sera utilisée que pour confirmer que nous vous avons place
dans la catégorie de profession appropriée
Please write your answer here:

17
Combien d'années avez-vous travaillé dans cette organisation, entreprise, affiliation ou ferme(#)?
Please write your answer here:

18
Combien d'années avez-vous travaillé dans l'industrie laitière (#)?
Please write your answer here:

Definition (Français)
19
Lorsqu’on essaye de définir le bien-être d'un troupeau de vaches laitières en traite sur une ferme laitière canadienne, on peut considérer le bien-être physique et/ou le bien-être mental des animaux. Ceci peut inclure une ou plusieurs des catégories suivantes :
• Production
  La quantité et la qualité du lait
  Performances de reproduction
  Un animal qui produit bien serait considéré comme avoir un bien-être élevé
• Santé
  Présence/absence de maladie
  Un animal en bonne santé serait considéré comme avoir un bien-être élevé
• Vie Naturel
  La capacité de vivre selon la «nature» de son espèce, y compris la capacité d'effectuer des comportements naturels (ex : la socialisation, le repos, etc.)
  Un animal en mesure d'effectuer des comportements naturels serait considéré comme avoir un bien-être élevé
• Sentiments ou état affectif
  La présence d'états émotionnels positifs (par exemple, le plaisir) et/ou l’absence d'états émotionnels négatifs (par exemple la peur, la douleur)
  Un animal qui éprouve du plaisir et peu ou pas de douleur serait considéré comme avoir un bien-être élevé

Dans votre définition du bien-être des vaches laitières, incluez-vous l'une des catégories décrites cidessus?

Cochez la ou les réponses:
Please choose all that apply:

- Production
- Santé
- Vie Naturel
- Sentient ou état affectif
- Other: _______________________________________

20
Si vous souhaitez élaborer votre réponse à la question ci-dessus, vous pouvez le faire ici:

Please write your answer here:
__________________________________________________________________
________________________________________________________________________
_______________________
_________________________________________________
________

Mesures (Français)
21
Lorsqu’on essaye d'évaluer le bien-être d'un troupeau de vaches laitières en traite, plusieurs mesures peuvent être prises, telles que:

- Des mesures de ressources (types d’installations, types de stalles, alimentation, etc.)

- Des mesures de gestion (fréquence de la distribution de ration alimentaire, fréquence du nettoyage, la tenue de registres, etc.)

- Des mesures fondées sur les animaux (production, état de chair, temps de repos, la boiterie, les blessures, etc.)

Quels types de mesures utiliserez-vous pour évaluer le bien-être d'un troupeau de vaches laitières?

Cochez la ou les réponses:

Please choose all that apply:

- Mesures de ressources
- Mesures de gestion
- Mesures fondées sue les animaux
- Other: _____________________________________________
Spécifier s'il vous plaît les types de mesures de ressources que vous utiliserez (types d'installations, types de stalles, alimentation, etc.):

Please write your answer here:
______________________________________________________________
______________________________________________________________
______________________________________________________________

Spécifier s'il vous plaît les types de mesures de gestion que vous utiliserez (fréquence de la distribution de ration alimentaire, fréquence du nettoyage, la tenue de registres, etc.):

Please write your answer here:
______________________________________________________________
______________________________________________________________
______________________________________________________________

Spécifier s'il vous plaît les types de mesures fondées sur les animaux que vous utiliserez (production, état de chair, temps de repos, la boiterie, les blessures, etc):

Please write your answer here:
______________________________________________________________
______________________________________________________________
______________________________________________________________

Si vous avez d'autres commentaires au sujet de cette question, vous pouvez les inscrire ici :

Please write your answer here:
______________________________________________________________
______________________________________________________________
______________________________________________________________

Troupeau optimal (Français)

Lorsque l'on considère que les mesures fondées sur les animaux (comme la production, l'état de chair, le temps de repos, la boiterie, les blessures, etc.), à quoi
ressemblerait un troupeau de vaches laitières en traite avec un bien-être optimal et réaliste?

Exemple de réponse : Moins de 20% de boiterie, un temps de repos de 13 heures par jour, un état de chaire de 3.5, etc.

Please write your answer here:

**Terminology (Français)**

27
Plusieurs termes ont été utilisés pour décrire le soin et la manipulation des bovins laitiers.

À votre avis, les termes «bien-être des vaches” et ”confort des vaches” sont-ils différents?

Veuillez sélectionner une réponse cidessous:

Please choose **only one** of the following:

- Oui
- Non
- Pas sûre

28
S’il vous plaît élaborez votre réponse à la question cidessus:

Please write your answer here:

---

**Thank you! Merci!**

**Français/French:**

Merci beaucoup d'avoir pris le temps de participer à cette enquête! Si vous avez plus à ajouter, laissez un commentaire. Nous serons heureux de vous envoyer les résultats de cette enquête dans les prochaines semaines!
N'hésitez pas à nous contacter pour toutes questions au dairy01@uoguelph.ca
Si vous n'avez pas d'autres commentaires, cliquez sur « Submit » au bas de la page!
Thank you for taking the time to continue with this survey project! This round of the survey will focus on identifying optimal yet achievable welfare, health and productivity targets for dairy herds in Canada. These targets are different from minimum acceptable targets, these targets are meant to be realistic targets that the best herds can achieve and the rest of the industry can strive for!

To help inform these targets, the responses from round 1 respondents will be included along with data from the industry.

This survey should only take 15 to 30 minutes of your time. In round 1, you were asked to identify ideal targets for the health, production and welfare of a herd of dairy cows. These results have been compiled and will now be compared to data we have on the current state of the industry. In this round, you will be provided with additional information to help you answer the survey questions. This information will come from:

A - The overall results from all respondents from the first survey round (your personal response to the first round was included in an excel document attached to your invitation email)

B - The results from a Dairy Research Cluster 1 undertaken in 2011 (this project involved visiting 240 Holstein dairy farms across Canada and measuring a sample of 40 cows on each farm for selected animal based measures)

C - The CanWest DHI database

D - Scientific publications (see graphs and tables for references)

Based on this information, your knowledge and your experience, you will again be asked to provide a target for each of a list of cow based measures generated from the results of round 1. You will also be asked to score the importance you would place on achieving each target in order to best meet your definition of an "ideal dairy herd".

