Connecting Farmer Well-being with Cattle Health and Perceptions of Wildlife on Dairy and Beef Farms in Western Canada and Ontario

By

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ABSTRACT

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This study surveyed 88 dairy and 17 beef farmers in Western Canada and Ontario to assess farmer well-being, and how it is connected to cattle health and perceptions of wildlife. Well-being was assessed using validated psychometric scales for mental health, sleep and injuries for physical health, and questions about social well-being. The survey additionally assessed farm management, animal health (including mastitis, and calf mortality), and perceptions and management of wildlife. Dairy farm visits (n=66) were conducted to assess lameness, body condition, and knee, neck, and hock lesions on a representative sample of each herd's lactating cows (30% to a maximum of 69 cows). Dairy farmer responses were analyzed statistically, and beef farmer data are presented using descriptive statistics due to a low response rate. For dairy farmers, clinical lameness tended to be negatively associated with stress scores (P=0.07) and anxiety scores (P=0.06), and mastitis incidence was positively associated with stress scores (P=0.02). Beef farmers reported stress related to weather, pasture condition, and finances, but were generally satisfied with their personal relationships at home. Associations between beef farmers' well-being and cattle health could not be drawn in this study. Overall,

there was a connection between farmer well-being and animal health on dairy farms, but more research is needed to determine the factors that influence these associations. Regarding wildlife perceptions, both dairy and beef farmers viewed mice and rats, raccoons, and corvids negatively. Beef farmers additionally had negative perceptions of small mammals and large predatory mammals. Dairy farmers with negative perceptions of mice tended to have higher depression scores (P=0.0002), as well as lower resilience scores (P=0.07), even when considering region. The majority of dairy and beef farmers reported using wildlife control for mice, raccoons, and corvids and reported choosing these methods based on effectiveness, ease of use, and cost.

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CHAPTER ONE:

LITERATURE REVIEW

Introduction

The One Welfare research framework seeks to understand the connections between the overall well-being of humans, animals, and the social and physical environment (García Pinillos et al., 2016). This framework was inspired by, and expanded on, the earlier One Health framework which asserts that animal health, human health, and environmental health all influence each other as summarized by Levov et al. (2017). Both One Health and One Welfare involve interdisciplinary collaboration to understand various health and welfare-related issues more holistically. While the two frameworks seem similar, there is a major distinction between health and welfare. One Health mainly focuses on physical health (Lebov et al., 2017) and the epidemiology of injuries and diseases and the obstacles surrounding treatment. One Welfare, on the other hand, looks at other aspects of well-being not typically included in One Health model, such as people's job satisfaction, mental, social, and emotional well-being, as well as animal welfare indicators including affective states and the ability to engage in natural behaviours (García Pinillos et al., 2016). Additionally, One Welfare looks beyond the physical environment to incorporate aspects of the social environment as well (García Pinillos et al., 2016).

In the past, animal agriculture-related research has been focused mostly on animal

outcomes and suggests changes to barn design and farm management based on animal stress, behaviour, health, and production (Fraser, 2008). Although farmers are generally supportive of promoting good animal welfare practices on their operations (Läpple and Osawe, 2023; Schuppli et al., 2023), they have expressed stress and frustration at the assumption from others (i.e. public, government officials, etc.) that addressing animal welfare includes changes that are "one size fits all" (Balzani & Hanlon, 2020; Smid et al., 2022).

Stress and mental health have been a growing area of concern worldwide, and farmers can be especially vulnerable for a variety of reasons (Hagen et al., 2019). Farming has been deemed to be a particularly stressful profession due to finances, workload, familial support on the farm, new and changing legislation, public perceptions and criticism, and farm transition planning, etc. (Booth and Lloyd, 2000; Deary et al., 1997). Recently, researchers have found that Canadian farmers scored higher on burnout (Jones-Bitton et al., 2019), stress, anxiety, and depression screening questionnaires, and scored lower on resilience questionnaires (Jones-Bitton et al., 2020) as compared to the general public. Rates of suicide have been higher among farmers as compared to non-farmers in the UK and Canada (Hounsome et al., 2012; Sturgeon & Morrissette, 2010).

While farming in general can be a stressful profession, different personal and occupational factors can impact stress and mental health. Demographics like age, gender, and farm type have all been shown to have specific impacts on stress and other indicators of well-being (Jones-Bitton et al., 2020; Rudolphi et al., 2020; Yazd et al., 2019). The majority of occupational stress-related research focuses on farmers as a general population, but it is important to delve into what specific occupational factors seen on different farm types are contributing to this stress.

Livestock farmers experience specific and unique stressors that come with working with animals. For example, farmers in one study expressed stress surrounding animal health, as it can be costly to treat diseases and to have the livestock numbers fluctuate due to health issues and/or involuntary culling (Hagen et al., 2021a). The majority of Irish dairy and beef farmers surveyed in one study reported elevated levels of stress and anxiety due to finances, weather, workload, and to a lesser extent, animal health (Brennan et al., 2022). Livestock farmers may also have specific environment-related stressors as well. For example, human-wildlife conflict, including property damage, crop destruction, livestock predation, management, and prevention strategies, can lead to higher costs for farmers (Hoag et al., 2011). These unique stressors can impact livestock farmers' well-being in different or more severe ways than other agricultural sectors. One study in France found that dairy and beef farmers were at a significantly higher risk of suicide than other farmer groups, due to specific economic pressures (Bossard et al., 2016).

Under the One Health and One Welfare frameworks, it is established that humans have an impact on animals and their environment and vice versa. For livestock farmers, human-animal interactions, including farmer attitudes and behaviour, can influence livestock behaviour and production (Hemsworth, 2003). Farmers further impact their environment with various choices they make, including interaction with wildlife and animal control decisions. With rising stress levels and financial pressures, it is important to understand how farm management, and by extension animal welfare, is connected to farmers' well-being.

Despite there being increased concern regarding farmer mental health and indications that human health and animal health may impact each other, there is limited research on how farmer physical and mental health are connected with animal welfare, health, and production. This literature review aims to explore the impact that beef and dairy farmer well-being and attitudes

have on cattle welfare and wildlife management.

Farmer well-being and cattle welfare

Physical well-being of farmers and cattle welfare

One of the most popular areas of One Health-related research surrounds the identification, pathogenesis, and treatment of zoonotic diseases. As dairy and beef farmers work directly with animals, zoonotic diseases are a higher concern for them compared to crop-based farmers. Globally, at least forty-five zoonotic diseases have been identified to infect both humans and cattle, including bacterial pathogens, viral pathogens, parasites, fungi, and prions (McDaniel et al., 2014). One of the most famous examples of this is the prion disease variant Creutzfeldt–Jakob disease (vCJD), commonly referred to as "mad cow disease," which is a fatal neurological disease that is caused by the ingestion of beef Bovine spongiform encephalopathy (BSE), a similar prion disease found in cattle (Lee et al., 2013). Although the majority of the research surrounding this disease was performed before the popularization of the One Health Framework, understanding the pathogenesis of both BSE and vCJD was crucial to controlling the spread of the disease in both beef cattle and consumers (Janka and Maldarelli, 2004). Currently, there is a push for continued One Health approaches surrounding prion diseases, as diseases like Chronic Wasting Disease in deer and Scrapie in sheep, so that the effect it may have on cattle and other livestock operations can be limited (Shurson et al., 2022).

Other recent studies have been focused on identifying diseases that more commonly affect both farm workers and their animals. One study found that mycotoxins in dairy cow feed can

contaminate milk and lead to negative effects for both the animals and exposed workers (Viegas et al., 2020). Additionally, ticks and tick-borne diseases affect both humans and cattle and other livestock species (Dantas-Torres et al., 2012). This research has identified common issues involving both farmers and their animals. Further research using the One Health framework may lead to breakthroughs in treatments and/or preventions that would be mutually beneficial for humans and farmed animals.

In addition to the identification of zoonotic diseases and their pathogenesis, the treatment of diseases, specifically surrounding antibiotic usage, has been a growing area of One Health research. Antibiotic use on both beef farms (Adator et al., 2020; Cameron and McAllister, 2016) and dairy farms (Jayarao et al., 2019) can result in antibiotic-resistant strains of bacteria and reduced efficacy of antibiotics. Strategies to reduce antibiotic usage while still maintaining animal health on dairy farms (Trevisi et al., 2014) and beef operations (Lhermie et al., 2019) are being developed to reduce antibiotic resistance.

Beyond disease risk, physical health can be further impacted by injuries on the farm. A review of risk factors for musculoskeletal injuries and disorders in farmers found that in addition to age, gender, and other demographic factors, specific occupational chores on dairy farms, like time spent working with animals or milking specifically can increase the risk of both upper and lower extremity musculoskeletal diseases (Osborne et al., 2012). A survey conducted with Norwegian livestock farmers found that approximately 32% of reported injuries involved an animal, although the circumstances surrounding these incidents were not reported (Svendsen et al., 2014). Researchers have reported an increase in injuries to farmers around hoof trimming or ear tagging, which can also be stressful to cattle (Lindsay et al., 2004). Farmers themselves also recognize these trends. A qualitative study involving Swedish dairy farmers found that critical

activities that disrupt daily routines of cattle, like herding, loading for transportation, or hoof trimming, and novel situations, like inseminating or milking a heifer for the first time are often most hazardous for dairy farm workers (Lindahl et al., 2012) Training and limiting risky behaviour around stressful situations, like hoof trimming may be helpful to limit these injuries(Nielsen and Norup, 2024), though there is limited research in this area.

Treating herds, and keeping disease prevalence low, may also be physically stressful (Kolstrup and Hultgren, 2011). One study found that farm managers experience higher injury and more symptoms related to musculoskeletal disease on farms where there is lower herd prevalence, overall, of a variety of clinical diseases, including mastitis, hoof lesions and other leg injuries, puerperal metritis, and teat lesions among other health factors (Kolstrup and Hultgren, 2011). Kolstrup and Hultgren (2011) concluded that both treatment and managing hygiene and cleanliness of both the animals and the barn is physically demanding work and is likely the cause of the association between farmer health and herd level health. Another factor impacting injuries of farmers while handling cattle would be staff knowledge, as research has shown that a major factor in cattle-related injuries is behaviour of the handler (Nielsen and Norup, 2024), which can be addressed using training.

While not common, fatal animal-involved accidents happen on farms. In one study of farm-related emergency room intakes in the United States, animal-related injuries were the most common reason for admission and the third most lethal after machinery accidents and vehicle-involved accidents (Damroth et al., 2019). Of the reported animal-related lethal accidents in that study, the specific species of animals involved were not cited (Damroth et al., 2019), however, other literature found that working with cattle and horses is considered most hazardous (Dogan and Demirci, 2012). The circumstances surrounding animal-involved lethal accidents,

specifically what chores or interactions with the animal were occurring at the time of the accident, are not well documented.

Farm environment and management factors can also be a risk to both farmers and livestock. Within a barn, there is growing evidence that indoor air pollution caused by air-borne particulates can have a significant impact on the respiratory health of both stock people and animals (Cambra-López et al., 2010). Additionally, farmers, in general, have been shown to be at a higher risk for cardiovascular diseases (van Doorn et al., 2017) and pulmonary diseases like Chronic Obstructive Pulmonary Disease (Guillien et al., 2018). Though cardiovascular and pulmonary diseases, in these cases, appear to be a workplace hazard, there is little research into what management, or environmental causes could be impacting farmers' health, highlighting a need for this issue to be view through a One Health lens.

Other farm-level management level factors can be associated with farmers' physical health. On dairy farms specifically, changing to an automated milking system (AMS) has been associated with a perceived reduction in musculoskeletal stress and a reduction in injury or musculoskeletal disease risk in farmers (Karttunen et al., 2016), and using AMS has been shown to be associated with less clinical lameness (Matson et al., 2022) and can be used for clinical mastitis detection (Naqvi et al., 2022) in cattle. The switch to AMS, in these cases, has been linked to both better health outcomes for both dairy farmers and their cattle.

In a broader sense, the environment surrounding the farm can impact both cattle and farmers. There has been a recent push to use a One Health approach to explore the impact of climate change in agriculture, as there is growing evidence that it can impact the spread of zoonotic diseases, access to healthcare and veterinary care, and increase weather and climate variability which all have negative impacts on both farmers and their livestock (Zinsstag et al.,

2018), though much of this research is little research in this area and it is generally not specific to dairy farming.

Mental well-being of farmers and cattle welfare

Traditionally-held mindsets in the farming community, including stoicism and self-reliance, likely reduce the likelihood farmers are to seek mental health support and receive a diagnosis if they do seek help (Hull et al., 2017). These attitudes towards work, and the animals they work with, may also impact animal health and welfare on the farm. Both personality and attitudes of farmers have been shown to be associated with animal health, welfare, and productivity on dairy farms (as reviewed by Adler et al., 2019). In one study of farmer personality, milk yield was positively associated with empathy and job satisfaction, but negatively associated with negative beliefs towards animal handling practices (Hanna et al., 2009). Another study found that farmers with higher empathy scores had more positive views of their animals, had fewer cows with lesions, but also had lower milk production than farmers with lower empathy scores (Kielland et al., 2010). The connection between empathy and milk yield were different in each study, highlighting a need to further understand farmer characteristics and they're connection to milk yield.

Although negative farmer attitudes towards animals can negatively impact animal welfare, researchers have demonstrated that perceptions and attitudes of animals can change. One study found that cognitive-behavioural intervention, or attitude- and behaviour-targeted training, improved stockperson's attitudes, and interactions with cattle on dairy farms and was also associated with a reduction of cattle flight distance and a slight increase in milk production

(Hemsworth et al., 2002). In this case, cognitive behavioural intervention was related to targeting workplace attitudes and behaviours by showing farmers fact-based evidence to support low stress animal handling techniques (Hemsworth et al., 2002), and research on attitude and behaviour intervention is often workplace-focused rather than on the individual. Currently, the research related to therapy or cognitive behaviour intervention focuses on incidences related to the workplace. In this case, the intervention was related to handling and workplace action, and does not address mental health of the farmers or farm workers, as that was not the goal of the study. There is no research on how treatment related to how seeking treatment for mental health or longer-term therapies or cognitive behaviour interventions have impacts on farms. There is research surrounding the effectiveness and accessibility of therapy for farmers and people living in rural areas (Bowyer et al., 2023; Freund et al., 2020; Kennedy et al., 2023), however there is little research focused on how receiving therapy effects or is affected by the work environment on the farm and the care and health of livestock.

One of the major areas of One Welfare research surrounds identifying factors that may lead to animal neglect. Animal neglect is uncommon on farms, but farmers facing financial, social, or psychiatric issues are more likely to be charged with animal neglect (Andrade and Anneberg, 2014). A study involving cattle and sheep found that stress surrounding lack of access to social and mental health support, finances, and existing mental health issues affect farm animal welfare and may also be contributing factors in neglect cases (Devitt et al., 2015).

Illness within the herd can impact livestock farmers' stress and mental well-being. For example, an outbreak of foot and mouth disease in Europe resulted in the culling of over 6.42 million animals in the UK, causing major economic impacts for farmers, and leaving many dairy farmers distressed (Mort et al., 2005). During these foot and mouth disease outbreaks, farmers

reported higher rates of severe Post Traumatic Stress Disorder (PTSD)-related symptoms (Olff et al., 2005), stress, and depression (Van Haaften et al., 2004). Similarly, this relationship between livestock disease outbreaks and farmer mental health has been seen across commodity groups. Sheep farmers impacted by ovine Johne's disease reported emotional distress surrounding outbreaks and were reported feeling further distressed by mandated government control programs (Hood and Seedsman, 2004). The link between disease rate and beef and dairy farmers' mental well-being has also been documented on farms impacted by BSE (Mitra et al., 2009) and bovine Tuberculosis (Crimes and Enticott, 2019).

Other aspects of animal health and animal care can further impact farm workers' well-being. Compassion fatigue, a specific form of burnout that comes with caring for others (Stoewen, 2019), is common in both veterinary and non-veterinary animal care workers (Hill et al., 2019). Though there is limited farmer-specific research on compassion fatigue, there is some limited evidence that animal care decisions, specifically culling decisions, can have a negative impact on farmers' mental health. A study surveying South Korean frontline and government workers in charge of making culling decisions during zoonotic disease outbreaks found that workers involved in more stressful procedures (i.e., culling) are more likely to display depression, trauma, and PTSD-related symptoms (Park et al., 2020a). This study did not involve farmers specifically, however it does highlight the need to perform a similar study with livestock farmers, as they are often making these decisions. Culling rates and cow longevity have been linked to farmer attitude, as farmers who were dissatisfied with culling rates and longevity and those who prioritized production had higher cull rates and lower cow longevity (Rilanto et al., 2022).

Working with livestock, on the other hand, can have a positive effect on mental well-

being. In a study involving women in rural areas of the Democratic Republic of Congo, Glass et al. (2014) found that livestock ownership was related to a decrease in PTSD and depression symptoms in women who experienced conflict and trauma. However, research on positive psychosocial impacts of livestock farming is limited. Some benefits of livestock farming, especially surrounding the socio-economic and health benefits, are primarily focused on farming in developing countries (Herrero et al., 2013). Animal-assisted therapy, including therapy involving interaction with cows and other livestock, has been used as a treatment for a variety of disorders, including depression, schizophrenia, and alcohol or drug addiction in the general public (Kamioka et al., 2014) though has Been shown to have a limited effect on anxiety (Berget et al., 2023). Currently the existing research is limited to the general public is little to no research on the therapeutic benefits of working with animals in farmers or farm workers. Some benefits of working with animals seen general public may not be seen in farmers, as farmers rely on the animals economically, but more research into determining the benefits (if any) of working with animals is needed, as it could provide a more nuanced insight into the connection between farmer well-being and animal welfare.

Animal health and production have also been linked to farmers' mental health and well-being, especially within the dairy industry. Farmers with better mental well-being and lower stress had herds that scored more positively on an animal welfare index, built on Norwegian animal welfare standards including milk yield, life span, metabolic health, udder health, fertility, hoof trimming and de-horning (Hansen and Østerås, 2019). In this study, mental health was seen to be connected to animal welfare in general, though since everything was scored in an index, it is hard to conclude which animal welfare indicators are directly connected in this case. In Japan, animal health indicators like milk quality, among other factors, had a negative association with

depression rates in farm managers with farms producing milk with lower protein content experiencing higher rates of depression (Kato et al., 2022). In this case, economic factors and farm management factors were theorized to be connected to the relationship between depression and milk quality, though more research would be needed to determine if this is the case.

This connection between farmer mental health and animal health is further demonstrated when other farm management factors are considered. On AMS farms, stress and anxiety were positively associated with severe lameness prevalence, while resilience was negatively associated with milk yield (King et al., 2021) meaning that farmers with less healthy or productive cows often had poorer well-being. Though that study was a pilot study with a limited sample size, King et al. (2021) theorizes that though mental health of farmers is influenced by a variety of factors, there is a clear interaction between cattle health and farmer well-being that should be studied under the One Welfare framework.

While installing new technology may improve farmers' mental health in the long run, the installation process and adaptation to new technology can also be stressful. Hansen et al. (2020) found that the installation of AMS can cause farmers to express stress surrounding "data overload". Alpass et al. (2004) additionally found that older farmers particularly struggle with the stress involved with the installation of new technologies as compared to younger farmers.

Farm environment and social environment factors can further influence both farmer well-being and animal health. For example, on smaller-scale dairy farms in the Eastern Alps region, farmers who are more satisfied with their land organization (land that is often more accessible and less fragmented in the mountain regions) and farmers who report having positive engagement with their community scored higher on animal welfare assessments (Spigarelli et al., 2021). More general environmental factors may impact farmers' mental well-being and animal

health. For example, drought and weather conditions are shown to be major stressors for farmers and impact animal welfare (Vins et al., 2015). With the advent of climate change and climate variability becoming a greater concern, farmers are expressing greater levels of climate-related anxiety, especially as it begins to impact farm profitability (Howard et al., 2020).

Farmers and Wildlife

Farmer well-being, perceptions, and management of wild animals

While there is limited research on dairy or beef farmer perceptions and attitudes towards wildlife specifically, it is important to remember that multiple factors may impact their perceptions. Attitudes toward wildlife species have been linked to demographic factors, including gender, education level, and farm type (Maas et al., 2021). In a study of German and Austrian farmers, Maas et al. (2021) found that farmers with higher education were more likely to consider biodiversity as highly important for agriculture production and ecosystem resiliency. Additionally, women and organic farmers were also more likely to think favorably of different classifications of animals for the perceived ecological benefit they provide (Maas et al., 2021). Attitudes towards wildlife have also been shown to change over time (Conover et al., 2018). Farmers' direct interaction (personally seeing or dealing with wildlife) and indirect interactions (wildlife present on farms and interacting with livestock, equipment, etc.) may impact their perceptions of different wildlife species. Animals involved in direct human-wildlife conflict at higher rates are more likely to be viewed negatively (Seoraj-Pillai & Pillay, 2016). These views are locationally dependent, as wildlife and access to control methods are unique to each

geographic location.

Indirect conflict further impacts farmers' perceptions of wildlife. The perceived need for wildlife control has been linked to perceived crop damage or livestock harm (Conover et al., 2018). However, the perceived economic impact and acceptability of loss have been shown to differ from actual crop and livestock loss; farmers often view the loss to be much greater than what can actually be attributed to wildlife (Goodale et al., 2015). These discrepancies are influenced by other perceptions of the animals such as aesthetics and whether that animal is perceived as physically threatening (Goodale et al., 2015). These authors also reported that perceptions of wild animals were impacted by the perceived threats to humans (Goodale et al., 2015), however, injuries or accidents relating to wildlife conflict are not well documented. A review of human-wildlife conflict found that the perceived human and livestock harm from carnivores, and the perceived harm to property from other mammals, may be overstated and the perceived need for control is likely more connected to the "charisma", or lack thereof, of a species (Peterson et al., 2010). Peterson et al. (2010), further argues that the use of human-wildlife conflict has become overused, as it has come to refer to crop damage livestock damage, property damage, etc. rather than direct interactions between humans and wildlife. The overuse of the term human-wildlife conflict, for example, could contribute to the labeling of certain large carnivorous mammals as "dangerous" or diminish the "charisma" of some species, when there is little to no threat between the animals and the nearby human population (Peterson et al., 2010) .

While human-wildlife conflict can impact the physical health of farmers, farmers' mental well-being may also be impacted by wildlife conflict, but there is less research to support this. There is some indication that interaction with species deemed as pests in a home environment can have an impact on mental health in the general public (Shah et al., 2018), however, there is

limited research on how wildlife conflict specifically impacts farmers' mental well-being. One Australian study found little association between natural resource management, wildlife biodiversity or conservation with farmer mental health (Batterham et al., 2022), however, that study focused on only Australian grasslands, and different ecosystems may yield different results. As mentioned previously, attitudes and perceptions of animals are impacted by perceived loss rather than actual loss, so further research on the connection between finances, wildlife management, and mental health could provide further insight. This is further exemplified in studies looking at farm sustainability in general. In one Canadian study of adaptive multi-paddock grazing, a high-density short-term rotational grazing method used to promote land sustainability and forage quality, farmers who employed this method had higher self-reported physical well-being, even though there was a financial barrier to using this method of grazing for some farmers (Sherren et al., 2022). This was likely connected to the fact that farmers who chose to use adaptive multi-paddock grazing tended to have non-traditional values, like the tendency to prioritize enjoying life over other things like finances or minimizing risks, compared to other ranchers (Sherren et al., 2022).

Wildlife present or near livestock farms can be a concern for farmers, as they can act as a vector or reservoir for zoonotic diseases. During an outbreak of bovine tuberculosis (bTB) near Riding Mountain National Park in Manitoba, farmers in the affected region reported greater concern surrounding the outbreak when there were higher numbers of elk sighted on their farm, as elk are a vector for bTB (Brook and McLachlan, 2006). In this instance, management strategies that limit cattle interaction with elk were found to be important for both animal health and limiting farmer concerns (Brook and McLachlan, 2006). Several diseases can pass from wildlife to cattle and/or farmers; for example, a higher prevalence of bTB was seen on cattle

operations that allow outdoor access and grazing on farms on the Iberian Peninsula in Spain and Portugal (González-Barrio, 2022), and in Riding Mountain in Canada (Brook and McLachlan, 2006). This means that, when it comes to disease-related fears, beef farmers may be more concerned with wildlife than the average dairy farmer in Canada, as dairy cattle are more likely to be housed indoors.

The attitudes and perceptions towards wildlife can impact the welfare of wildlife in the control methods that farmers choose to employ. Livestock losses contribute to a general negative perception of large carnivore species leading many farmers surveyed to opt for lethal control methods in one study (Whitehouse-Tedd et al., 2021). In another study, researchers found that in Australia where livestock welfare and limiting human-wildlife conflict are prioritized over wild animal welfare, dingoes and wild dog predation are typically controlled through lethal means as they are most effective in limiting harm to livestock (Allen and Hampton, 2020). Conversely, in another survey, cherry and blueberry farmers who reported that natural predators (in this case predators of fruit eating birds, mice, and/or other agricultural pests) and beneficial insects had a significant role on their farms were more likely to adopt less lethal conservation practices like preventative pest management and principles of Integrated Pest Management (Bardenhagen et al., 2020). Additionally, while perceptions of wildlife can be dependent on farm type, these perceptions of specific species or species groups also directly predict farmers' decision to control or attract these animals on farm with negatively viewed animals had the greatest likelihood of being controlled (Kross et al., 2018).

Animal control practices used on the farm can further impact the health and welfare of both farmers and wild animals. Wildlife control including on-farm biosecurity measures are crucial for stopping the spread of zoonoses among humans and livestock (Sleeman et al., 2017).

However, the choice of control method is impactful. Multiple studies have shown that the use of pesticides, including herbicides, insecticides, and rodenticides, have been shown to impact human physical health, animal health, and environmental health long term (Poudel et al., 2020). Pesticide use has also been linked to negative impacts on farmers' mental health as well, in part related to the fact that prolonged interaction with the chemicals within some pesticides has been linked to the development of anxiety, mood disorders, and in some cases depression and schizophrenia (Khan et al., 2019). Additionally, lethal methods, like rodenticides, not only pose a risk to human health at times, but also can be environmentally harmful as they are often non-specific and can impact other non-target wildlife species, such as other small mammals and predator birds, impacting local biodiversity (Elmeros et al., 2019).

Research Gaps in the Literature

In research linking farmers' mental and physical health to animal welfare, most studies focus on animal outcomes like disease rates and performance. Many measured responses are linked to the profitability of the animal, and while disease risk and milk production are important indicators of welfare, they should not be the only indicators of animal welfare. Research should be expanded to encompass more measures of dairy cow welfare like behaviour and other aspects of physical health like lesions, body condition, and lameness. There is also limited research looking into the effects of both farmer mental health and barn design on animal health and production. While it is likely that all three are related, most research only focuses on only two of those factors. Interdisciplinary research using mixed methods under the One Health and/or One

Welfare framework could help identify the relationship between animal welfare, farmer well-being, farm management, and environmental health more clearly.

Much of the research on farmer mental health aims to identify specific stressors and problems impacting farmers. While there are identified barriers to mental-health support in rural areas and farming communities (Hagen et al., 2021b), as it becomes more accessible and tailored to farmers' specific needs, long-term research examining the impacts of seeking and receiving mental health care on animal health and farm management should be conducted.

Research surrounding farmers' perception of wildlife is limited in Canada. It is important to perform this research in different geographic locations as wildlife species and conflicts may differ. Understanding attitudes towards wildlife and current animal control practices can be crucial to aiding wild animal welfare so that better alternatives can be recommended which are specific to each ecosystem type. Additionally, more research to understand common wildlife-related stress on farms, beyond the threat of zoonoses, should be performed. There is research that considers the effects that farmer demographics and farm type have on perceptions of wildlife and use of control methods, however, there is limited research that considers the relationship between human mental health and human-wildlife conflict, whether the conflict is causing stress or whether the mental well-being of an individual influences their perception of different species.

Projects goals and hypothesis:

The objective of this thesis was to understand the connection between farmers' mental and physical well-being, cattle welfare, and environmental health.

The first project seeks to understand the connection between farmer well-being and cattle health on dairy and beef farms in Western Canada and Ontario by:

1. Studying associations between dairy farmer mental health (stress, anxiety, depression, and resilience) and physical health (sleep and injuries received on farms), and cow welfare (lesions, lameness, body condition, mastitis, calf mortality) on dairy farms.
2. Identifying other factors that may influence dairy farmer well-being and cattle health.
3. Describing the physical, mental, and social health and well-being of beef farmers, their farm management practice, and animal health on their operations.

The author hypothesized that there would be associations between cattle health and farmer well-being, and that farmers who are less stressed, have lower scores for depression or anxiety, and/or higher scores for resilience would have a lower prevalence of animal health issues.

The second project seeks to describe and understand associations between farmer well-being, perceptions of wildlife, and control methods used to control wild animals by:

1. Assessing farmer perceptions of wildlife species commonly identified in Western Canada and Ontario and how they are associated with farmer well-being.
2. Identifying perceived benefits and nuisances of these wildlife species.
3. Describing the relationships between perceived benefits, nuisances, overall perceptions of, and wildlife control methods used on dairy and beef farms.

It is hypothesized that farmers have more negative perceptions of animals that they view as causing nuisance, and those negative perceptions are related to the use of animal control methods on the farm. Additionally, it is hypothesized that perceptions of wildlife on the farm are associated with the well-being of the farmers surveyed.

CHAPTER TWO:

CONNECTING FARMER WELL-BEING AND CATTLE WELFARE ON CANADIAN CATTLE FARMS

Introduction

Farming has historically been a stressful occupation (Berkowitz and Perkins, 1984; Deary et al., 1997). Farmers experience occupational and social stress surrounding several factors including financial pressures, workload, familial support on the farm, and government regulations (Booth and Lloyd, 2000b). In Canada, farmers have reported higher levels of stress, depression, anxiety (Jones-Bitton et al., 2020; Thompson et al., 2023), and burnout (Jones-Bitton et al., 2019) in comparison with the general population. Different types of farming operations also carry different stressors. For example, animal health (Brennan et al., 2022) and the financial uncertainty caused by the unpredictability of animals and animal production (Hagen et al., 2021a) make livestock production particularly stressful. The market can further complicate the unpredictability of livestock farming as the pricing, size of operations, housing, risk of disease, and regulation can vary (Nozières et al., 2011; Deary et al., 1997). The occupational stress of livestock farming is also uniquely high, not only compared to the public, but also in comparison with crop farmers (Sanne et al., 2004). Globally, some researchers have demonstrated that dairy farmers express higher levels of stress compared to the general public (Kolstrup et al., 2008;

Wallis and Dollard, 2008). Similar studies have reported high levels of stress in livestock farmers, including beef farmers (Simkin et al., 1998).

This is further exemplified when considering the stress surrounding the care of cattle. The mental health of cattle farmers is often negatively impacted when disease outbreaks impact their herds, as shown during mass outbreaks of foot-and-mouth disease (Olff et al., 2005), bovine tuberculosis (Crimes and Enticott, 2019), and bovine spongiform encephalopathy or "mad-cow disease" (Mitra et al., 2009). The act of caring for sick or injured animals may also be stressful, both physically and emotionally. One study found that preventing and treating diseases, like mastitis and cattle injuries, was related to increased injuries and musculoskeletal disease in farmers (Kolstrup and Hultgren, 2011).

Compassion fatigue and burnout related to caring and making healthcare decisions for others are often a concern for animal care professionals like veterinarians (Hill et al., 2019; Stoewen, 2019) and there is some evidence, although limited, that this may apply to farm workers as well (Park et al., 2020a). Commonly noted hazards in cattle farming, or dairy and beef production, are often physical. Animal-related injuries are among the most common reasons for farmers to require hospitalization and these injuries can be lethal (Damroth et al., 2019). Large animals, specifically cattle and horses, are more likely to be the cause of animal-related injury, putting dairy and beef farmers at higher risk for injury (Dogan and Demirci, 2012).

With the physical, mental, and emotional load of farming cattle, there is some indication that farmer well-being and animal welfare may be interconnected. The "One Welfare" framework asserts that human well-being, animal welfare, and environmental well-being are all connected (García Pinillos et al., 2016). In agriculture, these connections may be impacted by the on-the-farm environment, including farm management, social support for farmers, and barn

design, among other factors. Severe lameness prevalence, for example, has been linked to stress and anxiety levels on Canadian dairy farms using automated milking systems (AMS) (King et al., 2021b). In a Norwegian study, Hansen and Østerås (2019) found that positive mental well-being of dairy farmers was associated with a higher score on an animal welfare created by the researchers, which included health and welfare factors like milk yield, life span, udder health, metabolic health, and fertility, among other factors. On Japanese dairy farms, several animal health indicators, including milk protein content, were negatively associated with depression rates in dairy farm managers (Kato et al., 2022).

Understanding this connection is crucial to preserving the health and well-being of both farmers and animals, as research in this area is currently quite limited. This study aims to use a One Welfare approach to understand the connection between farmer well-being and cattle welfare on dairy and beef operations. It is hypothesized that a higher prevalence of cattle injuries, disease, and poor welfare indicators would be connected to more negative physical and mental well-being outcomes for the farmer caring for those animals.

Materials and Methods

Recruitment

Approval to conduct research with human participants was granted by the Research Ethics Board (REB) at the University of Manitoba for both dairy farmers (HE2023-0015) and beef farmers (HE2022-0039). The use of animals in this study was approved by the University of Manitoba Animal Care Committee (AC11823, F2023-014). Farmers were recruited through

several means for the dairy study: emails via farmer organizations, social media posts, online and print magazines, flyers handed out during farmer events, and phone calls using contact information from public-facing websites. Beef farmers were recruited using social media posts, flyers handed out during farmer events and meetings, and emails via farmer organizations.

For both studies, farmer surveys were hosted online using the survey platform Qualtrics (Provo, Utah, USA) to collect responses. Both surveys were open May 2023 to April 2024. To be eligible to participate in the survey, participants had to provide consent to participate in the study, be over the age of 18 years old, and identify as a primary or secondary/co-decision maker of a commercial dairy or beef operation located in one of the target provinces (British Columbia, Alberta, Saskatchewan, Manitoba, or Ontario). More than one response was allowed per operation, although there were not enough multi response farms to compare responses within the farm. Respondents were offered a $15 Tim Hortons gift card as an honorarium for participation.

The beef study involved one online survey, whereas the dairy study included two online surveys; dairy farmers were asked to complete a recruitment survey to ensure their eligibility and indicate their willingness and availability to allow researchers to visit their farm. Those who were interested in farm visits received the link to the full survey a few days before their farm visit whereas those who were only interested in the survey portion received a link to the full survey soon after submitting their recruitment survey.

The dairy recruitment survey received many spam responses, however, there were steps taken to remove spam responses based on several criteria approved by the REB for screening, including: participants not meeting the requirements of the study or participant IP addresses, phone numbers area codes located outside the target locations or where they said their operation was located, nonsense responses (including nonsense email or names that only included random

characters), responses including non-English characters, and/or incomplete responses. The surveys were not emailed to respondents determined to be spam. For the dairy survey, following the initial screening, there were 133 responses. Those surveys were screened again for legitimacy, and blank or nonsense responses were removed from inclusion using a REB-approved screening protocol, leaving 87 legitimate and complete responses.

For the beef farmer survey, over 4,400 responses were received, which many were likely spam, as most were completed immediately after a social media post. Non-complete responses and responses that did not meet the inclusion criteria mentioned earlier made up most of the spam responses and were removed from analysis. The remaining responses were screened using provided names, emails, IP addresses, and phone numbers and compared against the reported demographic information (i.e. province). Responses including IP addresses reported outside Canada or the province reported in the survey were removed from analysis. Responses missing or having suspicious email or phone numbers (i.e., phone numbers with area codes outside the province they reported living in, or emails that did not match the name reported) were flagged. Responses were further screened and any nonsense responses (i.e. repeat responses, contradictory responses, included non-English characters or gibberish strings of text, reported owning little to no cattle or an unreasonable number of cattle, etc.). Responses that were flagged for 3 or more reasons were removed from the dataset for analysis, as approved by the REB. After screening for spam responses, 17 verified responses remained.

Survey Design

Both the dairy and beef surveys included the same demographic questions (age, province of operation, decision-making status, and gender identity), as well as questions about workload,

social support, financial and succession or transition planning (for the purposes of this study, transition and succession planning are used interchangeably), and a list of stressors to rate (**Appendix 1** and **Appendix 2**). The survey provided to dairy farmers was comprised of 104 questions and had additional questions about occupational health (including sleep and injuries on the farm), animal housing and management, mastitis incidence, and calf mortality (as described below and in **Appendix 1**). The survey provided to beef farmers was compromised of 88 questions and asked farmers to report different health data about their cattle including: conception rates, weaning rates, feed efficiency, mortality rates for calves under 3-months, mortality rate, proportion of euthanized cows, and any bovine illnesses treated (**Appendix 2**). However, only weaning rate, conception rate, and calf mortality are reported as those were the only health indices that were consistently completed by the farmers participating in this study.

Well-being Assessments

To assess farmer well-being, both the dairy and beef surveys used validated psychometric scales to assess stress, anxiety, depression, and resilience. These scales were chosen as they have previously been used to assess farmers' mental health and well-being in Canada (King et al., 2021; Thompson et al., 2022). For farmers participating in the on-farm cattle health assessments, they were asked to fill out the survey as close to the assessment date as possible, as the psychometric scales capture well-being over a specific period of time.

Stress was assessed using the Perceived Stress Scale (PSS), which is a 10-question scale where participants rate their response on a scale of 0 (never) to 4 (very often) based on thoughts and feelings from the past month (Cohen et al., 1983). Scores were totaled (range from 0 to 40)

where a score of 0 to 13 was considered low stress, 14 to 26 was moderate stress, and 27 to 40 was high stress.

Resilience was scored using the Connor Davidson Resilience Scale 10-question scale (CD-RISC 10) and was used to assess individual's ability to adapt to change and bounce back from challenges, based on their feelings in the past month (Campbell-Sills and Stein, 2007; Connor and Davidson, 2003). Participants were asked to rate 10 questions on a scale of 0 to 4, with participants' scores ranging from 0 (low resilience) to 40 (high resilience).

The Patient Health Questionnaire (PHQ-9) is a 9-question scale used to screen for depression (Kroenke et al., 2001). Based on their experiences in the past two weeks, participants were asked to rate 9 scenarios on a scale of 0 (not at all) to 3 (nearly every day). Based on their responses, participants receive a score between 0 and 27. Scores were categorized as none or minimal risk for depression (0 to 4), mild (5 to 9), moderate (10 to 14), moderately severe (15 to 19), or severe (20 to 27).

Participants were screened for anxiety using the General Anxiety Disorder Scale (GAD-7), which involves 7 items scored on a scale of 0 (not at all) to 3 (nearly every day) based on whether the participant was bothered by different problems in the last 2 weeks (Spitzer et al., 2006). Participants received a score of 0 to 21 with a score of 0 to 4 to considered minimal risk for anxiety, 5 to 9 as mild risk, 10 to 14 as moderate risk, and 15 to 21 as severe risk.

Participants were then asked to rate farming-specific stressors on a scale of 1 (never) to 5 (very often) to indicate how often they find them stressful. Stressors included weather, drought, flooding, wild-fires, water pricing, feed pricing, feed availability, pasture condition, animal health and/or welfare, marketing and market prices, human resource management, policy and

regulations, public perceptions, workload, implementation and learning new technology, and public perception. Farmers were also allowed to indicate "other" and specify a different stressor in a text box. Dairy farmers were also asked to rate their stress surrounding the continuation of quota, the value of quota, energy pricing, raw milk pricing, and animal rights activists.

Dairy farmers were additionally asked questions about their physical well-being. Participants were asked about the average amount of sleep they have nightly and whether they are satisfied with the amount of sleep they get. They were also asked what types of major injuries they received on the farm (including broken bones or fractures, major bruising, burns, chronic use injuries or conditions, contusions, concussions or head injuries, dislocations or sprains, lacerations requiring stitches, partial or complete loss of hearing or vision, respiratory disease, tendon lesions or injuries and/or amputations). The farmers who received injuries were asked to identify factors that contributed to their injuries including animal involvement, equipment, machinery usage, or work environment.

Animal Health and Welfare Assessments

Farmers were asked to report the number of cattle on their operation and were additionally asked to provide data for some animal health variables. Beef farmers were asked to report approximate mortality rate for calves under 3 months old, conception rates and weaning rates for cow-calf operations, and approximate feed efficiency, mortality rate, and proportion of euthanized cows on feedlot and backgrounding operations. Dairy farmers were asked to report the approximate mortality rate for calves under 3 months old, and the number of mastitis cases (including recurring cases for a single cow) for the past year. Additionally, in-person farm visits

were conducted to assess cow health and welfare measures from June 2023 to October 2023. To be eligible for participation, farmers must have met the previously mentioned criteria, and they were further required to have a minimum of 30 cows in their lactating herd. To assess animal health and welfare, researcher surveyed 30% of the lactating herd, with a minimum of 30 cows and a maximum of 69 cows (Van Os et al., 2019). This means in smaller cows a larger number of cows were sampled. Systematic random sampling was used to select every nth cow for assessment depending on herd size and sample size (ex. every 3rd cow if scoring 30 out of 100). This ensured both lying and standing animals, as well as cattle found in all areas of the barn, or cows located both inside and outside depending on the barn design were included in the assessment. Assessments were representative of pen size and included lactating cows located in sick pens, if applicable. The knees, necks, and hocks of cows were assessed for bald spots and lesions and scored on a scale of 0-3, as outlined by Gibbons et al. (2012). Knees and neck were categorized as "Acceptable" (score of 0 or 1) or "Requires Attention" (score of 2 or 3) while hock lesions were categorized numerically. Because very few farms had any neck lesions that were scored as "required attention", neck lesion scores were not included in any analyses, but mean and standard deviation are reported.

Loose-housed dairy cattle (free-stall or bedded pack) were locomotion scored to assess lameness on a scale of 1 to 5 with 1-point increments, as outlined by Flower and Weary (2009), with a score of ≥3 considered clinically lame and ≥4 considered severely lame. Lameness on tie-stall farms was assessed using 4 behavioural indicators: placement of one or more hooves on the edge of the stall when stationary, repeated weight shifting, repeated resting of one or more foot, and uneven movement or reluctance to bear weight on a particular foot when the cow is encouraged to move from one side of the stall to the other (Leach et al., 2009). A cow with 2 out

of 4 behaviours present was considered clinically lame and a cow displaying 3 or 4 behaviours was considered severely lame (Leach et al., 2009). On tie-stall farms where cows were seasonally kept outdoors or were not in stalls during the assessment, cows were locomotion-scored using the 5-point scale.

Body condition score (BCS) was assessed on a scale of 1 to 5 with 0.25-point increments, as outlined in Edmonson et al. (1989). A cow was considered under-conditioned with a score of <2.75, and over-conditioned with a BCS of >3.25, in accordance with the recommended practices set by the Canadian National Farm Animal Care Council (NFACC) Codes of Practice for the Care and Handling of Dairy Cattle (NFACC, 2023).

Two trained observers performed all on-farm assessments. Both researchers received training for the scoring described above and achieved an interobserver reliability kappa value of 0.881 for lameness, 1 for hock lesions, and 0.87 for body condition scoring before starting farm visits. Sixty-six farm visits were conducted, however, 4 farms involved in the cattle health assessments did not submit a completed survey. There were 4 farms with two responses from both a primary and a secondary or co-decision maker. Both participants' responses were included in the analyses because farmers were considered the experimental unit and not the farm itself. For the analysis involving the on-farm animal health assessments, 66 responses were included.

Statistical Analyses

Statistical analyses were conducted using R Studio (R Core Team, 2024). Prior to analysis, all raw values (total number of cows with lameness, low/high BCS, etc.) were divided by the number of cows surveyed to calculate the prevalence of each. The number of mastitis

cases over the past 12 months were divided by the total number of lactating cows in the herd to calculate incidence. Data were then checked for normality using Shapiro tests, and only PSS and CD-RISC were normally distributed. To achieve normality, variables were transformed using the square root function (GAD, BCS outside normal range, and high BCS) or square root of the (variable+0.5) for PHQ. Because normality could not be achieved for the remaining animal health and farmer well-being variables, animal health data was categorized into two groups of either ≥5% ("yellow") vs. <5% ("green") OR >0% ("some") vs. =0% ("none") depending on the prevalence. For mastitis incidence, farms were divided into two groups: ≥10% vs. <10%. Calf mortality was categorized as <2%, 2 to 4%, or >4%. As there was a very low overall neck lesion prevalence across all the farms surveyed (<1%), they were not included in the analysis. Farmer well-being variables were categorized in the categories mentioned above, as recommended by each scale. Because CD-RISC has no set recommended categories and the data were normal, it was kept as a continuous variable.

For all analyses, significance was declared at $P \leq 0.05$ and tendencies at $0.05 < P \leq 0.10$. Animal health data was considered the predictor variable, and the farmer well-being data was considered the outcome variable, similar to the analysis performed by King et al. (2021). When mental well-being scores were the dependent variable, t-tests were performed using animal outcomes as the predictor variable. For analysis of categorical values, chi-square tests and bon-ferroini corrections were used. Univariable analyses was conducted first and covariates, including which were gender, farm type (tie stall vs. loose housing), percent of time spent working with animals, region, milking system (AMS vs. conventional), relationship satisfaction with nutritionist, relationship satisfaction with veterinarian, and decision-making status (primary decision-makers vs. secondary/co-decision makers), were examined. Farmers' satisfaction with

their professional relationships with both veterinarians and nutritionists were heavily skewed, with the majority of farmers somewhat or very satisfied with their veterinarian and nutritionist relationships, so these were ultimately not used for analysis. If a variable was related to a continuous well-being indicator at a confidence level of $P \leq 0.05$, it was included in a multivariable ANOVA using that variable and cattle health variable with the well-being indicator the demographic variable was associated with. If a variable was related to a categorical well-being indicator at a confidence level of $P \leq 0.05$, it was included in chi-square tests.

The beef survey response rate was so low (n=17) and lacked the power to perform statistical analysis. Therefore, the data were presented using descriptive statistics.

Results

Participation and Demographics

Of the total 87 dairy survey responses, the majority of responses the survey responses were from Ontario (n=43), followed by Manitoba (n=15), British Columbia (n=15), Alberta (n=12), and Saskatchewan (n=2). For analyses, respondents from Manitoba, Saskatchewan, and Alberta were grouped and referred to as "the Prairies" (n=29). About two thirds of the participants were male (n=59) and one third were female (n=29). Participants identified with the following age categories: 18 to 24 (n=1), 25 to 34 (n=22), 35 to 44 (n=34), 45 to 54 (n=15), 55 to 64 (n=12), and 65 or older (n=2). Participants represented primary decision makers (n=47) and secondary or co-decision makers (n=40). All farmers owned and/or managed their farm for at least one year, with 12 managing their farm for 1 to 4 years, 26 for 5 to 9 years, and 48 for 10 or

more years. Finally, 45 reported using robotic milking systems and 42 reported using conventional systems, while 72 had loose housing (freestall or bedded pack) and 15 had tie-stall housing.

Of the 17 responses to the beef survey, 11 farmers were located in Manitoba, 3 were from Saskatchewan, 1 was from British Columbia, and 1 was from Ontario. There were no responses from Alberta. There was a similar number of male (n=9) and female (n=8) participants. Participants categorized their age as follows: 18 to 29 (n=2), 30 to 39 (n=3), 40 to 49 (n=5), 50 to 59 (n=4), and 60 or older (n=3). Additionally, 12 participants self-identified as primary decision makers, while 4 participants self-identified as secondary or co-decision makers. The majority of participants (n=11) owned or managed their operation for more than 10 years, compared to those who owned and managed their operation between 5 and 10 years (n=2) or less than 5 years (n=3); one participant did not respond to this question. All 17 participants were from cow-calf operations, with 6 participants having either a backgrounding or feedlot enterprise in addition.

Dairy Farmer Well-being

Dairy farmer well-being scores are described in **Table 1**. The mean score for the farmers' (n=87) perceived stress (PSS) was 18.4, with the majority of farmers experiencing moderate stress (69%), followed by low stress (19.5%) and high stress (11.5%). The mean resilience (CD-RISC 10) score was 27.7. The average score for the depression questionnaire (PHQ-9) was 5.99, with 41.4% of farmers scoring at minimal risk for depression, 39.1% mild risk, 16.1% moderate risk, and 2.3% severe risk. The average score for the anxiety questionnaire (GAD-7) was 5.63 with 47.1% at no or minimal risk for anxiety, 32.1% mild risk, 16.1% moderate risk, 3.4%

moderate-severe risk, and 1.1% severe risk. For categorical analysis, those at moderate or severe risk for depression and those at moderate, moderately-severe, or severe risk for anxiety were grouped as there was relatively few participants in those groups.