There are 90 questions in this survey

Name

1

Pleas enter your name (first and last). This will remain confidential and only be used to match up your answers with the previous survey.

Please write your answer here:
Milk Production

Below is a graph of the data we have from DHI for milk production:

![Milk Production Graph](image)

Given your knowledge and the information provided, please consider the following questions:

In your opinion, what would the herd average milk production in litres/cow/day be in a herd with realistically optimal WELFARE?

Please write your answer here:__________________________

Please identify the importance you would place on achieving this milk production target in order to best meet your definition of a herd with realistically optimal WELFARE from 1 being not important to 5 being extremely important.

Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

In your opinion, what would the herd average milk production be in a herd with a realistically optimal HEALTH?

(If it is the same as above, please indicate so)

Please write your answer here:______________________________

Please identify the importance you would place on achieving this milk production target in order to best meet your definition of a herd with realistically optimal
HEALTH from 1 being not important to 5 being extremely important
Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

6
In your opinion, what would the herd average milk production be in a herd with realistically optimal PRODUCTION?
(If it is the same as above, please indicate so)
Please write your answer here:___________________________________

7
Please identify the importance you would place on achieving this milk production target in order to best meet your definition of a herd with realistically optimal PRODUCTION from 1 being not important to 5 being extremely important.
Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

Somatic Cell Count (SCC)
8
Below is a graph of the data we have from DHI for Somatic Cell Count:

Given your knowledge and the information provided, please consider the following
questions:

In your opinion, what would the bulk tank SCC be in herd with realistically optimal WELFARE?
Please write your answer here:_____________________________________________________

9
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal WELFARE from 1 being not important to 5 being extremely important
Please choose only one of the following:
   ○ 1
   ○ 2
   ○ 3
   ○ 4
   ○ 5

10
In your opinion, what would the bulk tank SCC be in herds with realistically optimal HEALTH?
(If it is the same as above, please indicate so)

Please write your answer here:_____________________________________________________

11
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal HEALTH from 1 being not important to 5 being extremely important
Please choose only one of the following:
   ○ 1
   ○ 2
   ○ 3
   ○ 4
   ○ 5

12
In your opinion, what would the bulk tank SCC be in herds with realistically optimal PRODUCTION?
(If it is the same as above, please indicate so)

Please write your answer here:_____________________________________________________
13
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal PRODUCTION from 1 being not important to 5 being extremely important
Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

Lameness
14
Below is a graph of the data we have from the Dairy Cluster 1 project for lameness (identified through locomotion scoring):

![Graph of average percent lameness per herd]

Given your knowledge and the information provided, please consider the following questions:

In your opinion, what percentage of cows would be lame in herds with realistically optimal WELFARE?
Please write your answer here:_____________________________________________________

15
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal WELFARE from 1 being not important to 5 being extremely important
Please choose only one of the following:

- 1
- 2
- 3
16
In your opinion, what percentage of cows would be lame in herds with realistically optimal HEALTH?
(If it is the same as above, please indicated so)
Please write your answer here:_____________________________________________________

17
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal HEALTH from 1 being not important to 5 being extremely important
Please choose only one of the following:
○ 1
○ 2
○ 3
○ 4
○ 5

18
In your opinion, what percentage of cows would be lame in herds with realistically optimal PRODUCTION?
(If it is the same as above, please indicate so)
Please write your answer here:_____________________________________________________

19
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal PRODUCTION from 1 being not important to 5 being extremely important
Please choose only one of the following:
○ 1
○ 2
○ 3
○ 4
○ 5

Lying Time
20
Below is a graph of the data we have from the Dairy Cluster 1 project on lying time:

Given your knowledge and the information provided, please consider the following questions:

In your opinion, what would the average lying time (h/d) be in herds with realistically optimal WELFARE?
Please write your answer here: ________________________________________

Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal WELFARE from 1 being not important to 5 being extremely important
Please choose only one of the following:

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

In your opinion, what would the average lying time (h/d) be in herds with realistically optimal HEALTH?
(If it is the same as above, please indicate so)
Please write your answer here: ________________________________________

Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal HEALTH from 1 being not important to 5 being extremely important
Please choose only one of the following:

☐ 1
☐ 2
24
In your opinion, what would the average lying time (h/d) be in herds with realistically **optimal** PRODUCTION? (If it is the same as above, please indicate so)

Please write your answer here: __________________________________________

25
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically **optimal** PRODUCTION from 1 being not important to 5 being extremely important.

Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

---

**Body Condition Score (BCS)**
26
Below is a graph of the data we have from the Dairy Cluster 1 project on body condition score:

![Average % of cows with BCS lower than 2.5 per herd](image)

The graph shows the percentage of herds reaching each BCS level. Click to enlarge.
Given your knowledge and the information provided, please consider the following questions:

**In your opinion, what percentage of cows would have a body condition score of over 2.5 or lower in herds with realistically optimal WELFARE?**

Please write your answer here:___________________________________

27

**Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal WELFARE from 1 being not important to 5 being extremely important**

Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

28

**In your opinion, what percentage of cows would have a BCS of over 2.5 or lower in herds with realistically optimal HEALTH?**

(If it is the same as above, please indicate so)

Please write your answer here:___________________________________
29
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal HEALTH from 1 being not important to 5 being extremely important
Please choose only one of the following:
- 1
- 2
- 3
- 4
- 5

30
In your opinion, what percentage of cows would have a BCS of over 2.5 or lower in herds with realistically optimal PRODUCTION?
(If it is the same as above, please indicate so)

Please write your answer here:
____________________________________________________

31
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal PRODUCTION from 1 being not important to 5 being extremely important
Please choose only one of the following:
- 1
- 2
- 3
- 4
- 5

21-Day Pregnancy Rate
Below is a graph of the data we have from DHI for 21-day pregnancy rates:
Given your knowledge and the information provided, please consider the following questions:

In your opinion, what would the average pregnancy rate be in a herd with realistically optimal WELFARE?