Table 1: Descriptive statistics of mental health scores for dairy farmers surveyed in Western Canada and Ontario, Canada.

	Mean	SD	Range	N
Stress (PSS)[1]	18.4	±6.5	3.0-33.0	87
Resilience (CD-RISC 10)[2]	27.7	±6.3	10.0-40.0	87
Depression (PHQ-9)[3]	6.0	±4.5	0.0-24.0	87
Anxiety (GAD-7)[4]	5.6	±4.5	0.0-21.0	87

[1]Stress was assessed using the perceived stress scale (PSS) which scores participants on a scale of 0 to 40 (Cohen et al., 1983).

[2]Resilience assessed using the Connor-Davidson 10 item Resilience Scale (CD-RISC 10) which scores participants on a scale of 0 to 40 (Campbell-Sills and Stein, 2007).

[3]Depression was assessed using the Patient Health Questionnaire (PHQ-9) which scores participants on a scale of 0 to 27 (Spitzer et al., 1999).

[4]Anxiety was assessed using the General Anxiety Disorder 7 item questionnaire (GAD-7) which scores participants on a scale of 0 to 21 (Spitzer et al., 2006).

Regarding physical health, the majority of farmers reported one or more injuries or chronic health conditions occurring as a result of working on the farm in the past (88.5%), with only 11.5% reporting no injuries. Additionally, 65.5% of those surveyed (or 74.0% of those reporting injuries) reported one or more injuries or chronic conditions related to working directly with animals. Animal-related injuries were the most commonly reported cause of injury, followed by machinery-involved injuries (49.4%) and injuries caused by the working

environment (49.4%). Of the farmers who reported injuries, 18.2% reported their injuries were caused by other means including: repetitive movement related to milking (n=6) or general clumsiness (n=3).

Of those who reported one or more injuries on the farm (n=77), the most reported injuries were major bruises (58.4%), chronic use injuries and/or joint pain (62.3%), broken bones and/or fractures (44.2%), lacerations requiring stitches (41.6%), dislocation and/or sprains (40.3%), and burns (35.1%). Further, 23.4% of farmers reported contusions to the head, concussions and/or other head injuries, 19.5% reported tendon injuries, 13% reported partial or complete loss of hearing, 7.8% reported respiratory disease, 1.3% reported partial or complete loss of vision, and 1.3% reported amputation. Nine participants selected "other" where to further contextualize an injury or included injuries not listed including poisoning, injury-related infections, or knocked out teeth. Most dairy farmers (57%) were not satisfied with the amount of sleep they get per night, with 54% reporting getting 5 to 6 hours of sleep per night on average, 40.2% getting 7 to 8 hours of sleep, and 5.7% getting less than 5 hours of sleep.

The mean dairy farmer mental health scores are somewhat similar to Canadian farmers in other studies. While it is improper to statistically compare the two groups based on different sample sizes, demographics, and other factors, comparing to the literature helps contextualize the current study, though there are no conclusions drawn based on these comparisons. Participants in the present study may have been more resilient, with an average score of 27.7 compared to the farmers surveyed by Thompson et al. (2022), with an average score of 24.7. Additionally, farmers' average stress scores (18.4) in this study were likely similar to average scores of Canadian farmers (18.4) surveyed by Jones-Bitton et al. (2020) and the scores of farmers (18.7) surveyed by Thompson et al. (2022), but they may have been higher compared to the Ontario

dairy farmers (16.8) surveyed by King et al. (2021). Average dairy farmer anxiety scores in the current study (5.63) were likely lower than the average Canadian farmer (6.12) as surveyed by Thompson et al. (2022). Finally, the average depression score in the present study (5.99) was numerically higher, than the average for farmers in the Thompson et al. (2022) study (5.89), though likely similar.

Dairy Cattle Welfare

The prevalence of animal health indicators is described in **Table 2**. The average prevalence for knee and hock lesions requiring attention was 4.1% ± 4.8% and 4.8% ± 7.2%, respectively. The prevalence of neck lesions requiring attention was 0.06% ± 0.36%, which was so low that it was decided not to include neck lesions in the analysis. The average prevalence of clinical and severe lameness was 7.9% ± 7.8 and 2.3% ± 2.9%, respectively. The prevalence of cows with a body condition score outside the target range (2.75-3.25) was 16.2% ± 11.7%, with more over-conditioned cows (13.9% ± 11.7%) than under-conditioned cows (2.4% ± 4.2%).

Mastitis incidence and calf mortality rates were self-reported in the survey as described in **Table 2**. A few respondents chose not to report their mastitis or calf mortality data; therefore, the sample sizes were 76 and 74, respectively. Some reported their calf mortality and mastitis incidence as "less than 5%" or "less than 1%", which could not be averaged. These responses were still used in analysis using categorical data.

The prevalence of the animal health indicators was much lower than the average prevalence reported in other studies (see **Table 2**). The majority of the animal health prevalence data were not normally distributed, so comparisons to literature are descriptive. Matson et al. (2022) and King et al. (2021) reported a clinical lameness prevalence of 28.3% and 26.5%

respectively, which is higher than the reported prevalence of the current study, 7.9%. Severe lameness prevalence found in this study (2.3%), however, was likely similar to both previous studies; King et al. (2021) and Matson et al. (2022) reported 2.4% and 3% respectively.

The prevalence of body condition scores outside the target range (both over-conditioned and under-conditioned) in this study was 16.2%, likely lower than the prevalence of 17.0% reported by King et al. (2021), but likely higher than the prevalence of 10.5% reported by Matson et al. (2022), though Matson et al. (2022) considered cows higher than 3.75 over conditioned, while a value of 3.5 was used in the current study. The prevalence of over-conditioned cows (13.8%) in this study was higher than both King et al. (2021) and Matson et al. (2022), 11.4% and 10.5% respectively, though, again, Matson et al. considered over-conditioned cows a score of 3.75 or greater. Matson et al. (2022) and King et al. (2021) reported a slightly higher prevalence of under-conditioned cows, 4.7% and 5.6% respectively, compared to the prevalence of 2.3% in the current study. Farms in this study had lower prevalence of knee lesions (4.1%) and much lower hock lesion prevalence (4.8%) compared to the range reported by Jewell et al. (2019) of 13.6% to 16.6% for knee lesions and 38.7% to 39.3% for hock lesions, with the lower values occurring in freestall farms and the higher values occurring in tie-stall farms.

The average self-reported mastitis incidence (16.9%) was also lower than the Canadian average of 23 cases per 100 cows per year reported by Riekerink et al. (2008). The mean reported mortality rate for calves under 3 months old in this study (3.7%) was slightly lower than the rate reported by Winder et al. (2018), who reported a pre-weaning mortality prevalence of 6.4%.

Table 2: Descriptive statistics of the number of cows and prevalence of animal health indicators on dairy farms in Western Canada and Ontario, Canada.

	MEAN	SD	Range	N
Number of cows per farm (lactating)	146.0	±174.8	30-1100	87
Knee lesions[1, 2]	4.1%	±4.8%	0-26.7%	66
Hock lesions[1, 2]	4.8%	±7.2%	0-28.6%	66
Neck lesions[1,2]	0.06%	±0.36%	0-2.6%	66
Under-conditioned cows (bcs <2.75)[1]	2.3%	±4.2%	0-20.7%	66
Over-conditioned cows (bcs >3.25)[1]	13.9%	±11.8%	0-55.2%	66
Clinical lameness[1, 3]	7.9%	±7.8%	0-33.3%	66
Severe lameness[1, 4]	2.3%	±2.9%	0-10.3%	66
Mastitis incidence (cases per year)[4]	16.8%	±17.4%	0-85.1%	76
Calf mortality[4]	3.7%	±3.3%	0-20.0%	74

[1]On farm assessments were performed to assess knee lesions, hock lesions, lameness, and body condition scores between May and September 2024.

[2]Hock, knee, and neck lesion prevalence include lesions scored 2 or 3 out of 3 on the lesion scoring scale outlined by Gibbons et al. (2012).

[3]Clinical lameness was considered a score of 3 or more out 5 using the lameness scale for free housed cows (Flower and Weary, 2009) and 2 or more out of 4 behaviours in tie stall housing (Leach et al., 2009).

[4]Severe lameness was considered a score of 4 or 5 out 5 using the lameness scale for free housed cows (Flower and Weary, 2009) and 3 or 4 out of 4 behaviours in tie stall housing (Leach et al., 2009).

[4]Farmers self-reported mastitis and calf-mortality as part of a survey.

Using t-tests, stress scores were associated with mastitis incidence and clinical lameness prevalence. Farmers with clinical lameness prevalence of <5% tended to have higher stress scores (P=0.074) as compared to ≥5% lameness prevalence (**Figure 1**), and farmers with mastitis incidence <10% had lower stress scores (P=0.023) as compared to those with ≥10% mastitis incidence (**Figure 2**). Anxiety scores were associated with clinical lameness prevalence in a t-test (P=0.064) with farmers that had ≥5% lameness prevalence having lower anxiety scores than those with <5% prevalence (**Figure 3**).

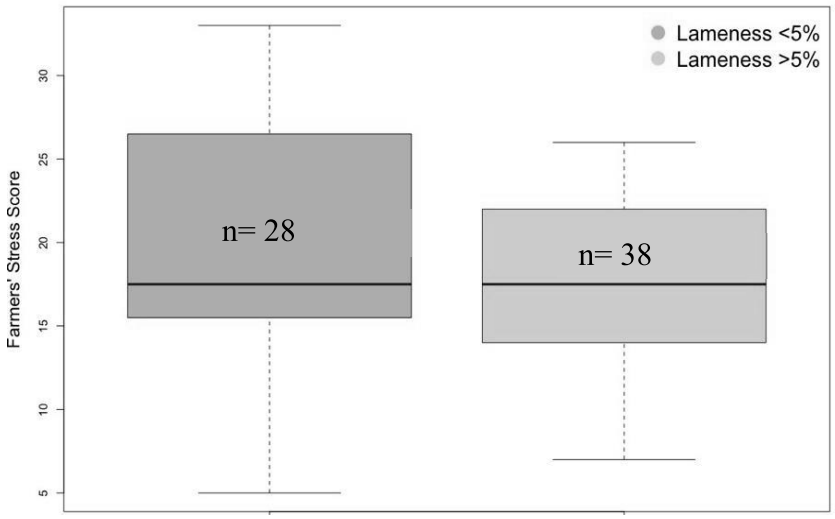

Figure 1: Stress scores[1] for farmers with a lameness prevalence of <5% and farmers with a clinical lameness prevalence[2] of ≥5% on dairy farms in Western Canada and Ontario, Canada

[1]Stress was assessed using the perceived stress scale (PSS) which scores participants on a scale of 0 to 40 (Cohen et al., 1983).

[2]Clinical lameness was considered a score of 3 or more out 5 using the lameness scale for free housed cows (Flower and Weary, 2009) and 2 or more out of 4 behaviours in tie stall housing (Leach et al., 2009).

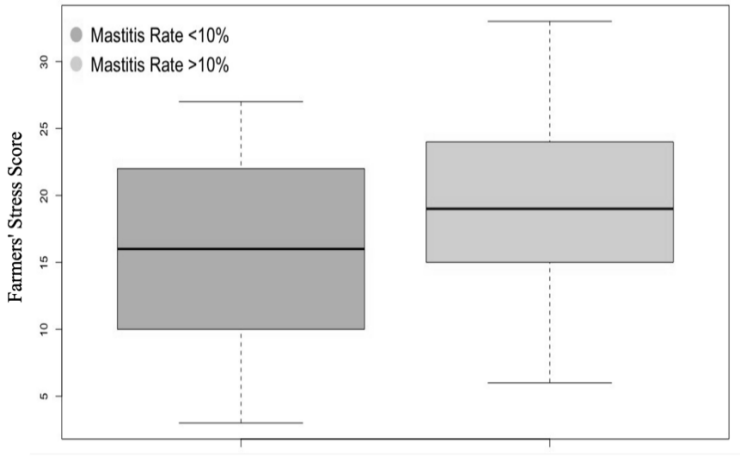

Figure 2: Stress scores[1] for farmers with a mastitis prevalence[2] of <10% and farmers with a mastitis prevalence of 10% on dairy farms in Western Canada and Ontario, Canada

[1]Stress was assessed using the perceived stress scale (PSS) which scores participants on a scale of 0 to 40 (Cohen et al., 1983).

[2]Mastitis prevalence was self-reported by farmers.

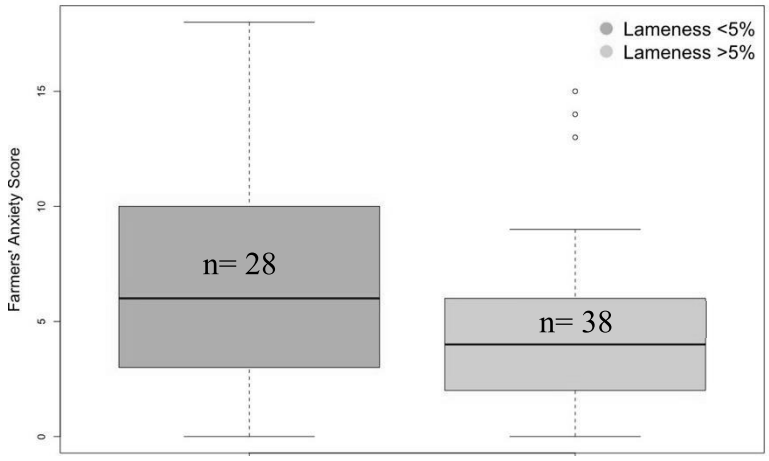

Figure 3: Anxiety scores[1] for farmers with a clinical lameness prevalence[2] of <5% and farmers with a lameness prevalence of ≥5% on dairy farms in Western Canada and Ontario, Canada

[1]Anxiety was assessed using the General Anxiety Disorder 7 item questionnaire (GAD-7) which scores participants on a scale of 0 to 21 (Spitzer et al., 2006).

[2]Clinical lameness was considered a score of 3 or more out 5 using the lameness scale for free housed cows (Flower and Weary, 2009) and 2 or more out of 4 behaviours in tie stall housing (Leach et al., 2009).

The association between animal health and farmer physical health (sleep amount and animal-related injuries) was also examined. Farmers with <5% clinical lameness prevalence were more likely to experience animal-related injuries (P=0.094) compared with those with ≥5% lameness prevalence **(Figure 4)**. Resilience scores (CD-RISC), depression scores (PHQ), and the amount of sleep participants got were not significantly associated with any animal health outcomes using t-tests or chi-squared tests.

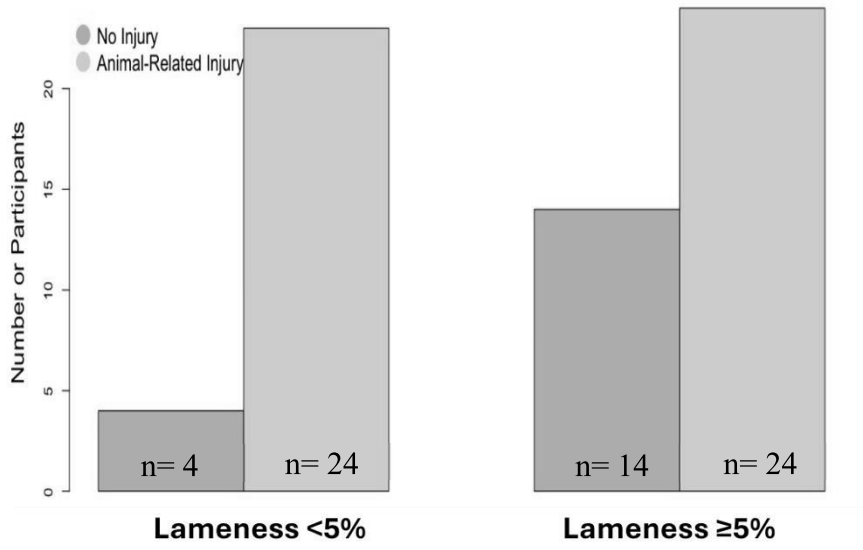

Figure 4: Animal-related injuries reported by farmers with a lameness prevalence[1] of <5% and farmers with a lameness prevalence of ≥5% on dairy farms in Western Canada and Ontario, Canada.

[1]Clinical lameness was considered a score of 3 or more out 5 using the lameness scale for free housed cows (Flower and Weary, 2009) and 2 or more out of 4 behaviours in tie stall housing (Leach et al., 2009).

Farmer well-being was then examined to determine if there was an association with any key factors other than animal health. Region was associated with anxiety (P=0.01), with farmers from the Prairies scoring significantly lower for anxiety than farmers from British Columbia

(P=0.03). Resilience scores were also found to be associated with decision-making status, with primary decision makers scoring higher for resilience, on average, than secondary or co-decision makers (P=0.04), as seen in Figure 6. Based on these associations, anxiety and resilience were analyzed with animal health indicators and with either region or decision-making status, respectively, as covariates. While including province as a covariate with anxiety, clinical lameness prevalence and anxiety (**Figure 5**) were still associated (P=0.085). While British Columbia and Ontario had higher anxiety scores than the Prairies, farmers with <5% clinical lameness prevalence had higher anxiety scores than those with ≥5% clinical lameness

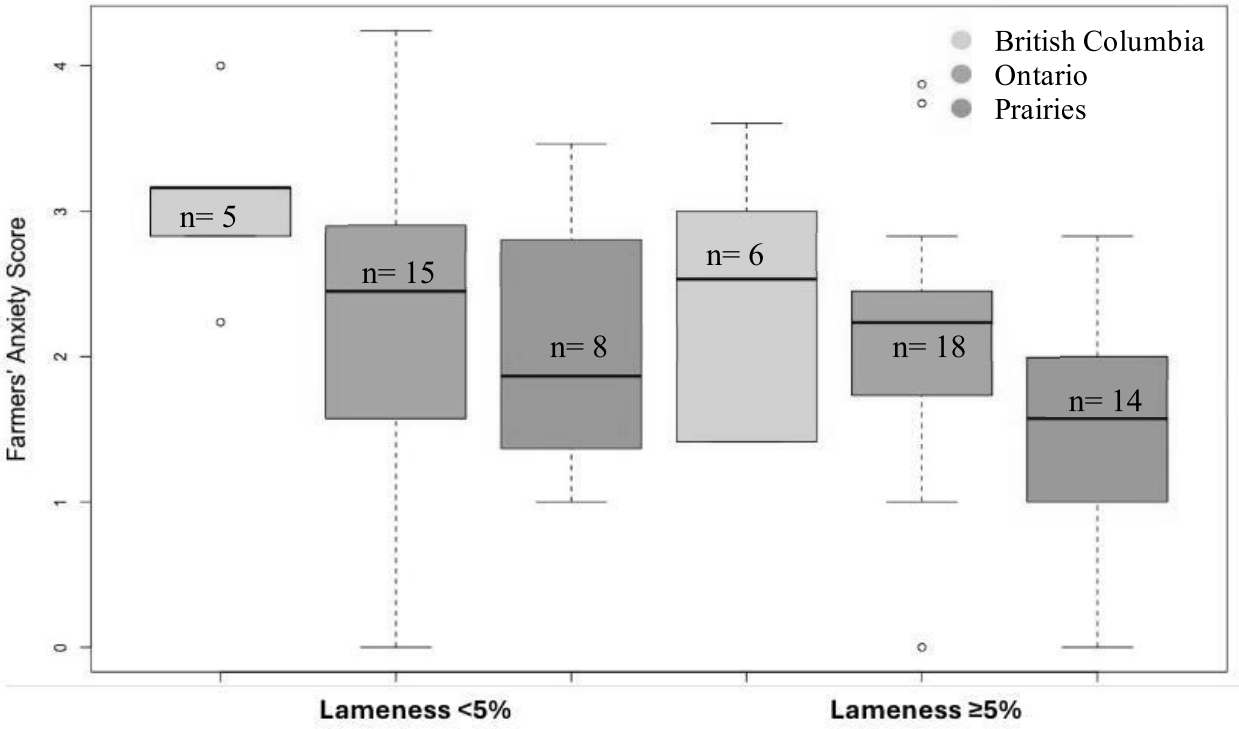

Figure 5: Anxiety scores[1] of farmers with a clinical lameness prevalence[2] of <5% and farmers with a lameness prevalence of ≥5% on dairy farms in Western Canada and Ontario, Canada.

[1]Anxiety was assessed using the General Anxiety Disorder 7 item questionnaire (GAD-7) which scores participants on a scale of 0 to 21 (Spitzer et al., 2006).

[2]Clinical lameness was considered a score of 3 or more out 5 using the lameness scale for free housed cows (Flower and Weary, 2009) and 2 or more out of 4 behaviours in tie stall housing (Leach et al., 2009).

When including decision-making status as a covariate, the percentage of cows with a BCS outside the target range (both over and under-conditioned) still tended to be associated with resilience scores (P=0.08) where those with <5% of cows outside the target BCS range had higher resilience scores than ≥5% of cows outside that range (**Figure 6**).

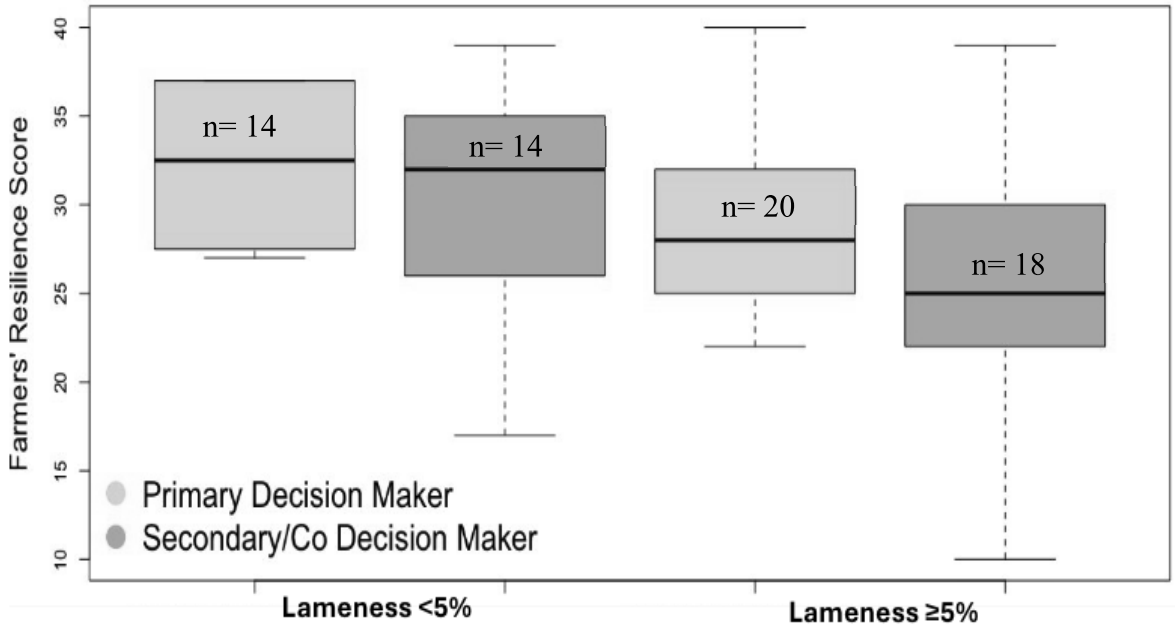

Figure 6: Resilience scores[1] of farmers in Western Canada and Ontario, Canada with a prevalence of <5% and ≥5% of cows with body condition scores outside the target range (2.75-3.25) compared by farmers' decision-making status.

[1]Resiliences was assessed using the Connor-Davidson 10 item Resilience Scale (CD-RISC 10) which scores participants on a scale of 0 to 40 (Campbell-Sills and Stein, 2007).

Beef farmer well-being, farm management, and cattle health

The mean number of animals on the operations was 133.1 ± 124.1 calves, 150.9 ± 137.8 cows, 43.2 ± 59.6 steer, and 8.6 ± 10.0 bulls. The mean calf mortality prevalence was 4.8% ± 4.6% (n=15). The mean conception rate 93.9% ± 4.3% (n=14). The mean weaning rate was

96.8% ± 3.4% (n=11). Farmers were also asked to report which diseases/health conditions they have treated on their operation. Common responses included pneumonia or respiratory illnesses, hoof/foot rot, and pink eye. Bloat, mastitis, and lameness were also reported.

Due to the small sample size (n=17), there was not enough power to run statistical analyses, and therefore, all results are descriptive. Farmer well-being scores are described in **Table 3**. The average perceived stress score for beef farmers was 18.6 with the majority scoring moderate (81.3%), followed by low stress (12.5%) and high stress (6.3%). The average resilience score for the beef farmers surveyed was 26.8 out of 40. Most farmers scored minimal risk for depression (37.5%), followed by moderate risk (31.3%), mild risk (18.8%), and severe risk (12.5%). The average depression score on the PHQ-9 was 8.7. The average anxiety score on the GAD-7 was 7.5 with 31.3% scoring no or minimal risk for anxiety, 31.3% mild risk, 25% moderate risk, and 12.5% moderately-severe. No beef farmers in this study scored as severe risk for anxiety.

Based on how farmers rated each stressor on the 5-point Likert scale, it was determined that farmers reported being most stressed by weather, followed by pasture condition, and farm and personal finances. Work-load pressures, drought, feed availability and/or prices, and marketing and/or market prices were also stressful "fairly often" or "very often" for the majority of respondents. Farmers in this study had limited stress from HR management, flooding, wildfires, water pricing, and public perception. Additional stressors that farmers added included lack of technology literacy, government oversight and interference, and child safety on the farm.

When asked what resources would best help managed their stress, the most beef farmers selected "making more time for things I enjoy" (47.1%), "better access to financial support resources" (35.3%), "reducing workload" (29.4%), and "better access to production support

resources" (29.4%). Several people selected "Other" and expanded on types of support they would find helpful, including specific types of financial support or presumably humorous remarks requesting "better weather".

Table 3: Descriptive statistics of mental health scores for beef farmers surveyed in Western Canada and Ontario, Canada.

	Mean	SD	Range	N
Stress (PSS)[1]	19.2	±5.8	9.0-33.0	17
Resilience (CD-RISC 10)[2]	25.6	±7.7	7.0-40.0	17
Depression (PHQ-9)[3]	8.7	±5.6	1.0-19.0	16
Anxiety (GAD-7)[4]	7.5	±5.3	0.0-18.0	16

[1]Stress was assessed using the perceived stress scale (PSS) which scores participants on a scale of 0 to 40 (Cohen et al., 1983).

[2]Resiliences was assessed using the Connor-Davidson 10 item Resilience Scale (CD-RISC 10) which scores participants on a scale of 0 to 40 (Campbell-Sills and Stein, 2007).

[3]Depression was assessed using the Patient Health Questionnaire (PHQ-9) which scores participants on a scale of 0 to 27 (Spitzer et al., 1999).

[4]Anxiety was assessed using the General Anxiety Disorder 7 item questionnaire (GAD-7) which scores participants on a scale of 0 to 21 (Spitzer et al., 2006).

Participants spent varying amounts of time working on the farm. All responses report doing at least a quarter of the work on the farm at minimum, with 8 farmers reporting they do approximately 26-50% of the total work personally, 2 reported doing about 51-75%, and 7 reported doing about 76-100%. Of the time spent working on the farm, the majority report spending 76-100% (n=7) or 51-75% (n=7) of the time working alone with fewer (n=3) spending 50% or less of that time alone. Most farmers reported working 6 (n=4) or 7 (n=12) days a week, with only one person reporting they spend 4 days a week, on average, working on their operation. Farmers in this study also take varying amounts of time off, with 6 taking less than 1

week, 4 taking 2 weeks off, 3 people reporting taking no time off, 2 taking 3 weeks off, 1 taking about 1 week off, and 1 person taking 4 or more weeks off.

For the farm management questions, farmers noted that they employed between 0 and 8 full-time or part-time employees not including themselves. The majority of those who employ others on their operation employ their spouse, child(ren), parent(s), or other family members. Two participants employed hired help outside their family, and one employed a neighbour. Farmers were also asked to select the people outside their operation with whom they have a working relationship. Farmers reported working relationships with neighbouring farmers (n=15), feed salesperson(s) (n=7), and/or equipment suppliers/technicians (n=6). Fewer participants reported relationships with business advisors (n=3), nutritionists (n=3), livestock breeders (n=2), livestock specialists (n=1), and/or government extension personnel (n=1). One person reported no working relationships with other people outside the farm. Overall, most farmers in this study reported having someone they could talk to at work about any personal or work-related concerns (n=14). The majority felt neutral about the personal and professional support they received at work (n=10) and more people were satisfied with the professional support (n=6) than the personal support (n=3) they received at work. Farmers are more satisfied with the personal support they receive at home, with the majority reporting they are satisfied (n=8) or very satisfied (n=2) with the support they received than those who were neutral (n=6), or dissatisfied (n=1).

Most participants reported not having a written business plan (n=15), or transition plan (n=9); 4 participants selected “not applicable” regarding transition planning. Additionally, most farmers said they do not perform annual risk assessments (n=13), with only two farmers reporting that they do. Only one farmer reported that their financial records were not up to date

(as of March 31, 2023), with 16 reporting that their records were up to date. Financial records were kept either using specialized software (n=6), a basic online spreadsheet (n=4), handwritten notes (n=4), or some combination of written and online (n=3). The majority of farmers (n=16) also reported that their production records were up to date (as of March 31, 2023) with only one person reporting records not up to date. These records were mostly kept in a hand-written format (n=11) with fewer farmers reporting keeping these records using a basic online spreadsheet (n=1), specialized software (n=2), or using a combination of handwritten and online notes (n=3). In their production records, farmers reported recording breeding records and genetics (n=13), calf mortality (n=12), animal age (n=11), treatment with antibiotics (n=11) and other medication (n=10), and their cow-to-bull ratio (n=9). Fewer reported recording general animal health records (n=4), total number of cattle (n=5), calf weaning weight (n=2), and mature cattle weight (n=2).

The number of routine appointments with their veterinarian varied across operations, with some reporting the veterinarian coming once per year (n=6), followed by less than once per year (n=5), twice per year (n=4), three times per year (n=1), and five or more times per year (n=1). For emergency vet appointments, more farmers reported vets come less than once per year (n=7), followed by once per year (n=4), twice per year (n=4), three times per year (n=1), and five or more times per year (n=1). Farmers were also mostly "satisfied" (n=7) or very satisfied (n=5) with the professional support they received from their veterinarian; 3 farmers were neutral with the support they received, and 2 reported being dissatisfied with their veterinarian support.

Discussion

Dairy Farmer Well-being and Cattle Health

The results of the univariate analyses were contrary to the hypothesis. Higher lameness prevalence, specifically, was associated with lower stress and anxiety scores, which was the opposite of that reported by King et al. (2021). Lower stress and anxiety levels on operations with a higher lameness prevalence could be related to a farmer's ability to detect lameness within their herd. A review on lameness detection and farmers' perception of lameness found that across several studies, farmers' estimates of lameness prevalence are often lower than the actual on-farm prevalence, regardless of housing type (Babatunde et al., 2019). The ability for farmers to identify lameness, especially cases of clinical – but not severe – lameness, can vary from farmer to farmer can may be dependent on education and farm experience (Bran et al., 2018; Richert et al., 2013). Therefore, it may be that farmers who are less able to detect clinical lameness are less stressed or anxious overall, as they cannot be stressed about animal health issues they cannot see. On the other hand, farmers who are more stressed about lameness may be performing more lameness assessments, treating animals earlier, and/or making more difficult decisions surrounding the culling of severely lame cows, which could be both physically and mentally taxing. Lameness has been identified as the top-ranking disease priority for Canadian dairy farmers (Bauman et al., 2016) and is the main health problem that farmers are most likely to treat with urgent attention (Martin-Collado et al., 2015), indicating that farmers are likely to treat lameness as soon as they detect it. Researchers have demonstrated that the treatment of other cattle health conditions on dairy operations, for example during outbreaks of foot-and-mouth disease, is stressful and mentally taxing (Crimes and Enticott, 2019; Van Haaften et al., 2004).

This may further explain the associations demonstrated between lameness and animal-related injuries, as some of the common treatments for lameness, including regular hoof trimming, can result in injury to farmers (Nielsen and Norup, 2024). Further exploration into the impacts of perceived and actual animal health on farmers' mental and physical well-being is needed to determine the nature of the associations between farmer well-being and hoof health.

The positive association between farmers' stress scores and mastitis incidence was expected. Mastitis was ranked as the second highest priority disease issue for Canadian dairy farmers (Bauman et al., 2016). Because mastitis incidence was self-reported and involves direct loss of milk which is diverted from the bulk tank and not sold, it is logical that seeing and treating more cases of clinical mastitis would be positively associated with stress scores. This trend is reflected in other research connecting disease prevalence and farmer stress with other bovine diseases, with farmers more stressed when diseases are prevalent on their operation (Hood and Seedsman, 2004; Mort et al., 2005; Van Haaften et al., 2004). The current study, however, relied on self-reported mastitis data, so further research comparing the stress surrounding perceived mastitis incidence, compared to the actual incidence of both clinical and sub-clinical incidence would bring further insight into the connection between udder health and farmer well-being.

Consideration and future research regarding the difference between perceived and actual disease prevalence could also illuminate some of the stresses that farmers face when adopting AMS or other health-detecting technologies onto their farm. While it is beyond the scope of this study, many farmers express stress surrounding the transition from traditional milking to AMS and learning new technology (Alpass et al., 2004). Many AMS systems have health-detecting features, like somatic cell count, and fertility tracking. One study found that farmers who

switched to AMS found health detection easier. Learning new technology, either AMS or other health-detecting technology, can be stressful, but this stress may be further complicated by farmers learning that disease prevalence in their herd is different than they initially considered, especially short term. One study of Canadian farmers transitioning to automated milking systems found that 66% made some sort of change to their health management practices after the transition to AMS, but over time found the AMS health detection to be easier (Tse et al., 2017). Use of technology may be useful in health detection for farmers, but the transition to using those technologies may be stressful short term, though more research should be performed to determine this relationship.

Milking system and housing type did not have an effect on the connection between animal health and farmer well-being, perhaps because neither system gives an advantage to detecting lameness, body condition or lesions. Different housing types and milking systems could also provide different stressors but a similar overall amount of stress. The potential stress around the difference between perceived and actual heard health prevalence can also be a potential stressor around proAction animal care assessments in Canada. Though farmers in previous research have been overall in favor of proAction, they also express that regulation can be overwhelming, especially if demands are perceived to be a lot of pressure in a short amount of time (Ritter et al., 2020).

When accounting for other variables, some findings are further contextualized. The percentage of cows with body condition scores outside the target range and resilience scores were associated when controlling for decision-making status. Resilience, as measured by CD-RISC 10, is defined as the ability to adapt to change or the ability to "bounce back" from challenges (Connor and Davidson, 2003). Primary decision makers are likely deciding how to

handle changes and tackle big challenges, so high resiliency would likely be needed to successfully run a farm and be a primary decision maker. For secondary and co-decision makers, making tough decisions and facing on-farm challenges is supported by another person, so having high resiliency may not be necessary to be successful, which may contextualize the relationship between decision making status and BCS. Additionally, BCS may be a more complicated animal health outcome to keep within a target range. For example, body condition can fluctuate with lactation stage, parity, breed of cow, gestation time, etc. (Roche et al., 2009), meaning there are many variables that will impact BCS and complicate treating over or under conditioned cows. While it may be assumed that farmers can score body condition with reasonable accuracy, there is little to no research documenting this or their attitudes surrounding the management needed to control body condition in the herd. Body condition could be an animal health indicator that is more complicated to control, and often up to primary decision makers to make decisions surrounding feed management. More research would be required to understand the connection between cattle BCS, farmer resilience, and decision-making on-farm.

The association between clinical lameness and anxiety was further contextualized when controlling for region, with farmers with greater lameness prevalence still scoring lower for anxiety. As anxiety was found to be associated with region, it is likely that region-specific factors such as like weather or natural disasters are affecting anxiety levels. For example, wildfires were more prevalent in Ontario and British Columbia than in the Prairie region during the summer of this study (Natural Resource Canada, 2024) and Ontario specifically reported higher anxiety scores in this study. If farmers are more anxious due to external factors, they may spend more time dealing with those outside factors and may have less time to dedicate towards animal care. More research would be needed to determine regional differences in anxiety and

how those regional differences may impact animal health. The connections between animal health, farmer well-being and the influence of other outside factors highlight the need for One Welfare research, as the influence of both farmer stress and animal welfare is multifaceted (García Pinillos et al., 2016). Other farm management-related factors, such as calf care, dry cattle care, culling decisions, etc., could also be affecting both farmer well-being and animal health, which should be investigated in future research.

In general, both farmer scores and cattle health scores were better than expected. This study found much less clinical lameness than the literature, as well as hock and knee lesions (Jewell et al., 2019; King et al., 2021; Matson et al; 2022). One reason for this could be that we are reaching more progressive farmers, or farmers who feel confident about their animal health on their farm, so they are not as hesitant to invite research to their farm. This could additionally be connected to the fact that farmers in this study scored overall higher for resilience than farmers in other studies (Thompson et al., 2022) and are more able to adapt to animal health concerns as they arise, however, additional research would need to be performed to see if there is a connection. Farmers scored lower for anxiety, but similarly for stress compared to other research involving dairy farmer's well-being (Thompson et al., 2022; Jones-Bitton et al., 2020). It could also be that farmers who are generally less anxious are more likely to participates in studies like this. Additionally, it is likely that all dairy farmers experience similar stressors, like stressors related to quote, feed availability, animal health concerns, farm management etc., so it would make sense that stress levels would be similar across studies. Calf mortality and mastitis rates may have been different from the literature; however, these differences are likely at least partially due to the fact that farmers self-reported those numbers.

Beef Farmer Well-being, Farm Management, and Cattle Health

Weather, pasture condition, and farm and personal finances were particularly stressful to the farmers who participated in this study and these are all commonly listed as common stressors for farmers overall (Booth and Lloyd, 2000b; Brennan et al., 2022; Thompson et al., 2023). The farmers in this survey were largely from Manitoba, which could contribute to factors like wildfires and floods ranking lower as potential stressors, as they were not an issue in Manitoba during the survey year (2023/2024). Conducting surveys over time could yield different results for some stressors, though some of the most common stressors seem to be similar over time.

The majority of farmers reported having up-to-date financial records, but not keeping a written business plan or transition plan. As finances are a major stressor for farmers in this study, up-to-date finances are likely a priority. With transition planning specifically, the lack of a written transition plan can be another barrier to succession planning, already identified in the industry. Transitioning the farm from one generation to the next is difficult for farmers, not just financially, but there is a social component as well. For example, most farmers in a previous study conducted in Ontario expressed waiting to establish a transition plan until a family member showed interest in a career on the farm, and although the majority of farmers had no transition farm plan at all, of those who had one, most had an unwritten plan (Earls and Hall, 2018). Additionally, many older farmers find it hard to retire, as farming is a part of their identity they do not want to lose, and there is often a perception that farmers do not retire (Conway et al., 2022). Social identity and family relationships complicate planning transitions of the farm, and finding ways to ease these concerns is necessary to ease this process.

Regarding animal health, while all farmers reported keeping records of at least one of the listed animal health variables, the type of data and amount of variables collected varied from

farm to farm. Most farmers recorded antimicrobial usage, which reflects Canadian initiatives to require farmers to track antimicrobial use within the beef industry (Hannon et al., 2020). The Verified Beef Production program, which assures the quality of Canadian beef and can impact the pricing of beef, requires antibiotic tracking (Canadian Cattlemen's Association, 2021). There is limited research into beef farmers' perceptions on the requirement to track antibiotics, however there are some barriers that research has indicated complicate farmers' ability to track antibiotic use and animal health. Farmer on cow-calf operations in Ontario were more likely to record information if they had specialized online software and were able to record treatments in the calf barn rather than having to record them in another location (Edwards et al., 2024). Additionally, animal health records were more likely to be recorded when people were working with non-family members (Edwards et al., 2024) as farmers who worked with family were likely to pass on information verbally. Based on these studies, the fact that most participants in this study worked with family members and took handwritten production records likely contributed to the number of different health variables recorded on these farms.

Regarding on-farm relationships, most farmers had someone they could talk to about stressors at work, mostly neutral about the personal and professional support they receive at work, and mostly satisfied by the personal support they receive at home. There is limited research on interpersonal relationships on farming operations, especially regarding beef farmers. One study regarding farmer social supports found that farmers found personal relationships important to maintain lower levels of stress, especially relationships with significant others and friends (Deegan and Dunne, 2022). The need for support can also be impacted by other socio-demographic factors. Farmers living with disabilities find familial and community support especially important, although they acknowledge barriers to accessing and asking for those

supports (Friesen et al., 2010). In this study, respondents had an overall positive relationship with their veterinarians. There is limited research regarding beef farmers' relationships with veterinarians, though this trend is consistent with the overall satisfaction with veterinarians, as seen on dairy farms both in this study and in the literature (Ritter et al., 2019). The relationship between farmer and veterinarian is also crucial in maintaining animal health and biosecurity on cattle farms (Grant et al., 2023; Ritter et al., 2019), and an active vet-patient-client-relationship is required for vets to write prescriptions for a farm (Neal and Greenberg, 2024) signifying that satisfactory vet-client relationships may impact both farmer-well-being and animal health.

Beef farmers' well-being was also assessed in this study. Although there is not enough power to statistically compare dairy and beef farmers, nor was it a primary objective, it is interesting to note that stress, depression, and anxiety scores were slightly higher and resilience scores were lower among beef farmers. There is less research examining the mental health of beef farmers specifically, so further research surrounding factors impacting beef farmers' stress and mental health would provide further insight as there are significant difference between beef farmers and other commodity groups.

Limitations

Responses in this study were likely limited by response bias. When compared to other farmers' well-being, the participants in the dairy study scored a bit better on most well-being assessment, compared to Canadian farmers in other studies (Thompson et al., 2022; Jones-Bitton et al., 2020; King et al., 2016). The prevalence of poor animal welfare outcomes was also relatively low on the farms visited. In reference to proAction, few farmers, if any, scored in the

"red" zone, where corrective action plans are required (prevalence >20% of body condition issues and >25% for lesions and lameness prevalence). For this study, animals that were considered in the "yellow", or the zone in which corrective action is recommended (Dairy Farmers of Canada, 2023), was adjusted. "Yellow" was considered farms with a prevalence of ≥5%, which is the guideline used for body condition, but not for lesions or lameness, which require corrective action for ≥10% prevalence. As the survey and the farm visits were voluntary, farmers who were doing well, and had relatively little few human or animal health concerns, were perhaps more willing to participate. It is also likely that more progressive farmers who are more informed and willing to talk about mental health mainly participated. Although the goal was to recruit farmers through a variety of means, there is an expected response bias due to the personal nature of physical and mental well-being studies, especially until trust is more established in the community. As mental health is often a difficult thing for people to talk about, especially with strangers, doing follow up studies involving researchers that are well-known and have a positive reputation within the community may help more farmers feel comfortable participating.

The timing of the survey may also have impacted the farmers' responses. Well-being assessments capture a snapshot of well-being at a specific point in time. As this took place in late spring to early summer for farmers in British Columbia, Alberta, Saskatchewan, and Manitoba, and late summer for farmers in Ontario, it is possible that farmers were stressed about different seasonal things, like cropping or heat stress, depending on the time we visited. Due to the limited amount of personal able to visit farms in person, this was unavoidable. The goal was to understand the link between farmers' well-being and animal health in a snapshot of time, so we

requested farmers fill out the survey as close to the cattle assessment as the reasonably could to address this.

The spam responses to the beef survey limited the amount of recruitment, as lots of time was spent dealing with spam responses rather than continuing to recruit legitimate farmers. The limited number of legitimate responses limited the statistical analysis of the data. As a pilot study, the beef producer survey was successful for this type of research as it pertains to the beef industry. In the future, a larger scale study using recruitment methods other than social media should be performed, for example, primarily using beef farmer magazines or other communications, organizations, and recruiting at beef farmer meetings or farm shows, or snowball recruitment (encouraging farmers to invite other farmers to the study).

Farmer well-being and physical health were considered the outcome variable in the study and were chosen based on methods used in previous research (King et al., 2021); however, farmer well-being and its connection to animal welfare are likely very complicated. It would be incorrect to assume that stress and poor well-being are caused by poor animal welfare or vice versa. Instead, both well-being and animal welfare are influenced by a myriad of factors, but poor animal welfare has the potential to exacerbate pre-existing stress, depression, and/or anxiety levels. Additionally, many farm factors, from finances to weather conditions and beyond, can impact both farmers' mental and physical well-being; thus, more research would be needed to determine the complex interactions between farm management, farmer well-being, and animal welfare.

Conclusions

Understanding the relationship between farmer well-being and animal welfare is crucial to maintaining sustainable farms. High levels of stress were found to be related to higher levels of mastitis rates on dairy farms. However, lameness was unexpectedly connected to a few well-being indicators, with farmers who had more lameness reporting better well-being. Other factors, like region and decision-making status were also related to well-being and animal health, meaning analysis of this relationship is likely very complicated. Unfortunately, due to a low response from beef farmers, no conclusions regarding whether beef farmer well-being was associated with cattle health were made. Future research, accounting for other farm management practices could lend greater insight in the connection between farmer well-being and cattle health.

CHAPTER THREE:

CONNECTING FARMER PERCEPTIONS OF WILDLIFE AND FARMER WELL-BEING ON CANADIAN CATTLE FARMS

Introduction

The presence of wildlife on farms can be a contentious issue for farmers. Farmers have expressed concerns about the presence of wildlife on their operations for causing nuisances including crop consumption, threatening staff safety, and damaging equipment or buildings (Hoag et al., 2011). Wildlife can cause added stress for livestock farmers especially when animals are kept outdoors, where there is concern that wildlife can be a vector for disease, especially during outbreaks, as shown during outbreaks of bovine tuberculosis, ovine Johne's disease, and other diseases affecting livestock (Brook and McLachlan, 2006; González-Barrio, 2022; Hood and Seedsman, 2004). There is additional concern surrounding consumption of animal feed by wildlife, especially by smaller animals, like rodents (Goodale et al., 2015). Larger species have been a source of conflict for many livestock farmers as they have a greater potential for livestock predation, which is one of the most commonly stated reasons for the use of animal control across several studies (Allen and Hampton, 2020; Goodale et al., 2015).

Farmers choose to use wildlife control methods for various reasons. Animal control on farms is necessary to limit the transfer of diseases from wildlife to livestock and to maintain on-farm biosecurity (Sleeman et al., 2017). Loss of livestock due to predation by wildlife also often

prompts livestock farmers to choose lethal methods of control to protect their animals (Allen and Hampton, 2020; Whitehouse-Tedd et al., 2021). While farmers have valid concerns for animal and staff safety and the financial damage wildlife can cause, there is also some discrepancy between the perceived damage and the actual damage that wildlife causes on farms. Researchers have found that the perceived danger of wildlife, rather than actual risk, is more likely to inform control measures on farms when it comes to large mammals (Goodale et al., 2015; Peterson et al., 2010).

Alternatively, farmers who recognize the beneficial roles of wildlife, including the role of natural predators and beneficial insects, are more likely to use non-lethal wildlife management methods or employ integrated pest management on their operation (Bardenhagen et al., 2020). Encouraging biodiversity not only promotes environmental sustainability but has also been shown to encourage farm economic sustainability, with improvement in crop yield both monetarily and quality-wise (Pywell et al., 2015), and even promote better farmer well-being (Sherren et al., 2022). For example, allowing for more native habitat strips had not only increased crop production even with a reduction of land use, but also preserved native habitat for local wildlife species (Pywell et al., 2015). Other researchers have shown that using more sustainable grazing methods, like multi-paddock grazing, was associated with better physical well-being for the farmers that employed it (Sherren et al., 2022).

There is an indication in the current literature that there is a connection between perceptions of wildlife and control methods, however, there is limited understanding of how these perceptions differ by commodity group. Additionally, understanding wildlife perceptions on farms has been not widely studied in Canada. Currently, there is little research regarding the connection between farmers' perceptions of wildlife and farmers' well-being. Little connection

between the mental well-being of farmers and the control of wildlife species was seen on Australian farms (Batterham et al., 2022). Goodale et al. (2015) evaluated the overall perceptions farmers have of wildlife in the Canadian Maritime provinces, but that study did not compare those perceptions to farmers' mental health and well-being. Therefore, to the author's knowledge, there is no published information regarding farmer well-being and perceptions of wildlife in Western Canada and Ontario.