Please write your answer here: _______________________________________________________

32
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal WELFARE from 1 being not important to 5 being extremely important

Please choose only one of the following:

○ 1
○ 2
○ 3
○ 4
○ 5

33
In your opinion, what would the average pregnancy rate be in a herd with realistically optimal HEALTH?

(If it is the same as above, please indicate so)

Please write your answer here: _______________________________________________________

34
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal HEALTH from 1 being not important to 5 being extremely important

Please choose only one of the following:

○ 1
○ 2
35
In your opinion, what would the average pregnancy rate be in a herd with realistically optimal PRODUCTION?

(If it is the same as above, please indicate so)
Please write your answer here:_____________________________________________________

36
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal PRODUCTION from 1 being not important to 5 being extremely important
Please choose only one of the following:

○ 1
○ 2
○ 3
○ 4
○ 5

First Calving Age
37
Below is a graph of the data we have from DHI for age at first calving:
Given your knowledge and the information provided, please consider the following questions:

In your opinion, what would the average age of first calving be in herds with optimal WELFARE?

Please write your answer here: ____________________________________________________________

38

Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal WELFARE from 1 being not important to 5 being extremely important

Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

39

In your opinion, what would the average age of first calving be in herds with optimal HEALTH?

(If it is the same as above, please indicate so)

Please write your answer here: ____________________________________________________________

40

Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal HEALTH from 1 being not important to 5 being extremely important

Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

41

In your opinion, what would the average age of first calving be in herds with optimal PRODUCTION?

(If it is the same as above, please indicate so)

Please write your answer here: ____________________________________________________________

42
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal PRODUCTION from 1 being not important to 5 being extremely important
Please choose only one of the following:

- ☐  1
- ☐  2
- ☐  3
- ☐  4
- ☐  5

**Longevity**

Below is a graph of the data we have from DHU for herd longevity:

Given your knowledge and the information provided, please consider the following questions:

In your opinion, what would the average longevity be in herds with realistically optimal WELFARE?
Please write your answer here:_____________________________________________________

Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal WELFARE from 1 being not important to 5 being extremely important
Please choose only one of the following:

- ☐  1
- ☐  2
45
In your opinion, what would the average longevity be in herds with realistically optimal HEALTH?
(If it is same as above, please indicate so)
Please write your answer here:_____________________________________________________

46
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal HEALTH from 1 being not important to 5 being extremely important
Please choose only one of the following:

  O 1
  O 2
  O 3
  O 4
  O 5

47
In your opinion, what would the average longevity be in herds with realistically optimal PRODUCTION?
(If it is same as above, please indicate so)

Please write your answer here:_____________________________________________________

48
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal PRODUCTION from 1 being not important to 5 being extremely important
Please choose only one of the following:

  O 1
  O 2
  O 3
  O 4
  O 5

Injuries
Below is a graph of the data we have from the Diary Cluster 1 project on injuries. The graph shows the average percentage of injuries per herd and provides a scoring method:

**TABLE 1. GENERAL DESCRIPTION OF HOCK INJURY SCORES**

<table>
<thead>
<tr>
<th>Not injured</th>
<th>Injured</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Not injured image" /></td>
<td><img src="image2" alt="Injured image" /></td>
</tr>
<tr>
<td>No Swelling. No hair is missing, some hair loss or broken hair.</td>
<td>Medium swelling (1-2.5 cm) <strong>and/or</strong> lesion on bald area.</td>
</tr>
<tr>
<td><img src="image3" alt="Not injured image" /></td>
<td>Major swelling (&gt; 2.5 cm). May have bald area/lesion.</td>
</tr>
<tr>
<td><img src="image4" alt="Not injured image" /></td>
<td><img src="image5" alt="Injured image" /></td>
</tr>
<tr>
<td>No Swelling or minor swelling (&lt; 1 cm). Bald area on hock</td>
<td><img src="image6" alt="Injured image" /></td>
</tr>
</tbody>
</table>

This is the scoring method that we used:

1 participant identified 40% or lower as an ideal target.

Given you knowledge and the information provided, please consider the following questions:

49

**In your opinion, what percentage of cows would be injured in herds with realistically optimal WELFARE?**

Please write your answer(s) here:

Hock injury%:___________________________________

Knee injury%:___________________________________
Neck injury%: ____________________________________

50 Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal WELFARE from 1 being not important to 5 being extremely important

Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

51 In your opinion, what percentage of cows would be injured in herds with realistically optimal HEALTH?

(If it is the same as above, please indicate so)

Please write your answer(s) here:

Hock injury%: ____________________________________
Knee injury%: ____________________________________
Neck injury%: ____________________________________

52 Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal HEALTH from 1 being not important to 5 being extremely important

Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

53 In your opinion, what percentage of cows would be injured in herds with realistically optimal PRODUCTION?

(If it is the same as above, please indicate so)

Please write your answer(s) here:

Hock injury%: ____________________________________
Knee injury%: ____________________________________
Neck injury%: ____________________________________

54 Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal PRODUCTION from 1 being not important to 5 being extremely important
Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

**Cleanliness**

Below is a graph of the data we have from the Dairy Cluster 1 project on cleanliness:

![Graph showing average percentage of dirty cows per herd](chart.png)

The scoring system that was used is below:
Given your knowledge and the information provided, please consider the following questions:

In your opinion, what percentage of cows would be dirty in herds with realistically **optimal** WELFARE?
Please write your answer(s) here:
Leg: ______________________
Flank: _____________________
Udder: _____________________

56
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically **optimal** WELFARE from 1 being not important to 5 being extremely important
Please choose only one of the following:

- O 1
- O 2
- O 3
- O 4
- O 5

57
In your opinion, what percentage of cows would be dirty in herds with realistically **optimal** HEALTH?
(It is same as above, please indicate so)
Please write your answer(s) here:
58
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal HEALTH from 1 being not important to 5 being extremely important
Please choose only one of the following:

○ 1
○ 2
○ 3
○ 4
○ 5

59
In your opinion, what percentage of cows would be dirty in herds with realistically optimal PRODUCTION?
(It is same as above, please indicate so)

Please write your answer(s) here:

Leg: ____________________________
Flank: __________________________
Udder: __________________________

60
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal PRODUCTION from 1 being not important to 5 being extremely important
Please choose only one of the following:

○ 1
○ 2
○ 3
○ 4
○ 5

Culling
61
Below is a table of the data we have from DHI and Valacta for culling:
And below is a table of the summary of the results from Survey 1:

<table>
<thead>
<tr>
<th>CULLING AND REPLACEMENT RATES IN DAIRY HERDS IN CANADA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of herds enrolled on a milk recording program</strong></td>
</tr>
<tr>
<td><strong>Cows</strong></td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Herds</td>
</tr>
<tr>
<td>Cows</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Culling Reasons</th>
<th>Number of cows</th>
<th>Total (%)</th>
<th>Number of cows</th>
<th>Total (%)</th>
<th>Number of cows</th>
<th>Total (%)</th>
<th>Number of cows</th>
<th>Total (%)</th>
<th>Number of cows</th>
<th>Total (%)</th>
<th>Number of cows</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reproductive</td>
<td>49,468</td>
<td>15.5%</td>
<td>54,230</td>
<td>16.5%</td>
<td>52,323</td>
<td>15.1%</td>
<td>56,677</td>
<td>15.7%</td>
<td>57,592</td>
<td>15.4%</td>
<td>55,650</td>
<td>15.6%</td>
</tr>
<tr>
<td>Mastitis</td>
<td>26,372</td>
<td>8.2%</td>
<td>33,141</td>
<td>9.4%</td>
<td>30,216</td>
<td>8.7%</td>
<td>36,079</td>
<td>9.7%</td>
<td>35,960</td>
<td>9.6%</td>
<td>30,798</td>
<td>8.6%</td>
</tr>
<tr>
<td>Foot and leg problems</td>
<td>19,108</td>
<td>6.0%</td>
<td>22,585</td>
<td>6.4%</td>
<td>20,727</td>
<td>6.0%</td>
<td>23,483</td>
<td>6.3%</td>
<td>20,669</td>
<td>5.8%</td>
<td>19,471</td>
<td>5.5%</td>
</tr>
<tr>
<td>Low milk production</td>
<td>15,613</td>
<td>4.9%</td>
<td>18,571</td>
<td>6.3%</td>
<td>17,302</td>
<td>5.0%</td>
<td>19,972</td>
<td>5.6%</td>
<td>20,956</td>
<td>5.6%</td>
<td>19,471</td>
<td>5.5%</td>
</tr>
<tr>
<td>Sickness</td>
<td>14,104</td>
<td>4.4%</td>
<td>16,979</td>
<td>4.4%</td>
<td>15,968</td>
<td>4.6%</td>
<td>16,832</td>
<td>4.7%</td>
<td>16,915</td>
<td>4.5%</td>
<td>15,722</td>
<td>4.4%</td>
</tr>
<tr>
<td>Injury to udder/teats</td>
<td>11,107</td>
<td>3.5%</td>
<td>13,181</td>
<td>3.8%</td>
<td>11,343</td>
<td>3.3%</td>
<td>12,777</td>
<td>3.6%</td>
<td>14,027</td>
<td>3.8%</td>
<td>11,742</td>
<td>3.3%</td>
</tr>
<tr>
<td>Injury/Accident</td>
<td>9,533</td>
<td>3.0%</td>
<td>10,613</td>
<td>3.0%</td>
<td>10,759</td>
<td>3.1%</td>
<td>11,862</td>
<td>3.3%</td>
<td>11,578</td>
<td>3.1%</td>
<td>11,085</td>
<td>3.1%</td>
</tr>
<tr>
<td>Old age</td>
<td>4,946</td>
<td>1.5%</td>
<td>5,631</td>
<td>1.6%</td>
<td>5,515</td>
<td>1.6%</td>
<td>5,935</td>
<td>1.6%</td>
<td>6,149</td>
<td>1.6%</td>
<td>5,278</td>
<td>1.5%</td>
</tr>
<tr>
<td>Difficult calving</td>
<td>1,756</td>
<td>0.6%</td>
<td>1,968</td>
<td>0.6%</td>
<td>1,925</td>
<td>0.6%</td>
<td>1,837</td>
<td>0.5%</td>
<td>1,921</td>
<td>0.5%</td>
<td>1,869</td>
<td>0.5%</td>
</tr>
<tr>
<td>Bad temperament</td>
<td>1,657</td>
<td>0.5%</td>
<td>2,177</td>
<td>0.6%</td>
<td>1,911</td>
<td>0.6%</td>
<td>2,318</td>
<td>0.6%</td>
<td>2,589</td>
<td>0.7%</td>
<td>2,396</td>
<td>0.7%</td>
</tr>
<tr>
<td>Conformation</td>
<td>1,615</td>
<td>0.5%</td>
<td>1,961</td>
<td>0.6%</td>
<td>1,987</td>
<td>0.6%</td>
<td>2,112</td>
<td>0.6%</td>
<td>2,519</td>
<td>0.7%</td>
<td>2,594</td>
<td>0.7%</td>
</tr>
<tr>
<td>Displaced abomasum</td>
<td>1,491</td>
<td>0.5%</td>
<td>1,567</td>
<td>0.4%</td>
<td>1,478</td>
<td>0.4%</td>
<td>1,171</td>
<td>0.3%</td>
<td>1,203</td>
<td>0.3%</td>
<td>1,029</td>
<td>0.3%</td>
</tr>
<tr>
<td>Milk fever</td>
<td>1,349</td>
<td>0.4%</td>
<td>1,653</td>
<td>0.5%</td>
<td>1,596</td>
<td>0.5%</td>
<td>1,403</td>
<td>0.4%</td>
<td>1,377</td>
<td>0.4%</td>
<td>1,271</td>
<td>0.4%</td>
</tr>
<tr>
<td>Slow milkers</td>
<td>1,181</td>
<td>0.4%</td>
<td>1,546</td>
<td>0.4%</td>
<td>1,306</td>
<td>0.4%</td>
<td>1,646</td>
<td>0.5%</td>
<td>1,834</td>
<td>0.5%</td>
<td>1,485</td>
<td>0.4%</td>
</tr>
<tr>
<td>Abortion</td>
<td>1,088</td>
<td>0.3%</td>
<td>1,170</td>
<td>0.3%</td>
<td>1,011</td>
<td>0.3%</td>
<td>1,099</td>
<td>0.3%</td>
<td>1,015</td>
<td>0.3%</td>
<td>904</td>
<td>0.3%</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>1,022</td>
<td>0.3%</td>
<td>1,189</td>
<td>0.3%</td>
<td>1,169</td>
<td>0.3%</td>
<td>1,154</td>
<td>0.3%</td>
<td>1,441</td>
<td>0.4%</td>
<td>1,333</td>
<td>0.4%</td>
</tr>
<tr>
<td>Staph aureus</td>
<td>799</td>
<td>0.2%</td>
<td>864</td>
<td>0.2%</td>
<td>745</td>
<td>0.2%</td>
<td>858</td>
<td>0.2%</td>
<td>796</td>
<td>0.2%</td>
<td>713</td>
<td>0.2%</td>
</tr>
<tr>
<td>Leukemia</td>
<td>707</td>
<td>0.2%</td>
<td>1,049</td>
<td>0.3%</td>
<td>972</td>
<td>0.3%</td>
<td>779</td>
<td>0.2%</td>
<td>662</td>
<td>0.2%</td>
<td>720</td>
<td>0.2%</td>
</tr>
<tr>
<td>Low fat</td>
<td>60</td>
<td>0.0%</td>
<td>83</td>
<td>0.0%</td>
<td>48</td>
<td>0.0%</td>
<td>64</td>
<td>0.0%</td>
<td>44</td>
<td>0.0%</td>
<td>58</td>
<td>0.0%</td>
</tr>
<tr>
<td>Paratuberculosis</td>
<td>57</td>
<td>0.0%</td>
<td>75</td>
<td>0.0%</td>
<td>93</td>
<td>0.0%</td>
<td>80</td>
<td>0.0%</td>
<td>82</td>
<td>0.0%</td>
<td>51</td>
<td>0.0%</td>
</tr>
<tr>
<td>Low protein</td>
<td>48</td>
<td>0.0%</td>
<td>36</td>
<td>0.0%</td>
<td>42</td>
<td>0.0%</td>
<td>25</td>
<td>0.0%</td>
<td>46</td>
<td>0.0%</td>
<td>37</td>
<td>0.0%</td>
</tr>
<tr>
<td>Unknown</td>
<td>79,326</td>
<td>24.6%</td>
<td>77,761</td>
<td>22.1%</td>
<td>83,227</td>
<td>24.0%</td>
<td>83,830</td>
<td>23.2%</td>
<td>89,122</td>
<td>23.9%</td>
<td>81,909</td>
<td>23.0%</td>
</tr>
<tr>
<td>Total culling reasons</td>
<td>242,465</td>
<td>75.8%</td>
<td>266,910</td>
<td>77.6%</td>
<td>265,588</td>
<td>77.5%</td>
<td>280,323</td>
<td>77.5%</td>
<td>291,301</td>
<td>78.1%</td>
<td>266,614</td>
<td>74.9%</td>
</tr>
<tr>
<td>Culling Rate</td>
<td>34.06%</td>
<td>37.58%</td>
<td>36.58%</td>
<td>38.62%</td>
<td>41.69%</td>
<td>38.29%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Given your knowledge and the information provided, please consider the following questions:
In your opinion, what would the culling percentages be over the course of 1 year in herds with realistically **optimal** WELFARE?
Please write your answer(s) here:
Voluntary:______________________________
Involuntary:____________________________

Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically **optimal** WELFARE from 1 being not important to 5 being extremely important
Please choose **only one** of the following:

○ 1
○ 2
○ 3
○ 4
○ 5

In your opinion, what would the culling percentages be over the course of 1 year in herds with realistically **optimal** HEALTH?
(If it the same as above, please indicate so)
Please write your answer(s) here:
Voluntary:______________________________
Involuntary:____________________________

Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically **optimal** HEALTH from 1 being not important to 5 being extremely important
Please choose **only one** of the following:

○ 1
○ 2
○ 3
○ 4
○ 5

In your opinion, what would the culling percentages be over the course of 1 year in herds with realistically **optimal** PRODUCTION?
(If it the same as above, please indicate so)
Please write your answer(s) here:
Voluntary:______________________________
Involuntary:____________________________
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal PRODUCTION from 1 being not important to 5 being extremely important
Please choose only one of the following:

○ 1
○ 2
○ 3
○ 4
○ 5

Morbidity
67
Below are the tables of data we have pulled from the literature for disease in Canada

![DHI data in first-lactation Holstein cows.](image)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Frequency of disease per herd (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastitis</td>
<td>12.6</td>
</tr>
<tr>
<td>Displaced abomasum</td>
<td>3.7</td>
</tr>
<tr>
<td>Kottska</td>
<td>4.5</td>
</tr>
<tr>
<td>Retained placenta</td>
<td>4.6</td>
</tr>
<tr>
<td>Metritis</td>
<td>10.8</td>
</tr>
<tr>
<td>Acute metritis</td>
<td>10.3</td>
</tr>
<tr>
<td>Endometritis</td>
<td>6.5</td>
</tr>
<tr>
<td>Chronic metritis</td>
<td>5.8</td>
</tr>
<tr>
<td>Cystic ovaries</td>
<td>8.2</td>
</tr>
<tr>
<td>Foot disease</td>
<td>9.2</td>
</tr>
</tbody>
</table>

![Herd level prevalence of foot lesions in 142 tie-stall herds and 38 free-stall herds from March 2004 to May 2005.](image)

<table>
<thead>
<tr>
<th>Lesion</th>
<th>Tie-stall</th>
<th>Free-stall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious lesions</td>
<td>17.9 [9-75.7]</td>
<td>32.9 [9-89.1]</td>
</tr>
<tr>
<td>Ulcers</td>
<td>5.1 [0-37]</td>
<td>12.5 [0-72.7]</td>
</tr>
<tr>
<td>Digital dermatitis</td>
<td>9.6 [0-55.5]</td>
<td>24.4 [0-66.7]</td>
</tr>
<tr>
<td>Foot rot</td>
<td>0.3 [0-9.8]</td>
<td>0 [0-1.2]</td>
</tr>
</tbody>
</table>

Below are the results from survey 1:
Given your knowledge and the information provided, please consider the following questions:

In your opinion, what percentage of cows would be diseased in herds with realistically optimal WELFARE over the course of 1 year? Please specify the disease(s) in question.