Understanding the factors that farmers' decisions around wildlife control and the reasons they choose various control methods are crucial to promoting sustainable farm-wildlife relationships. The goal of this study is to better understand the perceptions of wildlife seen on beef and dairy operations and how these perceptions may be influenced by farmers' well-being. For this study, the researchers hypothesized that farmers with more negative mental health outcomes will have more negative perceptions of wildlife.

Methods

Survey Design

Questions related to wildlife were included as part of a larger survey, as described in the previous chapter (Chapter 2). The surveys were hosted on the Qualtrics survey platform (Provo, Utah, USA) from May 2023 to April 2024. To be included in the study, farmers had to provide informed consent, be 18 years old or older, and be a primary or secondary/co-decision maker of a beef operation or dairy farm in British Columbia (BC), Alberta, Saskatchewan, Manitoba, or Ontario. Farmers who did not respond to >50% of the wildlife questions in the survey were not

included in analyses. The Research Ethics Board at the University of Manitoba approved this study for dairy farmers (HE2023-0015) and beef farmers (HE2022-0039).

Survey questions are available in **Appendix 3**. Many questions were adapted from the Nature of Nuisance questionnaire as developed by Goodale et al. (2015). Farmers were first asked to identify the wild animals they had seen on their operation from a list of 10 options: mice/rats, raccoons, deer or ungulates (deer/moose/caribou/other ungulates), bats, other small mammals (squirrels, prairie dogs, gopher, beavers, hares, rabbits and/or skunks), large predatory mammals (lynx, bobcat, cougar, coyote, wolf, fox and/or bears), crows or corvids (crows, ravens, starlings, and/or grackles), wild turkeys or game birds (wild turkeys, geese, ducks, pigeons and/or doves), predatory birds (hawks/eagles etc.), and reptiles and/or amphibians (snakes, turtles, frogs, toads). These species were chosen and grouped based on their significance to humans (King et al., 2023), and specifically farmers. Participants were also given the option to select "other" and include other wildlife they have seen on their operation. There were relatively few farmers who selected "other", so other and the species varied so this category was not included in analysis. Farmers were then asked about their perceptions and control methods used only for the animals they saw on their operation.

The survey also included questions to identify any perceived nuisance caused by the species present on their operation, including crop damage and/or feed consumption, physical harm to livestock, risk of disease(s), damage to buildings and/or structures, concern for personal or staff safety, and source of overall stress and tension. Thereafter, farmers were asked about perceived benefits related to the animals on their operation, including natural predation, improving soil health and/or land productivity, species preservation and/or conservation, enjoying seeing the animal/aesthetics, or other. After identifying the positives and negatives of

each animals' presence on their operation, there was a question asking farmers to identify how they would rate the overall presence of the animal on their farm on a scale of 1 (harmful/ stressful) to 5 (beneficial).

Farmers were then prompted to select all control methods employed for each animal identified on their operation, including hunting or shooting, lethal traps, non-lethal traps/relocation, poison, physical barriers, guardian animals, or other deterrent/repellent methods. Questions regarding the factors that influence the animal control methods employed on their farm were provided to farmers. They were also asked to select what would be needed, if anything, to change their methods. Reasoning included more information on other methods, costs, more information on policy, government compensation, demonstrations needed, or other farmers using the same methods. There were additionally questions regarding government compensation for either crop damage or livestock predation. Beef farmers were also asked to identify what ways they contribute to wildlife and/or habitat preservation on their operation.

Statistical Analyses

Statistical analyses were conducted using R Studio (Provo, Utah, USA), for the dairy farmer responses. Due to the relatively few beef farmer respondents, there was not enough power to run statistical analyses of the associations between farmer well-being and wildlife variables. Instead, descriptive statistics were used to summarize findings and to make recommendations for future research.

For the analysis of the responses from dairy farmers, chi-square tests were primary used as most variables were categorical. Chi-square tests were used to determine if there were

regional differences in the type and perceptions of wild animals. For the purposes of this study, regions were grouped as British Columbia, the Prairies (Alberta, Saskatchewan, and Manitoba), and Ontario.

A chi-square test was also used to determine if farmers overall perceptions of each wildlife species or species group were associated with farmers stress, anxiety, and depression scores. Overall perceptions and well-being scores were grouped to achieve categories containing at least 10% of responses with as many groups as possible (**Table 4** and **Table 5**). Categorization of well-being groups was based on the guidelines set by each psychometric scale, as listed in **Table 5**.

TABLE 4: Dairy farmers' perceptions[1] grouped for each species for statistical analyses

Species	Beneficial (n)	Somewhat beneficial (n)	Neutral (n)	Somewhat harmful/ stressful (n)	Harmful/ stressful (n)
Mice/Rat	0	0	16	38	26
Raccoons	1	2	20	17	15
Deer and other ungulates	7	9	33	8	4
Bats	18	6	16	4	0
Small mammal	4	6	28	29	5
Large predators	3	11	21	16	2
Crows and other corvids	1	2	32	24	15
Turkeys and other game birds	1	8	33	22	10
Predatory birds	30	17	23	2	0
Reptiles and Amphibians	12	11	41	1	1

[1]Perceptions were categorized following the administration of the survey into two or three groups to achieve at least 10% of participants in each group, while keeping groups fairly evenly distributed where possible. Groupings are indicated using different colors (green, blue, and/or yellow) for each group.

TABLE 5: Grouping of dairy farmer well-being scores for statistical analysis

	Category and score range for each well-being indicator		
Stress[2]	Low (0-13) n = 17	Moderate (14-26) n = 61	High (27-40) n = 10
Depression[3]	Minimal (0-4) n = 35	Mild (5-9) n = 36	Moderate to Severe (10-27) n = 17
Anxiety[4]	Minimal (0-4) n = 42	Mild (5-9) n = 28	Moderate or Severe (10-21) n = 18

[1]Well-being indicator scores were grouped into three groups to achieve at least 10% of participants in each group. Cut off scores are provided by the psychometric scales, listed below.

[2]Stress was assessed using the perceived stress scale (PSS) which scores participants on a scale of 0 to 40 (Cohen et al., 1983).

[3]Depression was assessed using the Patient Health Questionnaire (PHQ-9) which scores participants on a scale of 0 to 27 (Spitzer et al., 1999).

[4]Anxiety was assessed using the General Anxiety Disorder 7 item questionnaire (GAD-7) which scores participants on a scale of 0 to 21 (Spitzer et al., 2006).

The Connor-Davidson Resilience 10-item Scale (Connor and Davidson, 2007) does not have set recommended categories and was not used for chi-square analysis but was analyzed using ANOVA. However, because not all data met the normality assumption for each farmer well-being variable, it was decided to primarily chi-square for analysis. Stress and resilience scores were normal, and anxiety and depression scores were able to be transformed using square root (x+0.5) to achieve normality for the analysis of some species groups. ANOVA was used when data was normal to determine if there were associations between farmer well-being and animal health and if the association between farmer well-being and wildlife perceptions differed by region

Descriptive statistics were used to summarize the use of wildlife control methods, what would be needed for farmers to change the methods they use on their farm, and why they use the methods they currently use, and if they had received compensation for wildlife-related damage.

Results

Participation and Demographics

Respondents were the same individuals as described in the previous chapter, as these data were collected as a part of the same survey. For the dairy survey, 88 responses were included in analysis. One additional response was included in this survey but not the previous as this person filled out all the wildlife questions but not the animal health questions. Of these responses, the majority of responses the survey responses were from Ontario (n=44), followed by Manitoba (n=15), British Columbia (n=15), Alberta (n=12), and Saskatchewan (n=2). For analyses, respondents from Manitoba, Saskatchewan, and Alberta were grouped and referred to as "the Prairies" (n=29). About two thirds of the participants were male (n=59) and one third were female (n=29). Participants identified with the following age categories: 18 to 24 (n=1), 25 to 34 (n=22), 35 to 44 (n=34), 45 to 54 (n=15), 55 to 64 (n=12), and 65 or older (n=3). Participants represented primary decision makers (n=48) and secondary or co-decision makers (n=40). All farmers owned and/or managed their farm for at least one year, with 12 managing their farm for 1 to 4 years, 26 for 5 to 9 years, and 49 for 10 or more years.

For the beef survey, 17 verified responses were from 9 men and 8 women. Beef farmers were mostly located in Manitoba (n=11), followed by Saskatchewan (n=3), British Columbia (n=1), and Ontario (n=1). Participants categorized there age as follows:, 18 to 29 (n=2), 30 to 39 (n=3), 40 to 49 (n=5), 50 to 59 (n=4), and 60 or older (n=3). Additionally, more respondents identified as primary decision makers (n=12), while than secondary or co-decision makers (n=4).

Most participants (n=10) owned or managed their operation for more than 10 years, followed by those who owned and managed for less than 5 years (n=3), and 5 to 10 years (n=2).

Dairy Farmer Well-being and Perceptions of Wildlife

The animals that dairy farmers reported seeing on their operation is reported in **Table 6**. Some farmers (n=14) reported the presence of other species on their operation, which included coyotes (n=7), other species of birds (n=2), badgers (n=1), elk (n=1), and non-wildlife species like neighborhood dogs and cats (n=1).

TABLE 6: Total number of participating dairy farmers in Western Canada and Ontario, Canada who reported seeing various wildlife species on their operation, by province.

PROVINCE	BC	AB	SK	MB	ON	TOTAL
Total number of respondents	**15**	**12**	**2**	**15**	**44**	**88**
Raccoons	15	12	2	15	44	88
Small mammal	15	12	2	15	44	88
Large predatory mammals	15	12	2	15	43	87
Mice/rat	15	12	2	14	41	84
Turkey or other game birds	11	12	2	12	41	78
Crows or other corvids	13	11	2	13	38	77
Predatory birds	13	12	2	13	36	76
Reptiles and amphibians	13	10	2	12	33	70
Deer and other ungulates	7	8	2	13	32	62
Bats	12	6	1	1	27	47
Other	3	2	1	1	7	14

Regarding the nature of nuisance for the animals seen on their operation (**Table 7**), the majority of farmers reported that mice are a nuisance by causing damage to structures or buildings, crop damage, damage to equipment, and/or as a risk for disease. Raccoons, deer and other ungulates, crows and other corvids, and wild turkeys and other game birds were noted to cause crop damage, with both corvids and game birds noted to also be a risk for disease.

TABLE 7: Percentage of dairy farmers[1] in Western Canada and Ontario, Canada who perceive nuisances caused by each wildlife species or species group.

NATURE OF NUISANCE	DAMAGE TO STRUCTURES/ BUILDINGS	CROP DAMAGE	RISK OF DISEASE	DAMAGE TO EQUIPMENT	CONCERN FOR SAFETY	SOURCE OF OVERALL STRESS	PHYSICAL HARM TO LIVESTOCK
Raccoons	19.3%	45.5%	39.8%	12.5%	8.0%	14.8%	4.5%
Small mammal	12.5%	39.8%	18.2%	14.8%	4.5%	9.1%	2.3%
Large predators	2.3%	18.4%	16.1%	1.1%	10.3%	6.9%	20.7%
Mice/rat	70.2%	61.9%	61.9%	60.7%	11.9%	28.6%	1.2%
Turkey and other game birds	11.5%	55.1%	46.2%	9.0%	2.6%	17.9%	6.4%
Crows and other corvids	22.1%	63.6%	48.1%	7.8%	0.0%	22.1%	2.6%
Predatory birds	2.6%	2.6%	14.5%	0.0%	1.3%	2.6%	5.3%
Reptiles and amphibians	1.4%	0.0%	8.6%	0.0%	1.4%	5.7%	0.0%
Deer and other ungulates	1.6%	67.7%	19.4%	1.6%	1.6%	1.6%	0.0%
Bats	12.8%	2.1%	29.8%	0.0%	4.3%	6.4%	0.0%

[1] Percentages were calculated based on the number of dairy farmers who saw each species (group) on their operation.

There were some regional differences in the nuisances reported by dairy farmers. Specifically, regarding mice, farmers in Ontario were more likely to be concerned about disease risk than farmers in the Prairies (P=0.07). Perceptions of raccoons varied provincially; crop damage caused by raccoons were more likely to be reported by Ontario farmers than those in BC (P= 0.0005) or the Prairies (P=0.0004). Structural damage caused by raccoons was reported more by farmers located in Ontario than those in British Columbia (P=0.08). Raccoons were also seen as a risk for disease by more farmers in Ontario than in the Prairies (P=0.002) or in BC (P=0.006). Additionally, Ontario farmers were more likely to report raccoons as a source of overall stress or tension than farmers in the Prairies (P=0.03) and those in BC (P=0.08). Crows and other corvids were more likely to be reported to cause crop damage by farmers in Ontario than in the Prairie provinces (P=0.03). More farmers in BC reported that large mammals caused crop damage compared to Ontario farmers (P=0.04). More farmers in the Prairies reported small mammals caused crop damage on their operation (P=0.07) and posed a disease risk (P=0.05) as compared to farmers in BC. There were no significant provincial differences for the nuisances caused by deer and other ungulates, predatory birds, bats, wild turkeys and game birds, or reptiles and amphibians.

Regarding the benefits wildlife may have on their operation (**Table 8**), most dairy farmers reported enjoying the aesthetics or enjoying seeing predatory birds, deer, and other ungulates on their operation. Bats and predatory birds were recognized for their natural predation of wildlife by farmers. More farmers in the Prairies reported that they liked seeing raccoons on their operation compared to those in Ontario (P=0.03). Farmers also liked seeing game birds on their operation more in the Prairies than in BC (P=0.08). There were no differences in the potential positive impacts of any of the other wildlife species when compared by region.

TABLE 8: Percentage of dairy farmers in Western Canada and Ontario, Canada that perceived benefits of each wildlife species or species group.

POTENTIAL BENEFITS	NATURAL PREDATION	I LIKE SEEING THIS ANIMAL	SPECIES PROTECTION/ CONSERVATION	IMPROVES SOIL HEALTH, LAND PRODUCTIVITY	OTHER
RACCOONS	6.8%	4.5%	3.4%	1.1%	1.1%
SMALL MAMMAL	13.6%	21.6%	8.0%	1.1%	2.3%
LARGE PREDATORS	31.0%	25.3%	12.6%	0.0%	3.4%
MICE/RAT	3.6%	0.0%	0.0%	0.0%	1.2%
TURKEYS AND OTHER GAME BIRDS	7.7%	32.1%	11.5%	0.0%	3.8%
CROWS AND OTHER CORVIDS	16.9%	10.4%	5.2%	0.0%	0.0%
PREDATORY BIRDS	53.9%	55.3%	30.3%	2.6%	6.6%
REPTILES AND AMPHIBIANS	17.1%	35.7%	20.0%	1.4%	2.9%
DEER AND OTHER UNGULATES	12.9%	61.3%	21.0%	1.6%	3.2%
BATS	46.8%	36.2%	21.3%	2.1%	4.3%

[1] Percentages are based on the number of dairy farmers in this study who saw each species (group) on their operation.

Dairy farmers' overall perceptions of the 10 species groups they saw on their operation are reported in **Table 9**. Overall, mice and rats, raccoons, and crows and other corvids were reported as "harmful/stressful" or "somewhat harmful/stressful" by the majority of farmers. Bats and predatory birds were reported as "somewhat beneficial" or "beneficial" by farmers who saw them on their operation. Farmers had mostly neutral perceptions of reptiles and deer. Dairy farmers had variable perceptions of game birds, small mammals, and large predatory mammals. Regionally, there was a difference in the perceptions of raccoons and game birds. Ontario farmers perceived raccoons as more "harmful/stressful" or "somewhat harmful/stressful" than farmers in the Prairies (P=0.01) or in BC (P=0.02). Farmers located in BC reported game birds as being more "harmful/stressful" or "somewhat harmful/stressful" than farmers in the Prairies (P=0.007) or Ontario (P=0.03). There were no regional differences regarding overall perceptions for any other species group.

Table 9: Dairy farmers' overall perceptions[1] of wildlife species in Western Canada and Ontario, Canada by farmers who saw those species on their operation.

OVERALL PERCEPTION	TOTAL RESPONSE	BENEFICIAL	SOMEWHAT BENEFICIAL	NEUTRAL	SOMEWHAT HARMFUL/ STRESSFUL	HARMFUL/ STRESSFUL	NO RESPONSE
Raccoons	55	1.1%	2.3%	22.7%	19.3%	17.0%	37.5%
Small mammal	71	4.5%	6.8%	31.8%	33.0%	5.7%	19.3%
Large predators	53	3.4%	12.6%	24.1%	18.4%	2.3%	39.1%
Mice/rats	80	0.0%	0.0%	19.0%	45.2%	31.0%	4.8%
Turkey and other game birds	74	1.3%	10.3%	42.3%	28.2%	12.8%	5.1%
Crows and other corvids	74	1.3%	2.6%	41.6%	31.2%	19.5%	3.9%
Predatory birds	70	39.5%	22.4%	30.3%	2.6%	0.0%	7.9%
Reptiles and amphibians	66	17.1%	15.7%	58.6%	1.4%	1.4%	5.7%
Deer and other ungulates	61	11.3%	14.5%	53.2%	12.9%	6.5%	1.6%
Bats	44	38.3%	12.8%	34.0%	8.5%	0.0%	6.4%

[1] Percentages are based on the number of dairy farmers in this study who saw each species (group) on their operation.

The control methods, if any, farmers reported using for each species group is reported in **Table 10**. The control techniques used varied for each species or species group. The following are the top methods used for each animal employed by at least 9 respondents. Mice and/or rats were the animals that most dairy farmers said they managed on their operation; of the farmers with mice present on their farm, farmers reported using poison, guardian animals (i.e. cats or dogs), or other lethal traps. Game birds were also highly managed by many dairy farmers who saw them on their operation by hunting or shooting these animals. A smaller number of farmers reported not employing control methods for turkey or other game birds or using other control methods. Many farmers reported not using any wildlife control for deer, bats, predatory birds, and reptiles/amphibians if farmers saw them on their operation, although some farmers reported hunting or shooting deer. The control methods used for raccoons, small mammals, large predatory mammals, and crows and other corvids by farmers who saw them on their operation were more variable. On dairy operations where raccoons were present, respondents reported hunting or shooting, live-trapping and relocating, or not using any control methods. For large predatory mammals, some reported not using control methods for these animals, while others reported hunting or shooting. Control of small mammals was either hunting or shooting, lethal traps, or nothing. Corvid control either involved nothing, hunting or shooting, or the use of physical barriers.

The top reasons farmers selected as considerations they have for selecting animal control methods included: ease and effort required (72%), effective in the short-term (64%), and/or effective long-term (62%). Farmers selected that the top things they would need to consider other options included information on the efficacy of other methods (38%), cheaper and/or easier access (36%), and/or government compensation for wildlife-related damage (32%).

Table 10: Control methods Canadian dairy farmers report using for each wildlife species or species group described using descriptive statistics.

Control methods	Poison	Lethal traps	Guardian animals	Hunting or shooting	Physical barriers	Non-lethal traps/ relocation	Nothing/ not applicable	Other	No response	% of farmers using any wildlife control
Raccoons	6.8%	3.4%	8.0%	29.5%	4.5%	14.8%	19.3%	2.3%	38.6%	**42.0%**
Small mammal	12.5%	13.6%	12.5%	23.9%	2.3%	6.8%	30.7%	2.3%	28.4%	**40.9%**
Large predators	0.0%	2.3%	4.6%	18.4%	2.3%	0.0%	28.7%	0.0%	48.3%	**23.0%**
Mice/rat	78.6%	48.8%	72.6%	11.9%	8.3%	8.3%	1.2%	13.1%	2.4%	**96.4%**
Turkey and other game birds	0.0%	0.0%	7.7%	46.2%	6.4%	0.0%	30.8%	11.5%	15.4%	**53.8%**
Crows and other corvids	0.0%	2.6%	13.0%	29.9%	14.3%	1.3%	40.3%	13.0%	14.3%	**46.8%**
Predatory birds	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	81.6%	0.0%	18.4%	**0.0%**
Reptiles and amphibians	1.4%	0.0%	0.0%	0.0%	0.0%	1.4%	77.1%	0.0%	20.0%	**2.9%**
Deer and other ungulates	0.0%	1.6%	4.8%	25.8%	8.1%	0.0%	58.1%	1.6%	9.7%	**32.3%**
Bats	0.0%	0.0%	0.0%	2.1%	2.1%	0.0%	83.0%	0.0%	14.9%	**2.1%**

[1] Percentages were calculated based on the number of dairy farmers who saw each species (group) on their operation.

Farmers were also asked if they received government compensation for damage on their operation (either livestock loss or crop damage), with 20% reporting they had received compensation, 49% reported no compensation, 15% reported compensation was not applicable on their operation, and 15% reported not being aware of the program.

The mental health scores of dairy farmers in this study are described previously in Chapter 2, **Table 1.** Farmers' perceptions of mice and rats were associated with perceived stress scores (P=0.1), with those having more negative views of mice or rats scoring higher for stress. Additionally, farmers who ranked mice and rats "harmful or stressful" scored higher for depression than farmers who ranked mice and rats as "neutral" (P=0.0002). Conversely, farmers who scored raccoons as "harmful or stressful" or "somewhat harmful or stressful" tended to score lower for anxiety than farmers scored raccoons as "neutral" (P=0.06). Resilience scores also tended to be associated with perceptions of mice (P=0.07) with farmers who had higher resilience having "neutral" perceptions of mice.

There were also some regional differences in the associations between farmers' perceptions of wildlife and their well-being. When accounting for region, farmers' perceptions of mice and rats were positively associated with depression (P=0.03) and anxiety scores (P=0.03), with the farmers who had more negative perceptions of mice also having worse anxiety and depression scores in some regions (**Figures 7** and **Figure 8**). There was also a regional association between perceptions of raccoons and both depression (P=0.03) and scores (P=0.03) scores, with a positive association in the Prairies between perceptions and well-being scores and a negative association in Ontario (**Figures 9** and **Figure 10**). Finally, there was a regional association between farmers' perceptions of crows and corvids and farmers' resilience scores

(P=0.03), with farmers with more positive perceptions having higher resilience scores in British Columbia and the Prairies (**Figure 11**).

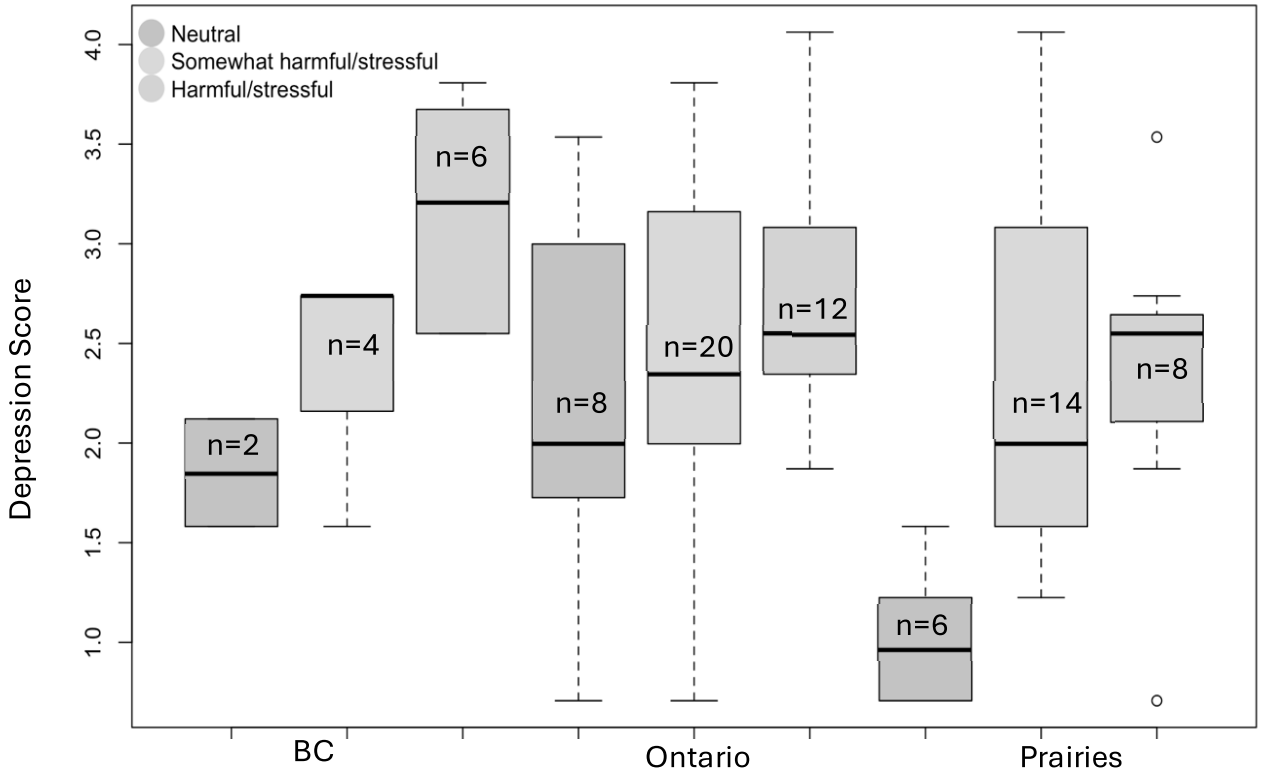

Figure 7: The connection between farmer depression scores[1] and their perceptions of mice and rats on dairy farms in Canada, compared regionally

[1] Depression was assessed using the Patient Health Questionnaire (PHQ-9) which scores participants on a scale of 0 to 27 (Spitzer et al., 1999). To achieve normality, scores were transformed using square root (x + 0.5).

[2] Using ANOVA, farmers' perceptions of mice and rats were positively associated with depression when accounting for region (P=0.03)

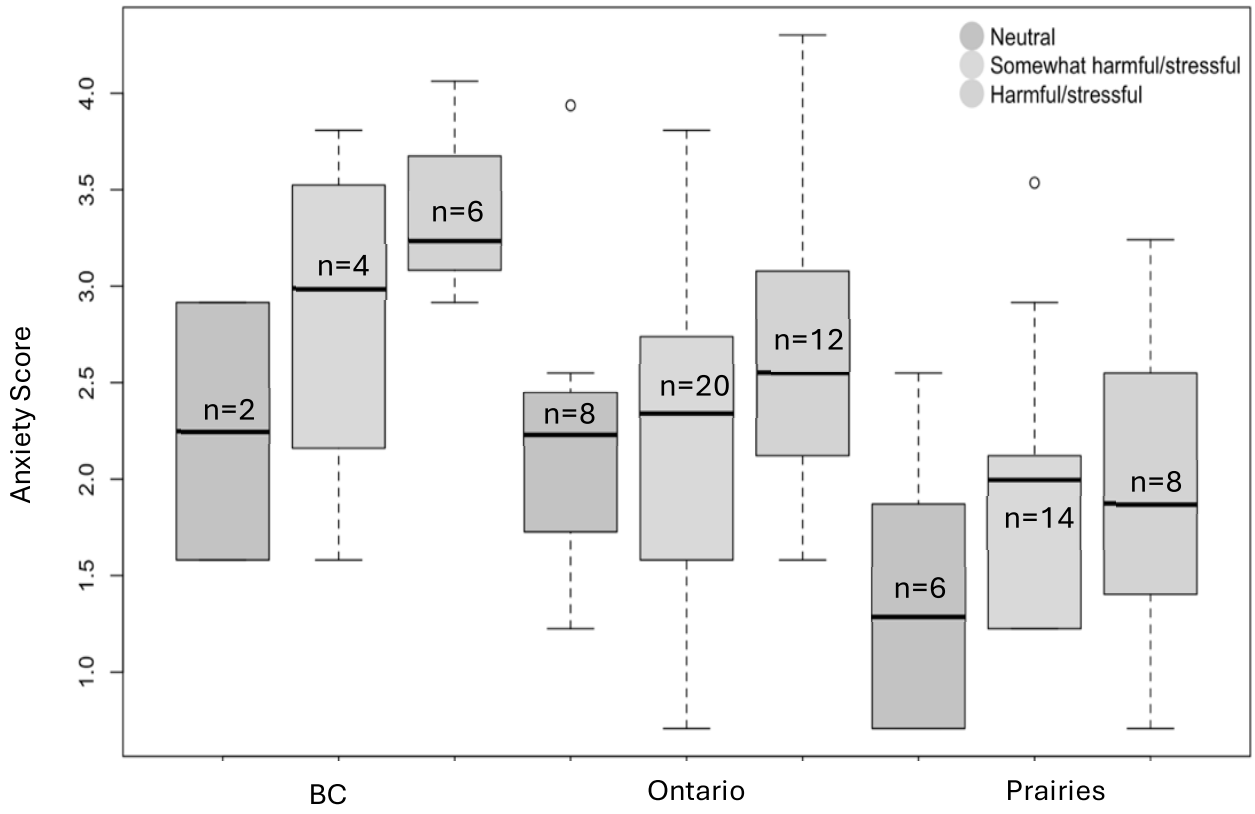

Figure 8: The connection between farmer anxiety scores[1] and their perceptions of mice and rats on dairy farms in Canada, compared regionally

[1]Anxiety was assessed using the General Anxiety Disorder 7 item questionnaire (GAD-7) which scores participants on a scale of 0 to 21 (Spitzer et al., 2006). To achieve normality, scores were transformed using square root (x + 0.5).

[2] Using ANOVA, farmers' perceptions of mice and rats were positively associated with anxiety when accounting for region (P=0.03)

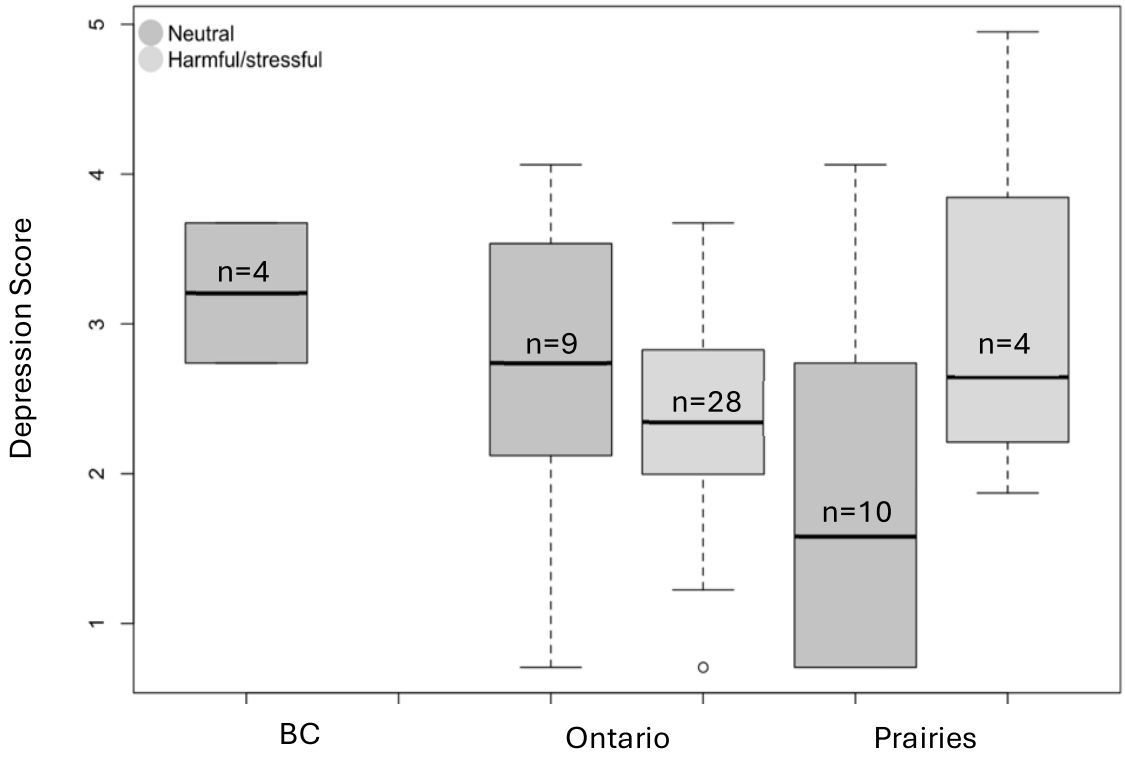

Figure 9: The connection between farmer depression scores[1] and their perceptions of raccoons on dairy farms in Canada, compared regionally

[1] Depression was assessed using the Patient Health Questionnaire (PHQ-9) which scores participants on a scale of 0 to 27 (Spitzer et al., 1999). To achieve normality, scores were transformed using square root (x + 0.5).

[2] Using ANOVA, it was found that was a regional association between perceptions of raccoons and both depression scores (P=0.03), with a positive association in the Prairies between perceptions and well-being scores and a negative association in Ontario

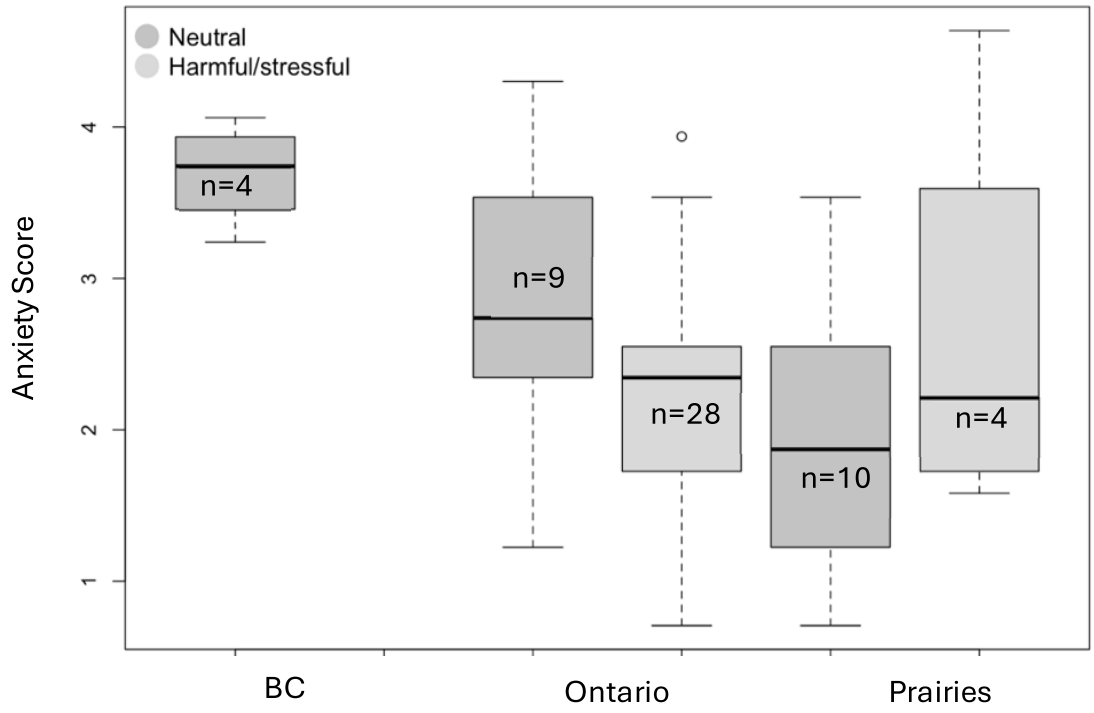

Figure 10: The connection between farmer anxiety scores[1] and their perceptions of raccoons on dairy farms in Canada, compared regionally.

[1]Anxiety was assessed using the General Anxiety Disorder 7 item questionnaire (GAD-7) which scores participants on a scale of 0 to 21 (Spitzer et al., 2006). To achieve normality, scores were transformed using square root (x + 0.5).

[2] Using ANOVA, it was found that was a regional association between perceptions of raccoons and both anxiety scores (P=0.03), with a positive association in the Prairies between perceptions and well-being scores and a negative association in Ontario.

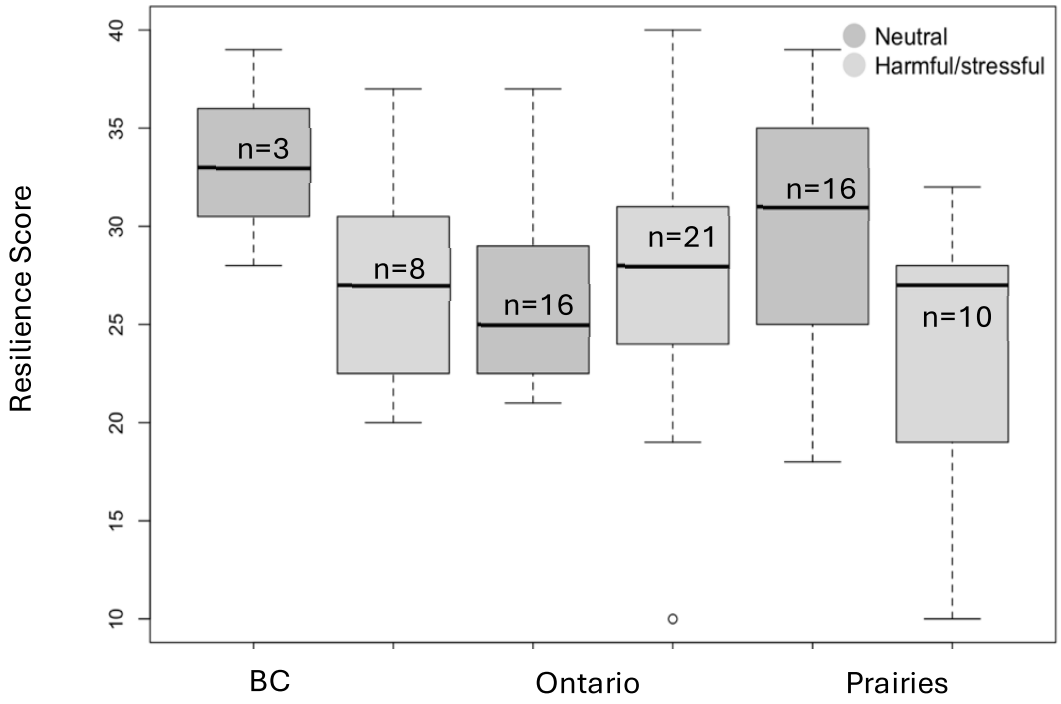

Figure 11: The connection between farmer resilience scores[1] and their perceptions of crows and other corvids on dairy farms in Canada, compared regionally.

[1] Resilience was assessed using the Connor-Davidson 10 item Resilience Scale (CD-RISC 10) which scores participants on a scale of 0 to 40 (Campbell-Sills and Stein, 2007).

[2] Using ANOVA, it was found that regional association between farmers' perceptions of crows and corvids and farmers' resilience scores (P=0.03), with farmers with more positive perceptions having higher resilience scores in British Columbia and the Prairies.

Beef Farmer Well-being and Perceptions of Wildlife

All beef farmers who responded to this study reported seeing small mammals, turkeys and other game birds, and crows and other corvids on their operation. While not all farmers saw

the rest of the species listed, 94% reported seeing mice and rats, deer, predatory birds, and reptiles and amphibians on their operation, 88% reported seeing large predatory mammals, and 69% reported seeing raccoons. Only 50% of farmers reported seeing bats on their operation. Two respondents reported seeing "other" animals, with one farmer reporting coyotes and the other reporting insects on their operation. Comparisons based on region were not performed with the beef farmers' responses as the majority of responses were from farmers located in Manitoba.

For nuisances caused by wildlife, many respondents reported mice as causing structure or building damage (80%), equipment damage (73%), or being a disease risk (60%). Raccoons (64%) and bats (63%) were seen as a disease risk by most respondents. Farmers saw crop damage from deer (53%) and small mammals (50%). Most farmers also reported large predatory mammals caused harm to livestock on their operation (86%). Regarding the perceived benefits of wildlife on their operation, farmers reportedly liked seeing deer (60%) and predatory birds (60%) on their operation. Beef farmers also reported predatory birds as being beneficial for their natural predation (53%).

Overall, most beef farmers who saw mice and rats, raccoons, small mammals, large predatory mammals, and/or crows and other corvids on their operations found them "somewhat harmful/stressful" or "harmful/stressful" (**Table 11**). Many farmers also found bats or predatory birds as "beneficial" or "somewhat beneficial". Farmers mostly had neutral perceptions about deer and turkeys and other game birds and neutral or positive perceptions about reptiles and amphibians.

Table 11: Beef farmers' overall perceptions[1] of wildlife species in Western Canada and Ontario by farmers who saw those species on their operation.

PERCEPTION	BENEFICIAL	SOMEWHAT BENEFICIAL	NEUTRAL	SOMEWHAT HARMFUL /STRESSFUL	HARMFUL /STRESSFUL
Raccoons	0.0%	0.0%	45.5%	45.5%	9.1%
Small mammal	6.3%	6.3%	37.5%	18.8%	31.3%
Large predators	0.0%	7.1%	7.1%	28.6%	57.1%
Mice/rat	0.0%	0.0%	26.7%	40.0%	33.3%
Turkey and other game birds	6.3%	12.5%	62.5%	12.5%	6.3%
Crows and other corvids	0.0%	6.3%	25.0%	50.0%	18.8%
Predatory birds	26.7%	26.7%	33.3%	0.0%	13.3%
Reptiles and amphibians	20.0%	26.7%	46.7%	0.0%	0.0%
Deer and other ungulates	0.0%	13.3%	73.3%	6.7%	6.7%
Bats	37.5%	12.5%	50.0%	0.0%	0.0%

[1] Percentages are based on the number of dairy farmers in this study who saw each species (group) on their operation.

Most farmers who had mice or rats on their operation reported using guardian animals (80%), poison (60%), or other lethal traps (53%) as wildlife control. The animal control methods used for raccoons was variable on beef operations, with 45% reported using hunting or shooting, 27% using non-lethal traps and relocation, and 27% not using animal control for raccoons. Control of deer was also variable with 40% of respondents not managing deer, 33% reporting hunting and shooting, and 20% reporting using physical barriers to control deer on their operation. Of the farmers who noted small mammals on their operation, 68% reported hunting or shooting, 25% reported using non-lethal traps and relocation, and 19% reported using lethal traps (not including poison) as the animal control methods they use for those animals. Large predatory

mammals were mostly hunted or shot (71%), while some used guardian animals (36%) and physical barriers (29%). Farmers reported either using hunting or shooting to control crows and other corvids (32%) or using no control methods for those birds (19%). For turkeys and other gamebirds, farmers either used hunting or shooting (12%) or used no control methods (56%). Most farmers reported not using any method to manage bats (75%), predatory birds (60%), or reptiles and amphibians (53%) on their operation.

The majority of farmers reportedly chose their wildlife control methods based on their long-term (63%) and short-term (63%) effectiveness, with some farmers also reporting that they prefer humane control measures (38%) or lethal methods of animal control (38%). In order to consider changing the animal control practices employed on their farm, farmers said they would prefer more government compensation for damage caused by wildlife (50%) or would need the new methods to be cheaper and easier to access (38%).

Farmers were asked whether they have received compensation for livestock harm or crop damage caused by wildlife on their operation. The majority (69%) reported they had received compensation, with 25% reporting not receiving compensation and 6% reporting they were not aware of any compensation program.

Discussion

Perceptions of wild animals in this study varied by species and farmers did not simply view all wildlife as negative or positive. Instead, it is likely that farmers consider both nuisances and benefits of each animal. Overall, both dairy and beef farmers had positive perceptions and

reported benefits from predatory birds on their operation, likely related to natural predation of wildlife and enjoying their presence. Mice and rats were overall the most negatively viewed animals and they caused the most reported nuisances including disease risk, crop damage, and structure, building, and/or equipment damage. In order to understand farmer perceptions, it is crucial to understand the nuisances and benefits they perceive for the animals on their operation.

If perceptions of wildlife are impacted by the nuisance they cause, the efficacy of wildlife control should be considered its ability to control those nuisances rather than its ability to reduce the amount of wildlife in the target area. For example, one study on the use of efficacy on lethal or non-lethal methods to control predatory mammals examined at the overall cost associated with livestock loss on farms to measure which method was most effective rather than measuring the reduction of the predatory mammals seen on farms (McManus et al., 2015). Because there seemed to be some connection between the type of nuisance, perceptions, and control of wildlife, mitigating damages and associated costs, in this case, could ease negative perceptions of animals, and perhaps associated stress. More research regarding mitigating nuisances is needed to understand the effect on the perception and the need for lethal control for negatively perceived, nuisance-causing animals.

For dairy farmers, there were some regional differences when it came to farmers' perceptions of wildlife. For example, farmers from Ontario viewed raccoons more negatively. There may be region-specific factors that impact nuisances seen on farms, as well as the overall perceptions and related stress. Using Ontario farmers and raccoons as an example, there could be several factors impacting this relationship regionally. First, the density of raccoons in southern Ontario, where many farms are located, is relatively high even in rural areas (Rosatte et al., 2010), especially compared to Prairie provinces (Larivière, 2004), likely leading to more human-

raccoon conflict. Farmers in Ontario were also specifically more concerned with the disease risk of raccoons. Ontario has historically struggled with rabies, a zoonotic disease that is deadly to mammals (cattle and humans included), more than other provinces in Canada (Tinline and Rosatte, 2020). In 2015, a raccoon variant of rabies was identified in Ontario, which has since led to rabies becoming of higher concern in Ontario in recent years (Rosatte, 2020; Tinline and Rosatte, 2020). While the population density and rabies concern may contribute to the negative perception of raccoons in Ontario, other factors like ecology, geography, social demographics, and farming strategies, may also impact these perceptions. It is beyond the scope of this study to understand the reason that farmers have a more negative perception of raccoons in Ontario, however, it is important to understand that there is a regional difference in perceptions about animals. There were also regional differences in the perceptions of the nuisances caused by mice and rats, small mammals, crows and other corvids, and the overall perceptions of game birds. These perceptions could vary based on the population density of the animal, or social environments specific to the region. Future research into perceptions of wildlife and targeted wildlife conflict mitigation strategies should be region-specific to help identify other factors influencing farmers' perceptions of wildlife.

While the purpose of this study was also not to compare dairy and beef farmers, it is important to note some key differences in their perceptions. Beef farmers had a more negative overall perception of large predatory mammals and a high percentage of them noted livestock loss as a nuisance for those animals. As beef farmers keep their cattle outside, there is a higher potential for livestock-wildlife conflict. Most dairy farmers in Canada house their cattle indoors, so they are less likely to encounter any livestock loss due to wildlife. Therefore, the potential for danger may be significant when farmers form their perceptions of animals. Each commodity

group may have different wildlife-related nuisances or benefits that would impact their perception of those animals. Therefore, perceptions of wildlife may be related to the commodity group of the farmer and should be considered when conducting research in the future.

There were some associations between farmer well-being and perceptions of wildlife. Farmers' perceptions of mice were associated stress, anxiety, and depression in this study. There is relatively little research on the association between the perception of wildlife or the use of wildlife control methods and well-being, especially in an agricultural context. In two studies, researchers found that mice and rat infestations in homes can negatively impact the mental health of the people living there (Murray et al., 2024; Shah et al., 2018). Although many farmers live on the farm, there is little research regarding the effects workplace interactions with wildlife, and rodents specifically, have on people's mental health. Research regarding the mental health surrounding contact with insects may give further insight into the impact the perception of animals has on mental health. A review of the mental health impact of bed-bug infestation found that dealing with these infestations can result in a wide range of negative mental health effects, including increased rates of stress, anxiety, depression, Post-Traumatic Stress Disorder (PTSD) and general distress (Ashcroft et al., 2015). Another review on the connection between pollinator health and human health postulates that the health of bees could be connected to human health as green spaces, maintained by bees and other pollinators, have been shown to have a positive impact on human mental health, though there is little research that explores this connection (Garibaldi et al., 2022). The perception of insects may contextualize the link between perceived benefits or nuisances, perception, and mental health. Insects that are viewed as pests, that cause nuisances, and are negatively perceived, like bed bugs, have a negative impact on mental health. On the other hand, insects that have a more positive impact on mental health, like bees, have an

overall more positive perception and are often encouraged to be in green spaces rather than controlled. In the current study, negative perceptions of wildlife species, especially those that reportedly caused nuisances on farms like mice, rats, and raccoons, were connected to more negative mental health outcomes.