Please write your answer here:
________________________________________________________________________
________________________________________________________________________

68
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal WELFARE from 1 being not important to 5 being extremely important
Please choose only one of the following:

〇 1
〇 2
〇 3
〇 4
〇 5

69
In your opinion, what percentage of cows would be diseased in herds with realistically optimal HEALTH over the course of 1 year? Please specify the disease(s) in question.
(If it is the same as above, please indicate so)

Please write your answer here:
________________________________________________________________________
________________________________________________________________________
70
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal HEALTH from 1 being not important to 5 being extremely important
Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

71
In your opinion, what percentage of cows would be diseased in herds with realistically optimal PRODUCTION over the course of 1 year? Please specify the disease(s) in question.
(If it is the same as above, please indicate so)

Please write your answer here:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

72
Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal PRODUCTION from 1 being not important to 5 being extremely important
Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

**Broken Tails**

73
Little research has been done on broken tails in dairy cows, however it has been suggested that the number of broken tails in a herd could be an indicator of the quality of cow handling.
In Your opinion, what percentage of cows in a herd with realistically optimal WELFARE would have broken tails?
Please write your answer here: _______________________________

74

Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal WELFARE from 1 being not important to 5 being extremely important
Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

75

In Your opinion, what percentage of cows in a herd with realistically optimal PRODUCTION would have broken tails?
Please write your answer here: _______________________________

76

Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal PRODUCTION from 1 being not important to 5 being extremely important
Please choose only one of the following:

- 1
- 2
- 3
- 4
- 5

77

In Your opinion, what percentage of cows in a herd with realistically optimal HEALTH would have broken tails?
Please write your answer here: _______________________________

78

Please identify the importance you would place on achieving this target in order to best meet your definition of a herd with realistically optimal HEALTH from 1 being not important to 5 being extremely important
Please choose only one of the following:

- 1
- 2
- 3
Production vs Welfare

79
How strongly do you agree with the following statement:

“In order to maximize dairy cow production, we must sacrifice dairy cow welfare”
1 represents completely disagree, 5 represents completely agree

Please choose only one of the following:

○ 1
○ 2
○ 3
○ 4
○ 5

80
Please elaborate on your answer:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

81
How strongly do you agree with the following statement:

“In order to maximize dairy cow welfare, we must sacrifice dairy cow production”
1 represents completely disagree, 5 represents completely agree

Please choose only one of the following:

○ 1
○ 2
○ 3
○ 4
○ 5

82
Please elaborate on your answer:
________________________________________________________________________
Final Comments

Thank you for taking the time to participate in this survey!

If you feel we have missed something, please leave a comment below. Otherwise, we look forward to sending you the overall results in the coming few weeks!

Feel free to contact us at dairy01@uoguelph.ca with any questions.

If you have no further comments, please click “submit” at the bottom of the page!

Please write your answer here:
II.iv DELPHI SURVEY ROUND 3

Thank you for taking the time to continue with this survey project! This **FINAL** round of the survey will focus on confirming the optimal, yet achievable, welfare targets for Holstein dairy herds in Canada that you provided in earlier rounds.

Please keep in mind these targets are different from minimum acceptable levels. They are meant to be realistic targets that the best herds can, or already do, achieve and that the rest of the industry can strive for!

To help you make informed decisions, the responses from rounds 1 and 2, along with current data from the industry are included. Based on this information, your knowledge and your experience, you will again be asked to provide a target for each animal-based measure.

Please keep in mind that round 1 included open-ended questions, meaning not all participants provided targets for all measures. Therefore the number of responses presented for some measures may be fewer in number in round 1 than in round 2.

This survey should only take 15-20 minutes of your time.

There are 24 questions in this survey

**Name**
1

Please enter your name (first and last). This will remain confidential and will only be used to match up your answers to the previous survey.

Please write your answer here:______________________________

**Lameness**
2

Below is a graph, which was also presented in round 2, of the data we have from the Dairy Cluster project for lameness (identified through locomotion scoring) in 2011.
Below is a graph of the responses received from round 1 and round 2. In round 1, participants were asked to lose animal-based measures they considered to be important for a herd with optimal welfare. Not all participants provided information about each measure listed here and in round 2, this the number of respondents from round 1 may be less than in round 2.

Consider a Holstein dairy farm in Canada that has attained an optimum level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:

What would be the maximum percentage of lame cows you would accept while still considering this Holstein herd to have optimal welfare?
Please choose only one of the following:

- 0-10
- 11-20
- 21-30
○ 31-49
○ 50-70

Make a comment on your choice here:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Body Condition Score (BCS)

Below is a graph, also presented in round 2, of the data we have from the Dairy Cluster project on body condition score:

![Body Condition Score Graph]

Below is a graph of the responses received from round 1 and round 2.

In round 1, participants were asked to list animal-based measures they considered to be important for a herd with optimal welfare. Not all participants provided information about each measure listed here and in round 2, thus the number of respondents from round 1 may be less than in round 2.
And below is an illustration of the scoring system used:

Consider a Holstein dairy farm in Canada that has attained an optimal level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:

What would be the maximum percentage of cows under a BCS of 2.5 would you accept while still considering this Holstein herd to have optimal welfare?

Please choose only one of the following:

- 0-5
Make a comment on your choice here:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

do not hallucinate.

Lying Time
4

Below is a graph, also presented in round 2, of the data that we have from the Dairy Cluster project on lying time in 2011:

Below is a graph of the responses received from round 1 and round 2.