When discussing wildlife on farms and animal control, sustainability is often at the forefront of the conversation. Sustainability has three pillars: environmental, social, and economic sustainability (Purvis et al., 2019). While the discussion often tends to focus on environmental sustainability, it is important to discuss the social and economic aspects as well. Environmentally, researchers have called some techniques of pest control into question in terms of animal welfare and conservation implications. For example, the use of rodenticide has been criticized for often being non-specific to rodents and causing ill health and death in animals higher up the food chain (Elmeros et al., 2019; Nakayama et al., 2019). Some other animal control methods have also been criticized for animal welfare concerns. For example, sticky board traps are often criticized because the animal is often in pain and distress for an extended period of time (Mason and Littin, 2003). Other methods, like live traps or fumigation, can also have negative animal welfare effects, like prolonged periods of distress for the animal, if improperly used (Mason and Littin, 2003). Researchers and policy-makers tend to promote the use of preventative measures, relocation of wildlife, landscape management and/or other forms of natural pest control, as they better promote biodiversity in the local environment (Bianchi et al., 2006) and reduce the likelihood of human-wildlife conflict. The use of wildlife management practices varied in this study, though most farmers noted they use at least one technique for at least one of the wildlife species seen on their farms.

Economically, damages caused by wildlife and the cost of wildlife control are crucial to consider when discussing the sustainability of farming operations. Farmers in this study reported that cost and ease of use of control is an important factor when choosing which animal control. Additionally, beef farmers specifically reported that they would likely require more government compensation related to livestock loss or crop damage to consider using other methods. There are reports that species that are of little conservation interest to research, like many rodent species, often cause the most damage monetarily in both urban and rural spaces (Peterson et al., 2010). In this study, farmers were not asked the specific dollar amount associated with wildlife damages caused by wildlife on their operation, however, several nuisances farmers reported, including livestock loss, building, structural, equipment and/or crop damage, have a monetary cost associated with them. Therefore, financial considerations are an important part of wildlife management on farms and should be a part of agricultural sustainability research going forward.

One major goal of this study is to understand the social sustainability of wildlife control, reflected by the focus on the perceptions and well-being of farmers. Dealing with certain wildlife species, specifically rats, mice, and raccoons, was found to negatively impact the well-being of some farmers. Farmers in this study mentioned that efficacy and ease of use are important when considering what control methods they use on their operation. They also note that any recommendation of new practices needs to be at least equally effective and less expensive or easier to access. When recommending new sustainability-related practices to farmers, it is often more effective to help farmers decide on what is most effective for their operation rather than mandating practices through legislation (Kröbel et al., 2021). Kröbel et al. (2021) contends that sustainability research involving farmers directly allows farmers to gain a more big-picture understanding of agriculture-related sustainability issues and current solutions, and often leads to

greater adoption of different techniques specific to their farm type. Farmers' needs and perceptions should be considered when making recommendations and legislation on wildlife control methods used on farms.

Limitations

This study asked farmers to report the animals they have seen on their operation and the nuisances and benefits they noticed related to those animals. The nuisances and benefits are, therefore, perceived by the farmer and may not represent the actual nuisances or benefits of wildlife species. The actual nuisances and benefits of wildlife species on farms may differ from what is actually occurring on the farm. Research has found that cost of wildlife damage was often lower than the damages these species were perceived to have caused (Goodale et al., 2015). Additionally, asking participants to scale the level of impact of those nuisances or benefits have on their operation, may provide further insight into how nuisances or benefits, both actual and perceived, impact farmers' perceptions of wildlife.

Due to the length of the survey, researchers chose to group some animals to keep the survey a manageable length, to limit survey fatigue. Some categories were broad (ex. game birds, or predatory birds) and it is possible that it masked some effects. Some farmers may have had stronger attitudes towards some animals in a group over others, which could have effected their selections when asked to share their perceptions of animal groups. More categories of animals could be beneficial to limit this effect in the future.

Due to the regional interaction, these findings likely do not apply to all farmers across Canada. Previous research had found a limited interaction between farmer well-being and

perception of wildlife; however, it was conducted with crop farmer and in Australian grasslands, which is a different environment (Batterham et al., 2022). As region also appeared to be related to overall perceptions and their connection to farmers' well-being score in this study, when performing this type of research, region, either at the provincial level or at an even smaller level, should considered. There may also be a seasonal effect, as the survey was open for the majority of a year, however, the majority of responses were received in the summer or early fall. Additionally, this research should be performed with other commodity groups and industries, as wildlife nuisances and benefits are likely specific to different commodity groups.

The relatively low response rate from beef farmers made it difficult to draw limited the statistical analysis that could be performed. More research involving beef farmers, and other commodity groups, should be performed to determine what connection, if any, occurs between wildlife perceptions and control methods and farmer well-being. Given the new provincial programs to provide more financial support to farmers facing livestock predation, like the one seen in Manitoba, are being added due to wildlife conflict often expressed by beef farmers (Government of Manitoba, 2024). Future studies may have better uptake if they were focused on wildlife predation as opposed to being included in a larger study on farmer well-being.

Conclusions

Understanding farmers' perceptions of wildlife, and factors that may influence those perceptions, is key to addressing the sustainability of wildlife on farms. Both dairy farmers and beef farmers in Western Canada and Ontario reported that mice, rats, raccoons, and corvids

caused nuisances while the presence of bats and predatory birds had some benefits. Overall, the species that caused the most nuisance were also more negatively perceived while the ones that were noted to have benefits were also more positively perceived. Animals that caused more nuisances and were more negatively perceived, like mice and rats, tended to be more controlled on farms. Farmers reported that ease of use, effectiveness, and cost were most important when choosing or changing the animal control methods they choose to employ. This study gives insight into how farmers perceive wildlife and choose to control wildlife on their farms, which is key to understanding how to approach the sustainability of wildlife in agriculture.

CHAPTER FOUR

GENERAL DISCUSSION

The goals of these studies were to better understand the associations between: (1) farmer well-being and cattle health on dairy and beef farms, and (2) farmer well-being, perceptions, and management of wild animals in Western Canada and Ontario. Through these studies, some interesting associations, recommendations for future research, and suggestions on how to implement this knowledge in industry were identified.

Major Findings

Farmer Well-being and Cattle Welfare

In Chapter 2, there were several identified associations between the measured dairy farmer well-being and lactating cattle health. Farmer stress and anxiety tended to be negatively associated with clinical lameness prevalence, with farmers who had a higher prevalence of lameness on their operation scoring lower for both stress and anxiety. Injuries were also associated with clinical lameness prevalence, with farmers who had <5% lameness prevalence on their operation reporting more injuries, proportionally, than farmers who had ≥5% clinical lameness prevalence. On the other hand, stress scores were positively associated with mastitis, meaning that farmers with a higher mastitis incidence experience more stress. Additionally, there was an association between region and anxiety scores, such that farmers in the Prairies reported lower anxiety as compared to farmers in Ontario. When accounting for regional differences,

farmers that had a prevalence clinical lameness of ≥5% still scored lower for anxiety than farmers with <5% lameness prevalence on their farm. Resilience scores were found to be associated with decision-making status on farms, with primary decision makers scoring higher on the resilience scale than secondary or co-decision makers. When accounting for decision-making status, resiliency tended to be associated with body condition scores outside the ideal range.

These associations were somewhat unexpected. It was originally hypothesized that poorer well-being would be associated with more negative animal health prevalence, as seen in the association between farmer stress and reported mastitis prevalence. However, the opposite association between clinical lameness prevalence and various well-being indicators was found. Perhaps the ability for farmers to identify animal health issues in their herd could impact their stress and well-being. In this study, mastitis incidence and calf mortality rate were reported by farmers, while researchers collected data to get the prevalence of lameness, body condition outside the target range, and lesions. In this case, farmers aware of the cows with mastitis on their farm, as they reported it, but the prevalence of lameness, or other animal health indicators that were collected, could be different than what they perceive. For example, research has shown that farmers' estimates of lameness are often less than the actual prevalence of lameness in their herd (Babatunde et al., 2019). It could be that farmers who are better able to detect lameness in their herd are more stressed about it and are more likely to treat it. For farmers who are less able to detect clinical lameness in their herd, they are not stressed about something they cannot see.

Secondly, the prevalence of some animal health indicators was low compared to the literature and some of the mental health outcomes in this study were higher. Due to the sensitive nature of this study, there is likely a response bias of farmers that are doing relatively well,

which could be affecting the data. Farming communities often have social barriers when it comes to discussing mental health, especially with people outside their family (Hagen et al., 2021). There may be more of a connection between farmer well-being and animal health on farms that are struggling more with animal health, however these people are less likely to volunteer for a study like mine. Some studies have found a link between animal health and mental health of farmers who are experiencing animal health issues on the opposite extreme, and struggle animal neglect on farm (Andrade and Anneberg, 2014; Devitt et al., 2015). It is often difficult to reach the farmers who are starting to struggle with animal health on their farm and could use support.

Finally, the connection between animal health and farmer well-being is likely very complicated. Based on this study at present, it is difficult to know if high stress or poorer well-being is caused by poor animal health, or if poor animal health is a result of farmers with high stress having less time to dedicate to animal health. It is likely that this connection is very complicated and is connected to other factors, like what was seen with regional differences and decision-making status difference. People with high levels of stress, anxiety, and depression have often been shown to have more pessimistic outlooks (Kagan et al., 2004; Shields et al., 2016), so they are more likely to look for and see animal health issues on their operation and treat for it. It could also be the opposite, that farmers who are more able to perceive animal health issues in their herd are more stressed or anxious about animal health because they are more likely to notice issues. Ultimately, the connection is likely multifaceted and may vary based on the resilience of the farmers, the severity of the mental and workload pressure, and access to social supports. More research is necessary to explain the connection between clinical lameness, body condition, and farmer well-being.

Due to limited responses from beef farmers, no associations between beef farmers' well-being and cattle welfare could be drawn. Instead, it was found that beef farmers reported that weather, pasture condition, and finances were the most stressful. To mitigate stress, beef farmers reported that "making more time for things I enjoy", along with workload reduction and financial support would be the most beneficial. Beef farmers also report working 6-7 days per week and taking very limited amounts of time off. Most farmers also reported that they had people at work that they could talk to about personal or work-related concerns but were more satisfied with the support they received at home. Farmers also reported they were overall satisfied with the professional relationship with their vet. The majority reported they were up to date with their financials, though few had written business or transition plans. All plans were kept using different methods. Farmers also reported keeping a variety of production records, with the majority keeping breeding records, calf mortality, animal age, and treatment with antibiotics.

Several findings in this study are aligned with those previously reported in the literature. First, weather, pasture condition, and finances are commonly stated stressors for farmers across several decades of research (Booth and Lloyd, 2000; Brennan et al., 2022; Thompson et al., 2023). Other stressors less noted in this study can be stressors that are more dependent on the year, like drought, wildfires, and other natural disasters. As beef farmers in this study mainly identified that they worked in Manitoba, some of these stressors are most reflective of farmers on the Prairies in 2023. Any conclusions related to weather, climate, provincial commodity group support, etc. are reflective of Manitoba specifically, and would likely be different if we reached other provinces. Secondly, beef farmers varied a lot when it came to the animal health data they recorded. Farmers reported collecting different animal health indicators, and reported keeping records by different methods (online or on paper), which is likely impacted by farm factor like

access to internet connection on the operation, and whether people work with family on non-family employees (Edwards et al., 2024). Most farmers in this study also kept antibiotic usage records, likely due to mandates to keep these records in Canada to participate in the Verified Beef Program, effecting farmers ability to price and sell their cattle (Hannon et al., 2020). Also, while the lack of written business plan and transition plans was interesting, researchers have previously found that farmers in Canada often lack transition plans, and wait to form even unwritten plans until someone in their family shows interest in taking over (Earls and Hall, 2018). Finally, farmers in this study reported they are generally satisfied with the support they received at home and would like more time to do things they enjoy. Research has shown that personal and community relationships are most important for farmers to find and maintain support and lower levels of stress (Deegan and Dunne, 2022; Friesen et al., 2010).

In this case, it is difficult to reach any conclusions for the connection between farmer well-being and animal health on beef farms due to the low response rate hindering the statistical analysis that could be run. This study could, however, act as a pilot study for future "One Welfare" projects involving beef farmers.

While it is out of the scope of this study to compare beef farmers and dairy farmers, there are some differences in animal management, housing, and common industry practices that may impact farmers and their cattle from either commodity groups differently. For example, finances are stressful to all farmers (Booth and Llyod, 2000), but the economics of the beef and dairy industry are very different in Canada. Dairy is managed using a quota supply management system, while pricing of beef products is managed through a price discovery system (Canadian Dairy Commission, 2023; Statistics Canada, 2022). This means that pricing for dairy is more expected, but it may be harder to expand operations, while beef prices may be more variable, but

there is more flexibility with production. Each come with their own stresses which could vary based on the market. Additionally, the way animal health is monitored is different between the two industries. Dairy farming, in Canada, is monitored through ProAction, which is mandatory, while beef cattle health is monitored through the Verified Beef Program, which is voluntary, while both programs monitor various indicators of cattle health (Dairy Farmers of Canada, 2023; Canadian Cattlemen's Association, 2024). This may impact the stress surrounding cattle health, what farmers are more likely to look for, treat, and manage with the most urgency, and could therefore influence the connections between farmers' well-being and animal health. Beef farmers also spend more variable amounts of time with their animals throughout the year, while dairy farmers are consistently interacting with their animals for similar amounts of time, so the ability for farmers to identify animal health issues may vary. The beef farmers participating in this study were slightly than the dairy farmers, which may impact the willingness to engage in discussion of mental health and age has also been found to be linked to well-being scores in the past (Hagen et al., 2021). Ultimately, there are many factors (from demographics to farm management) that will contribute to both farmer well-being and animal health and welfare across commodity groups, highlighting the need for researchers to consider these nuisances when performing this type of research.

Farmer Well-being and Perceptions of Wildlife

Dairy farmers in this study reported nuisances mostly caused by mice and rats, but also for raccoons, deer and other ungulates, crows and other corvids, and turkeys and other game birds (Chapter 3). There were regional differences in the number of nuisances reported on farms, mostly with Ontario farmers reporting more raccoon-related nuisances. Farmers also reported

benefits associated with wildlife on their operations, mainly surrounding predatory birds, deer, and other ungulates. There were additionally some regional differences in the perceived benefits of wildlife, though these tendencies were less significant than the perceived nuisances. The regional differences between nuisances and benefits were expected as native species and population density of those animals will vary from province to province. For example, raccoons have a greater population density in Ontario, and Ontario has historically struggled raccoon-related nuisances, like the risk of rabies (Rosatte, 2020; Rosatte et al., 2010). It is likely that when performing this research outside of Western Canada and Ontario, there would be different reported nuisances benefits and perceptions of wildlife.

Dairy farmers had an overall positive perception of bats and predatory birds and a more negative perception of mice and rats, raccoons, crows, and other corvids. There was a regional difference in some of the perceptions towards specific species groups as well, with BC farmers having a generally more negative perception of game birds while Ontario farmers had a more negative perception of raccoons than other regions. Animals that were negatively perceived were more likely to have more negative perceptions, which was expected. Often nuisance causing mammals are more likely to be controlled, even if these nuisances are just perceived and not actually occurring on farms (Goodale et al., 2015). The regional difference in perceptions again shows the need for this research to account for different habitats or ecosystems of wildlife, as nuisances, benefits, and therefore perceptions will vary.

When these perceptions were statistically compared to the mental health scores of farmers, it was found that there was an association between the perceptions of mice and rats and farmers' stress, resilience, and depression levels, such that those with more negative perceptions also had poorer mental health scores. Additionally, there was a connection between farmers'

perceptions of raccoons and their anxiety levels. When accounting for region, negative perceptions of raccoons were associated with higher anxiety and depression scores in some provinces. The perceptions of crows and corvids were also found to be positively associated with resilience scores in some provinces, meaning that people who viewed corvids more positively were more resilient. Previous research has shown a link between people exhibiting higher levels of stress or diagnosed with anxiety or depression and having pessimistic views (Kagan et al., 2004; Shields et al., 2016). It could be that people who scored higher for stress, anxiety, or depression may be more pessimistically biased, and that could influence their perceptions of wildlife. On the other hand, if the nuisances of animals are harmful, meaning the animal is negatively perceived, and that animal could be causing stress. Ultimately, more research would be needed to understand how exactly well-being and perceptions of wildlife are connected.

Beef farmers reported nuisances from mice and rats, deer, and small mammals. The majority also reported large predatory mammals as causing livestock harm on their operation. They reported benefits from predatory birds for their predation of wildlife and liked seeing deer and predatory birds on their operation. Overall, beef farmers had positive perceptions of bats and predatory birds and more negative perceptions of mice and rats, raccoons, small mammals, large predatory mammals, and corvids.

The perceptions of animals could vary between beef farmers and dairy farmers for a variety of reasons. For example, feed is more likely to be stored farther from barns and human activity on beef operations, where bails may even be kept on the fields; wildlife can not only be a concern for food competition and destruction of feed but can also be a concern surrounding disease transmission as well (Lavelle et al., 2016). Housing is also different between dairy and beef farmers, with the majority of beef cattle housed outdoors, which puts beef cattle at a higher

risk for predation and zoonotic disease (Park et al, 2020b). This may influence the nuisances reported by beef farmers, as biosecurity may be a higher concern, and livestock depredation would be a more of an issue, which may be reflected by the fact that beef farmers reported a greater number of animals as nuisances in this study. Differences in housing practices, feed management, animal health concerns, etc. may not only influence the nuisances that farmers note associated with certain wildlife species but may also impact their attitudes and perceived need to control those species. This highlights the need for this research to be performed with a variety of commodity groups.

Overall, both dairy and beef farmers had different preferred methods for managing each species on their operation, though more negatively viewed animals were often controlled more. Mice and rats were the primary group of animals for which pest control methods were used on both dairy and beef farms. The majority of beef farmers reported that they used wildlife control for mice and rats, large predatory mammals, small mammals, and raccoons, though the methods they choose to employ vary by species. Dairy farmers mostly chose the methods they use on their operations due to the ease of use and effectiveness of those methods, and would need methods to be equally effective, cheap, and/or receive government compensation for wildlife-related damages to choose to use other wildlife control method. Though not asked in this study, it would be interesting to ask farmers what they consider "effective" animal control, control that keeps animals away from farms, or control that limits nuisances caused by animals. Non-lethal methods, like livestock protection collars (spiked collars cattle may wear to deter wildlife predation) and guardian animals (animals, often dogs, trained to deter predatory wildlife), have been shown to be more effective than lethal methods in protecting livestock from predation in South Africa (Whitehouse-Tedd et al., 2021). It seems that limiting nuisances could have an

effect on perceptions of wildlife, and by controlling for nuisance rather than wildlife, biodiversity could be enhanced on farms.

The consideration for biodiversity is important as it promotes both environmental sustainability and has been shown to promote more sustainable and productive farms. One study found that allowing for preserved habitat strips on farms that promote biodiversity resulted in a greater crop yield despite the lowered available land space (Pywell et al., 2015). Some farmers have recognized animals as having benefits to their farm, though most recognize natural predation and aesthetics rather than the benefit to land health in the current study. Beef farmers additionally reported choosing the control methods based on the humaneness of the control method.

The need for government compensation when considering other control methods is reflected by the fact that the majority of farmers have received compensation for damages in the past. Beef farmers specifically reported needing compensation for wildlife predation, which would make sense considering beef cattle cow-calf operations in Canada, the operation ran by all participants in the study, are more likely to be housed outside. At this time, there is extremely little research regarding the need for and use of government compensation for wildlife predation. However, more wildlife predation compensation programs are being implemented in Canada currently. In Manitoba, where a large number of livestock farmers in this study were located, a new program to fund farms so they can invest in prevention practices, like guardian dogs, fences, and other equipment is available to farmers (Manitoba Government, 2024). Although there is some discussion on the actual level of livestock predation, as the perceived threat of predators is often found to be higher than what is actually occurring on farms (Peterson et al., 2010).

Providing funding for farmers to prevent nuisances from occurring on their farms, has been shown to reduce the need for lethal control on farms (McManus et al., 2015).

Future Research

Farmer Well-being and Cattle Welfare

Future research into the connections between farmer well-being and animal welfare should consider new ways of recruiting farmers. Recruitment was a major hurdle with these projects. While social media is an easy way reach a large amount of people, advertising the surveys using social media platforms lead to a large amount of spam responses. A recruitment-specific survey helped mitigate the number of spam responses in the main dairy survey, however there were some farmers who filled out the recruitment survey who did not respond to the actual survey. Primarily using methods like recruiting through more farmer-focused companies (like feed companies, equipment companies, genetic companies, etc.) and veterinarians, in addition to provincial commodity groups, recruiting at events, and using snowball sampling to recruit instead of social media-based recruitment would have aided the recruitment of farmers. Additionally, these surveys were administered following the COVID-19 pandemic, a time that some researchers suggest people may have been experiencing survey fatigue, and less likely to participate in survey-based studies (de Koning et al., 2021).

Further, reaching a greater diversity of farmers is important when pursuing this research in the future. It is likely that we mainly had responses from more progressive farmers who are more informed about mental health, as they are more likely to want to participate in these types of studies. The farmers in the study had a relatively low prevalence of some of the animal health indicators, compared to the existing Canadian literature. To better understand the connection

between animal health and farmer well-being, it is important to reach farmers that are more at-risk. Those farmers are less likely to volunteer for studies like this, so reaching out buy means other than social media, including farmer groups, especially those that run animal health programs like ProAction, is necessary to help find better methods of farmer recruitment. Ultimately, building trust within the community will be the best way to reach a greater population of farmers, though this trust is built overtime by performing more research like this and attending events and meeting people in person.

It may also be beneficial to understand the different impacts of the perceived prevalence of animal health indicators compared to their actual prevalence. In this study, there was a positive association between farmer well-being and mastitis incidence, whereas the associations between well-being and lameness and body condition scores collected by the researchers were negative. Therefore, high prevalence of animal health was associated with poorer well-being for self-reported animal health indicators but was opposite for indicators that may be harder for farmers to detect themselves. For mastitis, it could be more urgent and easier to detect, as mastitis can impact milk yield (Gonçalves et al., 2018). Lower milk yield has an impact on farm finances, which is one of the most common stressors to farmers (Thompson et al., 2023), so it is more vital to treat it right away. Whereas, for lameness, and clinical lameness especially, it is harder to detect (Cutler et al., 2017), and may go unnoticed longer without impacts to milk yield. To better understand the connection between farmer well-being and animal welfare, it is crucial to identify the difference between the impact perceived and actual animal health prevalence.

Finally, this study was only conducted with dairy and beef farmers. Due to the low verified response rate from beef farmers, there should be another study conducted with beef farmers. Additionally, similar studies involving other livestock commodity groups, like swine

egg, or broiler farmers, etc., should also be conducted. There are different stressors associated with different commodity groups, so the connection between farmer well-being and animal health may be specific to the commodity group.

Farmer Well-being and Perceptions of Wildlife

Future research should consider different regions (beyond just regional or provincial differences), and commodity groups. The goal of these surveys was not to compare commodity groups, although, descriptively, there were differences between perceived nuisances, benefits, and overall perceptions for some species of wildlife between beef and dairy farmers. There are likely factors specific to every commodity group (both crop and livestock farmers) that would impact the perception of wildlife. Additionally, the research at present found that there were regional differences in the nuisances and benefits identified for some species, as well as the perceptions and how that related to farmer well-being. Future research should consider regional differences as it relates to perceptions of wildlife, not only provincially, but also considering differences within a province as well. Understanding how regional factors, like different biomes and habitat types or proximity to urban landscapes, impact perceptions of wildlife is also important when continuing this type of research.

There may have been a seasonal effect on the survey, as the majority of participant responded in summer or early fall. While the survey encouraged farmers to think of all nuisances caused by animals on their operation, recency of some wildlife-related nuisances may have affected the perceptions of some species. Migratory birds, for example, will only seasonally cause nuisances on farms. There is some seasonal management of harvest time in Canada to address migratory overabundance of geese in Canada (Neufeld et al., 2024). During these times, geese may be causing more nuisances, resulting in farmers more likely to report nuisances or

negative perceptions of geese. Additionally, deer and geese have hunting seasons, and hunting was included in the methods of animal control. During hunting season, deer may be more likely to be selected as wildlife in need of control regardless of nuisance detected on farms, as farmers may be hunting them at that time. Seasonal nuisances caused by wildlife and the effect on farmers perception needs to be better understood to understand farmer-wildlife conflict and the effect on farmers' well-being.