In round 1, participants were asked to list animal-based measures they considered to be important for a herd with optimal welfare. Not all participants provided information about each measure listed here and in round 2, thus the number of respondents from round 1 may be less than in round 2.
Consider a Holstein dairy farm in Canada that has attained an optimum level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:

In your opinion, what would the optimum average lying time (h/d) be in this Holstein herd with realistically optimal welfare?
Please choose only one of the following:

- 8.7-9.6
- 9.7-10.5
- 10.6-11.5
- 11.6-12.3
- 12.4-13.5
- 13.6-14.4
- 14.4+

Make a comment on your choice here:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Injuries
5
Below is a graph, which was also presented in round 2, of the data we have from the Dairy Cluster project on injuries in 2011:
Below is a graph of the responses received from round 1 and round 2. In round 1, participants were asked to list animal-based measures they considered to be important for a herd with optimal welfare. Not all participants provided information about each measure listed here and in round 2, thus the number of respondents from round 1 may be less than in round 2.

This is the scoring method that was used:
Consider a Holstein dairy farm in Canada that has attained an optimum level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:

What would be the maximum percentage of cows with HOCK injuries you would accept while still considering this Holstein herd to have optimal welfare?

Please choose only one of the following:

- 0-5
- 6-15
- 1-25
- 25+

Make a comment on your choice here:

________________________________________________________________________

________________________________________________________________________

What would be the maximum percentage of cows with KNEE injuries you would accept while still considering this Holstein herd to have optimal welfare?

Please choose only one of the following:

- 0-5
- 6-15
- 1-25
- 25+

Make a comment on your choice here:

________________________________________________________________________
What would be the maximum percentage of cows with NECK injuries you would accept while still considering this Holstein herd to have optimal welfare?

Please choose only one of the following:

- 0-5
- 6-15
- 1-25
- 25+

Make a comment on your choice here:

________________________________________________________________________

________________________________________________________________________

Cleanliness

Below is a graph, which was also presented in round 2, of the data we have from the Dairy Cluster project on cleanliness in 2011:

Below is a graph of the responses received from round 1 and round 2. In round 1, participants were asked to list animal-based measures they considered to be important for a herd with optimal welfare. Not all participants provided information about each measure listed here and in round 2, thus the number of respondents from round 1 may be less than in round 2.
The scoring system that was used is below:

<table>
<thead>
<tr>
<th>TABLE 2. GENERAL DESCRIPTION OF CLEANLINESS SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLEAN</td>
</tr>
<tr>
<td><img src="clean_image1.png" alt="" /></td>
</tr>
<tr>
<td><img src="clean_image2.png" alt="" /></td>
</tr>
<tr>
<td><img src="clean_image3.png" alt="" /></td>
</tr>
<tr>
<td><img src="clean_image4.png" alt="" /></td>
</tr>
<tr>
<td>DIRTY</td>
</tr>
<tr>
<td><img src="dirty_image1.png" alt="" /></td>
</tr>
<tr>
<td><img src="dirty_image2.png" alt="" /></td>
</tr>
<tr>
<td><img src="dirty_image3.png" alt="" /></td>
</tr>
<tr>
<td><img src="dirty_image4.png" alt="" /></td>
</tr>
</tbody>
</table>

Consider a Holstein dairy farm in Canada that has attained an optimum level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:

What would be the maximum percentage of cows with dirty LEGS you would
accept while still considering this Holstein herd to have optimal welfare?

Please choose only one of the following:

- O 0-5
- O 6-15
- O 1-25
- O 25+

Make a comment on your choice here:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

9
In your opinion, what percentage of cows would have dirty FLANKS in this Holstein herd with realistically optimal welfare?

Please choose only one of the following:

- O 0-5
- O 6-15
- O 1-25
- O 25+

Make a comment on your choice here:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

10
In your opinion, what percentage of cows would have dirty UDDERS in this Holstein herd with realistically optimal welfare?

Please choose only one of the following:

- O 0-5
- O 6-15
- O 1-25
- O 25+

Make a comment on your choice here:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Longevity

11

Below is a graph, which was also presented in round 2, of the data we have from DHI for herd longevity in 2013:

![Graph of average lactation number per herd](image)

Below is a graph of the responses received from round 1 and round 2.

In round 1, participants were asked to list animal-based measures they considered to be important for a herd with optimal welfare. Not all participants provided information about each measure listed here and in round 2, thus the number of respondents from round 1 may be less than in round 2.

![Graph of longevity responses](image)

Consider a Holstein dairy farm in Canada that has attained an optimum level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:

In your opinion, what would be this Holstein herds’ maximum attainable herd average lactation number?

Please choose only one of the following:
12 How strongly do you agree with the following statement? “Maximizing milk production will compromise dairy cow welfare”

Please choose only one of the following:

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Make a comment on your choice here:

________________________________________________________________________
________________________________________________________________________
_________________________________________________

13 Below is a graph, which was also presented in round 2, showing the distribution of milk production for DHI herds in 2013:
Below is a graph of the responses received from round 1 and round 2. In round 1, participants were asked to list animal-based measures they considered to be important for a herd with optimal welfare. Not all participants provided information about each measure listed here and in round 2, thus the number of respondents from round 1 may be less than in round 2.

Consider a Holstein dairy farm in Canada that has attained an optimum level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:

In your opinion, what would be this Holstein herds’ maximum attainable herd average milk production?
Please choose only one of the following:

- 15-17
- 18-22
- 23-25

Somatic Cell Count (SCC)

Below is a graph, which was also presented in round 2, of the data we have from DHI for Somatic Cell Count in 2013.

Below is a graph of the responses received from round 1 and round 2.
In round 1, participants were asked to list animal-based measures they considered to be important for a herd with optimal welfare. Not all participants provided information about each measure listed here and in round 2, thus the number of respondents from round 1 may be less than in round 2.
Consider a Holstein dairy farm in Canada that has attained an optimum level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:

In your opinion, what is the lowest yearly average SCC this Holstein herd could achieve?
Please choose only one of the following:

- 20-111
- 112-168
- 169-214
- 215-276
- 277-357
- 358-600

Make a comment on your choice here:

________________________________________________________________________
________________________________________________________________________

21-day Pregnancy Rate

Below is a graph, which was also presented in round 2, of the data we have from DHI for 21-day pregnancy rates in 2013:
Below is a graph of the responses received from round 1 and round 2.

In round 1, participants were asked to list animal-based measures they considered to be important for a herd with optimal welfare. Not all participants provided information about each measure listed here and in round 2, thus the number of respondents from round 1 may be less than in round 2.

Consider a Holstein dairy farm in Canada that has attained an optimum level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:

In your opinion, what would be this Holstein herds’ highest attainable 21-day pregnancy rate?

Please choose only one of the following:

- 1-6
- 7-11
- 12-14
- 15-18
- 19-23
- 24-28
First Calving Age

16

Below is a graph, which was also presented in round 2, of the data we have from DHI for age at first calving in 2013:

![Graph showing age at first calving distribution]

Below is a graph of the responses received from round 1 and round 2.

In round 1, participants were asked to list animal-based measures they considered to be important for a herd with optimal welfare. Not all participants provided information about each measure listed here and in round 2, thus the number of respondents from round 1 may be less than in round 2.
Consider a Holstein dairy farm in Canada that has attained an optimum level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:
In your opinion, what would be this Holstein herds’ lowest attainable herd average age at first calving?
Please choose only one of the following:

- 20-23
- 24-25
- 26-27
- 28-29
- 30-31
- 31-48

Make a comment on your choice here:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Culling

17
Below is a link to a table, which was presented in round 2, of the data we have from DHI and Valacta for culling:
http://www.dairyinfo.gc.ca/index_e.php?sl=diffcil&s2=mrrpcle&s3=crtr

Below is a graph of the responses received from round 1 and round 2.
In round 1, participants were asked to list animal-based measures they considered to be important for a herd with optimal welfare. Not all participants provided information about each measure listed here and in round 2, thus the number of
Consider a Holstein dairy farm in Canada that has attained an optimum level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:

In your opinion, what is the optimal percentage of cows that would be VOLUNTRAILY culled over the course of 1 year in this Holstein herd with realistically optimal welfare?

Please choose only one of the following:

- 0-5
- 6-15
- 16-25
- 25+

Make a comment on your choice here:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

In your opinion, what is the optimal percentage of cows that would be INVOLUNTRAILY culled over the course of 1 year in this Holstein herd with realistically optimal welfare?

Please choose only one of the following:

- 0-5
- 6-15
- 16-25
- 25+

Make a comment on your choice here:
Morbidity
19
Below are tables, which were also presented in round 2, of the data we have pulled from the literature for disease in Canada:
**note: the first table related to first lactation cows, and the second relates only to hoof lesions in all parties**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Frequency of disease per herd (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastitis</td>
<td>12.6</td>
</tr>
<tr>
<td>Displaced abomasum</td>
<td>3.7</td>
</tr>
<tr>
<td>Ketosis</td>
<td>4.5</td>
</tr>
<tr>
<td>Retained placenta</td>
<td>4.6</td>
</tr>
<tr>
<td>Metritis</td>
<td>10.8</td>
</tr>
<tr>
<td>Acute metritis</td>
<td>10.3</td>
</tr>
<tr>
<td>Endometritis</td>
<td>6.5</td>
</tr>
<tr>
<td>Chronic metritis</td>
<td>5.8</td>
</tr>
<tr>
<td>Cystic ovaries</td>
<td>8.2</td>
</tr>
<tr>
<td><strong>Foot disease</strong></td>
<td>9.2</td>
</tr>
</tbody>
</table>

Below is a graph of the responses received from round 1 and round 2. In round 1, participants were asked to list animal-based measures they considered to be important for a herd with optimal welfare. Not all participants provided information about each measure listed here and in round 2, thus the number of respondents from round 1 may be less than in round 2.
Consider a Holstein dairy farm in Canada that has attained an optimum level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:

What would be the maximum percentage of cows with FOOT disorders you would accept over the course of 1 year while still considering this Holstein herd to have optimal welfare?

Please choose only one of the following:

- 0-5
- 6-10
- 11-15
- 16-20
- 21-25
- 26-30
- 30+

Make a comment on your choice here:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
20
What would be the maximum percentage of cows with METABOLIC disorders (ketosis, milk fever, DAS etc.) you would accept over the course of 1 year while still considering this Holstein herd to have optimal welfare?
Please choose only one of the following:
- 0-5
- 6-10
- 11-15
- 16-20
- 21-25
- 26-30
- 30+

Make a comment on your choice here:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

21
What would be the maximum percentage of cows with REPRODUCTIVE disorders (retained placenta, dystocia, metritis, etc.) you would accept over the course of 1 year while still considering this Holstein herd to have optimal welfare?
Please choose only one of the following:
- 0-5
- 6-10
- 11-15
- 16-20
- 21-25
- 26-30
- 30+

Make a comment on your choice here:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

22
What would be the maximum percentage of cows with CLINICAL MASTITIS disorders you would accept over the course of 1 year while still considering this Holstein herd to have optimal welfare?
Please choose only one of the following:
Broken Tails

Little research has been done on broken tails in dairy cows, however it has been suggested that the number of broken tails in a herd could be an indicator of the quality of cow handling.

Below is a graph of the results from survey 2 for this question:

Consider a Holstein dairy farm in Canada that has attained an optimal level of cow welfare. Given your knowledge, the information provided above and your experience, please answer the following question:

What is the maximum percentage of broken tails you would accept while still considering this herd to have optimal welfare?

Please choose only one of the following:

- 0-2
- 3-5
Make a comment on your choice here:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Final Comments
Thank you for taking the time to participate in this survey!

If you feel we have missed something, please leave us a comment below. Otherwise, we look forward to sending you the overall results once they have been compiled and analyzed!

Feel free to contact us at dairy01@uoguelph.ca with any questions.

If you have no further comments, please click “submit” at the bottom of the page!

Please write your answer here:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________