Further research including a wider variety of species or species groups and their impacts on farmers' well-being should also be performed. These studies found that there are different nuisances and benefits associated with each species or species group which may impact the overall perception of those animals. Each region also has species specific to that ecosystem, so using animals specific to the target region when conducting future research should be considered.

Linking the perceived nuisances and benefits of wildlife species should be examined more closely to understand what nuisances and/or benefits have the biggest impact on the overall perception and farmer well-being. For these studies, farmers were asked if they noticed any of the listed nuisances or benefits for each wildlife species, but there was no timeframe or way for farmers to rank how nuisance causing or beneficial each of the listed items were. There may be seasonal nuisances that farmers may notice at time of study (nuisances involved with cropping or animals being active in summer) and failed to consider nuisances occurring in other seasons (ex. nuisances of migrating birds like geese). Additionally, some nuisances, like threat to staff or livestock safety, may be more concerning to farmers than others, but the questions asked farmers to identify only what nuisances were occurring, not the perceived severity. While nuisances and

benefits may impact the overall perception of the animal, asking farmers to scale the impact of each would also inform those perceptions.

There may also be a difference between the perceived nuisance or benefit of wildlife and what is actually occurring on farms. Several studies have shown that the perceived threat of large predatory mammals is often higher than the actual livestock predation and other harms those animals cause (Goodale et al., 2015; Peterson et al., 2010). This was beyond the scope of this study; however, future research should consider how perceived nuisances affect overall perceptions and attitudes towards various species compared to the actual nuisances they cause.

Finally, research surrounding animal control used on farms should also consider ease of use, cost, and effectiveness when testing control methods and making recommendations. For this study, farmers indicated those factors were most important when adopting new control methods on their farms.

Recommendations for Industry

The goals of these studies aim to understand the impact farming has on farmers' well-being on cattle operations. Thus, the findings of these studies allow stakeholders to understand where farmers need support. The clearest connection between farmer mental health and cattle health was the connection between higher prevalence of mastitis and higher stress scores for farmer. There providing support for farmers struggling with mastitis could be helpful to reduce farmer stress. This could include animal health initiatives, allowing for farmers to access farm specific herd health support when mastitis in the herd reach certain levels, or it could include farmer specific initiatives that give farmers access to mental health support to reduce stress or monetary support to help them address mastitis in the herd.

There may also be a connection to other disease prevalence as well, but more research would be needed to establish this link. While farmers reported that different resources would work for them, providing added support, especially for farmers struggling with animal health on their operation, can be beneficial for helping both farmers and their animals. In the dairy industry, providing support resources (including sharing access to rural therapy options, expanding mental health support in rural areas, running initiatives to address stigma around receiving mental health support in farming communities, etc.) during or after proAction assessments could be beneficial.

Regarding farmers' perceptions of wildlife, there were some wildlife species that farmers reported caused nuisances. Beef farmers were more likely to report that they deal with livestock predation and need compensation for those losses, although some dairy farmers reported similar issues. Currently, in Canada, livestock loss compensation programs vary by province, and have different requirements farmers must follow to receive compensation. Manitoba, for example, provides a provincial government program for applicants to apply for funding to build fences, purchase non-lethal deterrence equipment, or purchase livestock guardian dogs, though there is an annual deadline to apply for this program (Manitoba Government, 2024). British Columbia, on the other hand, has a livestock loss prevention program that is government funded but run by commodity groups, like the BC Cattlemen's Association, which and focuses on giving compensation for cattle loss rather than wildlife prevention, despite its name (BC Cattlemen's Association, 2024). Some farmers in this study expressed uncertainty surrounding livestock compensation programs in their province; thus, providing clear information to farmers about these programs would help support them.

Farmers with higher stress and poorer well-being also had more negative perceptions of racoons, mice and rats, and this differed by region. Understanding what wildlife nuisances are affecting farmers in the region is crucial in supporting them. By identifying the wildlife and nuisances or benefits they cause, local farmer organizations can make resources to help farmers deal with the wildlife and the nuisances in a way that best supports their farms and the environment. This could include informational campaigns on best ways to mitigate nuisances sustainably, information about how sustainable agriculture initiative may benefit farms, or providing funding for farmers to implement new deterrence methods or sustainable farming initiative if not already applicable in the province.

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APPENDIX

Appendix Page

Appendix 1. Survey questions to assess dairy farmer well-being and animal health.

A) Questions about you and your role on the farm

Please select your age group:

o 17 or younger (excluded)	o 30-39	o 50-59
o 18-29	o 40-49	o 65 or older

Please select the province your farm is located:

o Alberta	o Manitoba	o Saskatchewan
o British Columbia	o Ontario	o Other (excluded)

With what gender do you identify? _____

How involved are you in the decision-making process on your farm?
o I am a primary decision maker
o I am a secondary decision maker or co-decision maker
o I am not actively involved in making decisions (excluded)

How long have you owned/managed the farm as a primary or secondary decision maker?
o Less than a year o 1-5 years o 5-10 years o 10 or more years

On your operation, roughly what proportion of your time do you spend working directly with animals?
o 0-20% o 21-40% o 41-60% o 61-80% o 81-100%

On your operation, roughly what portion of your time is spent working alone?
o 0-20% o 21-40% o 41-60% o 61-80% o 81-100%

From the list below, please select all farm work you perform on a regular basis:
o Calf management
o Cleaning and bedding stalls/pack
o Cleaning milking equipment
o Cropping (seasonally)
o Feeding cows and heifers
o Finances
o Health checks and treatments
o Milking cows (including bringing to parlour/robot)
o Reproduction and breeding
o Other _____

Does your workload allow you to achieve a healthy work-life balance?
o Yes o Sometimes o No

During an average week, how often are you able to take time for recreation or rest or anything that brings you joy? (i.e. sports, playing games with family, walking the dog, spending time with calves, watching TV, etc.)
o Less than once per week
o Once per week
o A few times per week
o Nearly everyday
o Everyday

On average, how many days do you work per week? (This includes time spent physically at work, or any work you may do from home)?

o 1 o 2 o 3 o 4 o 5 o 6 o 7

How much vacation time do you take per year (not including your regular days off)? (This time does not need to be consecutive)

o None
o 1-2 days
o 3-6 days
o One week off
o Two weeks off
o Three weeks off
o Other: _____

B) ANIMAL HEALTH QUESTIONS:

Over the last 12 months, what was your approximate calf mortality rate for calves under 3 months old? _____

Over the last 12 months, how many cases of mastitis did you have on your farm? (Please include recurring cases for a single cow and count them as multiple cases.)_____

C) Occupational health & well-being

Have you experienced any of the following injuries or health problems while farming? (Select all that apply)

o Broken bone/Fracture
o Burns
o Chronic use injuries/joint pain
o Contusion Head injury/concussion
o Dislocation/sprains
o Laceration (requiring stiches)
o Major bruises
o Partial or complete loss of eyesight
o Partial or complete loss of hearing
o Respiratory disease
o Tendon lesion/injury
o Amputation
o Other _____

What was the cause of the injury? (Select all that apply)

o Machinery or equipment (i.e., tractor, truck, farm machines, etc.)
o Work Environment (i.e., slippery surfaces, unleveled terrain, splash with chemicals, confined spaces, etc.)
o Animals (i.e., kick, bites, headbutts, stepped on, etc.)
o Other _____

On average, how many hours do you sleep?

o Less than 5
o 5-6
o 7-8
o 9-10
o More than 10

Do you feel like you are getting enough sleep per night?

o Yes o No

The following section involves questions to ask you about your feelings and thoughts during the last month to assess your stress level. In each case, you will be asked to indicate by selecting how often you felt or thought a certain way.

In the last month, how often have you been upset because of something that happened unexpectedly?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt that you were unable to control the important things in your life?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt nervous and "stressed"?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt confident about your ability to handle your personal problems?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt that things were going your way?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you found that you could not cope with all the things that you had to do?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you been able to control irritations in your life?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt that you were on top of things?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you been angered because of things that were outside of your control?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt confident in your ability to handle your business and operation problems?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

The following section involved questions used to assess your resilience.
Please rate how you have felt over the past month.

I am able to adapt to change:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I can deal with whatever comes:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I try to see the humorous side of problems:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

Coping with stress can strengthen me:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I tend to bounce back after illness or hardship:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I can achieve goals despite obstacles:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I can stay focused under pressure:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I am not easily discouraged by failure:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I think of myself as a strong person:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I can handle unpleasant feelings:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

The following section involves questions used to assess your mental health.
Don't take too long over your replies: your immediate reaction to each item will probably be more accurate than a long thought-out response.

Over the last 2 weeks, how often have you been bothered by any of the following problems?

Little interest or pleasure in doing things
o Not at all
o Several days
o More than half of the days
o Nearly every day

Feeling down, depressed, or hopeless
o Not at all
o Several days
o More than half of the days
o Nearly every day

Trouble falling or staying asleep, or sleeping too much
o Not at all
o Several days
o More than half of the days
o Nearly every day

Feeling tired or having little energy
o Not at all
o Several days
o More than half of the days
o Nearly every day

Poor appetite or overeating
o Not at all
o Several days
o More than half of the days
o Nearly every day

Feeling bad about yourself – or that you are a failure or have let yourself or your family down
o Not at all
o Several days
o More than half of the days
o Nearly every day

Trouble concentrating on things, such as reading the newspaper or watching television
o Not at all
o Several days
o More than half of the days
o Nearly every day

Moving or speaking so slowly that other people could have noticed? Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual.
o Not at all
o Several days
o More than half of the days
o Nearly every day

Thoughts that you would be better off dead or of hurting yourself in some way
o Not at all
o Several days
o More than half of the days
o Nearly every day

Over the last two weeks how often have you been bothered by any of the following problems?

Feeling nervous, anxious or on edge
o Not at all
o Several days
o More than half of the days
o Nearly every day

Not being able to stop or control worrying
o Not at all
o Several days
o More than half of the days
o Nearly every day

Worrying too much about different things
o Not at all
o Several days
o More than half of the days
o Nearly every day

Trouble relaxing
o Not at all
o Several days
o More than half of the days
o Nearly every day

Being so restless it is hard to sit still
o Not at all
o Several days
o More than half of the days
o Nearly every day

Becoming easily annoyed or irritable
o Not at all
o Several days
o More than half of the days
o Nearly every day

Feeling afraid as if something awful might happen
o Not at all
o Several days
o More than half of the days
o Nearly every day

The following table seeks to determine specific stressors on your operation.

In the past month, how often have you felt stressed or concerned by the following on a scale of 0 to 5 (0 = Never; 4 = Always)?

	Never 0	Rarely 1	Sometimes 2	Very often 3	Always 4	Not Applicable
Animal health						
Animal rights activists						
Continuation of quota						
Drought						
Energy pricing						
Feed availability						
Feed costs						
Finances (personal and farm)						
Flooding						
Government policy and industry regulations						
Human resource management						
Installing new farm machinery						
Public perception						
Raw milk prices						
Transitioning the farm to the next generation						
Value of quota						
Weather						
Wildfires						
Workload/time constraints						
Other (please specify)						

What resources would help reduce your stress? (Select all that apply)

o Reduced workload
o Finding more time for the things I enjoy (including time family, self-care etc.)
o Attracting reliable employees
o Retaining reliable employees
o Better emotional support from my family
o Better access to preventative stress management and mental health resources
o Better access to mental health treatment services (counsellor, therapist, doctors, etc.)
o Better access to production support resources (equipment, technology, land, etc.)
o Better access to financial support resources (including capital and financial analysis tools)
o Better access to business support resources (including marketing, human resource management advisors, etc.)
o Better understanding of my business options and opportunities (including financial, marketing, human resource management, farm transition, technology, etc.)
o A change in my production practices (ex. timing, equipment, buildings, technology, etc.)
o A change in my business practices (ex. planning, record-keeping, human resource management, marketing, financial analysis, etc.)
o Other: (please specify) _____

Appendix 2. Survey questions to assess beef farmer well-being, animal health, and farm management.

A) GENERAL BACKGROUND QUESTIONS: Questions about you and your role on your operation

Please select your age group:

o 17 or younger (excluded)	o 40-49	o 65 or older
o 18–29	o 50-59	
o 30-39	o 60-64	

In which province/territory is your operation located?

o British Columbia	o Saskatchewan	o Ontario
o Alberta	o Manitoba	o Other (excluded

With what gender do you identify? _____

What is your role in your operation?
o I am a primary decision maker
o I am a secondary decision maker or co-decision maker
o I am not actively involved in making decisions (not eligible for study)

How long have you owned/managed the operation as a primary or secondary decision maker?

o Less than a year	o 5-10 years
o 1-5 years	o 10 or more years

On your operation, roughly what portion of the total work do you personally perform?

o 0-25%	o 26-50%	o 51-75%	o 76-100%

On your operation, roughly what proportion of your time do you spend working alone?

o 0-25%	o 26-50%	o 51-75%	o 76-100%

On average, how many days do you work per week? (This includes time spent physically at work, or any work you may do from home)

o 1	o 2	o 3	o 4	o 5	o 6	o 7

How much vacation time do you take per year (not including your regular days off)? (This time does not need to be consecutive)

o Never	o 3-6 days	o Two weeks off	o Other:
o 1-2 days	o One week off	o Three weeks off	_____

B) Questions about your farm/operation

What type of operation do you run? (Select all that apply)
o Cow-Calf o Backgrounding o Feed lot

Approximately how many calves do you have on average, in your operation? _____

Approximately how many mature heifers/cows do you have on average, in your operation? ____

Approximately how many steers do you have on average, in your operation? _____

Approximately how many bulls do you have on average, in your operation? _____

(Display if selected Cow-Calf in demographics):

Over the last 12 months:
- what is your approximate calf mortality rate for calves under 3 months old? _____

- what is your approximate conception rate? _____

- what is your approximate weaning rate? _____

(**Display if selected "Backgrounding" AND/OR "Feedlot" in demographics**):

Over the last 12 months:
- what is your approximate feed efficiency? _____
- what is your approximate mortality rate? _____
- of your mortality, what proportion are euthanized cows? _____
- what types of bovine illness(es) have you treated on your operation?_____

How many total workers (full time and part time, not including yourself)) do you employ on your farm? (Please include family members who work on your farm). _____

Please select the people who work on your farm as full-time or part-time workers: (Select all that apply)
o Spouse o Sibling(s) o Hired employee(s)
o Parent(s) o Another family o Other (please specify):
o Child(ren) member(s) _____

Do you have someone you feel comfortable talking to at work about any concerns (personal, work-related)?
o Yes o No

Are you satisfied with the personal/social support you receive at home?
o Very dissatisfied
o Dissatisfied
o Neutral
o Satisfied
o Very Satisfied

Are you satisfied with the personal/social support you receive at work (this may include family members who you work with)?
o Very dissatisfied
o Dissatisfied
o Neutral
o Satisfied
o Very Satisfied

Are you satisfied with the professional support you receive at work (this may include family members who you work with)?
o Very dissatisfied
o Dissatisfied
o Neutral
o Satisfied
o Very Satisfied

What people outside of your operation (i.e. non-employees) do you have a working relationship with? (Select all that apply)
o Business advisor
o Equipment supplier/technician
o Feed salesperson
o Nutritionist/Feed rep
o Neighbour/Other Farmers
o Government Extension
o Livestock Specialist
o Livestock breeding contractor/technician
o Other (Please Specify)_____

Are you satisfied with the professional support you receive from your veterinarian?
o Very dissatisfied
o Dissatisfied
o Neutral
o Satisfied
o Very Satisfied

How often is your veterinarian scheduled to come to your operation? (Not including emergencies)
o Less than once a year
o Once a year
o Twice a year
o Three times a year
o Four times a year
o Five or more times a year

How often in the last year has your veterinarian come to your operation for unscheduled/emergency visits?
o Less than once a year
o Once a year
o Twice a year
o Three times a year
o Four times a year
o Five or more times a year

C) FINANCIAL PLANNING AND RECORD KEEPING

Do you have a **written** business plan?
o Yes o No

Was your business plan created with professional assistance?
o Yes o No o Not Applicable

Do you have a **written** farm transition or succession plan (to transfer ownership and control of farming assets to the next generation to continue the business)?
o Yes o No

Was your transition plan/succession plan created with professional assistance?
o Yes o No o Not Applicable

Do you conduct risk assessments annually and have a written risk management/contingency plan(s)?
o Yes o No

Are your financial records up to date (as of March 31, 2023)?
o Yes o No

What format do you use to keep your financial records?
o Hand-written notes
o Formatted hand-written records or handwritten spreadsheet
o Basic online spreadsheet
o Specialized software
o A combination of handwritten and online
o Other (please specify)

Are your production records up to date (as of March 31, 2023)?
o Yes o No

What format do you use to keep your production records?
o Hand-written notes
o Formatted hand-written records or handwritten spreadsheet
o Basic online spreadsheet
o Specialized software
o A combination of handwritten and online
o Other (please specify)

What type of production records do you keep? (Select all that apply)
o Animal age
o Animal health and/or body condition
o Treatment with antibiotics
o Treatment with medicine other than antibiotics
o Breeding records / Genetics
o Calf mortality
o Number of animals
o Calf weaning weight
o Mature cattle weight
o Cow:Bull Ratio
o Other (please specify)

D) Occupational health & well-being

Have you experienced any of the following injuries or health problems while farming? (Select all that apply)

o Broken bone/Fracture
o Burns
o Chronic use injuries/joint pain
o Contusion Head injury/concussion
o Dislocation/sprains
o Laceration (requiring stiches)
o Major bruises
o Partial or complete loss of eyesight
o Partial or complete loss of hearing
o Respiratory disease
o Tendon lesion/injury
o Amputation
o Other _____

What was the cause of the injury? (Select all that apply)

o Machinery or equipment (i.e., tractor, truck, farm machines, etc.)
o Work Environment (i.e., slippery surfaces, unleveled terrain, splash with chemicals, confined spaces, etc.)
o Animals (i.e., kick, bites, headbutts, stepped on, etc.)
o Other _____

On average, how many hours do you sleep?

o Less than 5
o 5-6
o 7-8
o 9-10
o More than 10

Do you feel like you are getting enough sleep per night?

o Yes
o No

The following section involves questions to ask you about your feelings and thoughts during the last month to assess your stress level. In each case, you will be asked to indicate by selecting how often you felt or thought a certain way.

In the last month, how often have you been upset because of something that happened unexpectedly?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt that you were unable to control the important things in your life?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt nervous and "stressed"?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt confident about your ability to handle your personal problems?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt that things were going your way?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you found that you could not cope with all the things that you had to do?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you been able to control irritations in your life?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt that you were on top of things?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you been angered because of things that were outside of your control?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

In the last month, how often have you felt confident in your ability to handle your business and operation problems?
o Never
o Almost never
o Sometimes
o Fairly often
o Very often

The following section involved questions used to assess your resilience.
Please rate how you have felt over the past month.

I am able to adapt to change:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I can deal with whatever comes:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I try to see the humorous side of problems:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

Coping with stress can strengthen me:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I tend to bounce back after illness or hardship:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I can achieve goals despite obstacles:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I can stay focused under pressure:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I am not easily discouraged by failure:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I think of myself as a strong person:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

I can handle unpleasant feelings:
o Not true at all
o Rarely true
o Sometimes true
o Often true
o True nearly all of the time

The following section involves questions used to assess your mental health.
Don't take too long over your replies: your immediate reaction to each item will probably be more accurate than a long thought-out response.

Over the last 2 weeks, how often have you been bothered by any of the following problems?

Little interest or pleasure in doing things
o Not at all
o Several days
o More than half of the days
o Nearly every day

Feeling down, depressed, or hopeless
o Not at all
o Several days
o More than half of the days
o Nearly every day

Trouble falling or staying asleep, or sleeping too much
o Not at all
o Several days
o More than half of the days
o Nearly every day

Feeling tired or having little energy
o Not at all
o Several days
o More than half of the days
o Nearly every day

Poor appetite or overeating
o Not at all
o Several days
o More than half of the days
o Nearly every day

Feeling bad about yourself – or that you are a failure or have let yourself or your family down
o Not at all
o Several days
o More than half of the days
o Nearly every day

Trouble concentrating on things, such as reading the newspaper or watching television
o Not at all
o Several days
o More than half of the days
o Nearly every day

Moving or speaking so slowly that other people could have noticed? Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual.
o Not at all
o Several days
o More than half of the days
o Nearly every day

Thoughts that you would be better off dead or of hurting yourself in some way
o Not at all
o Several days
o More than half of the days
o Nearly every day

Over the last two weeks how often have you been bothered by any of the following problems?

Feeling nervous, anxious or on edge
o Not at all
o Several days
o More than half of the days
o Nearly every day

Not being able to stop or control worrying
o Not at all
o Several days
o More than half of the days
o Nearly every day

Worrying too much about different things
o Not at all
o Several days
o More than half of the days
o Nearly every day

Trouble relaxing
o Not at all
o Several days
o More than half of the days
o Nearly every day

Being so restless it is hard to sit still
o Not at all
o Several days
o More than half of the days
o Nearly every day

Becoming easily annoyed or irritable
o Not at all
o Several days
o More than half of the days
o Nearly every day

Feeling afraid as if something awful might happen
o Not at all
o Several days
o More than half of the days
o Nearly every day

The following table seeks to determine specific stressors on your operation.
How often have you felt stressed or concerned by the following on a scale of 0 to 5 (0 = Never; 4 = Always)? Please check the box that describes your level of concern for each.

	Never 0	**Rarely 1**	**Sometimes 2**	**Very often 3**	**Always 4**	**Not Applicable**
Weather						
Drought						
Flooding						
Wildfires						
Water pricing						
Feed Availability						
Feed Pricing						
Pasture Condition						
Animal Health and Welfare						
Personal Finances						
Farm Finances						
Marketing and Market Price						
Human Resource Management						
Policy and Regulations						
Workload/Time Pressure						
Learning and Implementing New Technology						
Other (please specify) _____						

What resources would help reduce your stress? (Select all that apply)
Reduced workload (more time for the things I enjoy including family and self-care)
o Attracting reliable employees
o Retaining reliable employees
o Better emotional support from my family
o Better access to preventative stress management and mental health resources
o Better access to mental health treatment services (counsellor, therapist, doctors, etc.)
o Better access to production support resources (equipment, technology, lands, etc.)
o Better access to financial support resources (including capital and financial analysis tools)
o Better access to business support resources (including financial, marketing, human resource management advisors, etc.)
o Better understanding of my business options and opportunities (including financial, marketing, human resource management, farm transition, technology, etc.)
o A change in my production practices (ex. timing, equipment, buildings, technology, etc.)
o A change in my business practices (ex. planning, record-keeping, human resource management, marketing, financial analysis, etc.)
o Other: please explain _____

Appendix 3: Survey questions to assess dairy and beef farmers' perceptions of wildlife and wildlife control methods employed on their operations.

The following questions ask about various wild animals that may be present on your farm. We are interested in learning about how you view different species and how they may affect you, positively or negatively. Because we are interested in connecting the well-being of farmers and animals, we would also like to ask about how you manage wildlife on your farm.

Do you also grow crops on your operation?

o Yes o No

Which of the following wildlife species have you seen on your operation? (Select all that apply)

o Mice and/or rats
o Raccoons
o Deer, moose, caribou, and/or other ungulates
o Bats
o Other small mammals: (squirrels, prairie dogs, gopher, beavers, hares, rabbits and/or skunks)
o Large Predatory mammals: (lynx, bobcat, cougar, coyote, wolf, fox and/or bears)
o Crows, ravens, starlings, and/or grackles
o Wild turkeys, geese, ducks, pigeons and/or doves
o Predatory Birds (Hawks, Eagles etc.)
o Reptiles & amphibians (snakes, turtles, frogs, toads)
o Other, Not listed (please specify): _____

For each animal listed, please check a box to identify the nature of the nuisance for ONLY the animal(s) you have identified on your operation. If you have not encountered any of the listed animal groups, please leave the row blank.

Animal	Crop Damage/ Feed consumption	Physical Harm to Livestock	Risk of disease(s)	Damage to structures/buildings	Damage to Equipment	Concern for Human Safety	Source of overall stress and tension
Mice and/or Rats							
Raccoon							
Deer, moose, caribou, etc.							
Bats							
Small Mammals							
Large Predatory Mammals							
Crows, ravens, etc.							
Wild turkeys, geese, ducks, pigeons, doves							
Predatory Birds							
Reptiles & amphibians							

Please check a box to identify positive effects wildlife or wildlife considerations you may have for ONLY the animal(s) you have identified on your operation. If you have not encountered any of the listed animal groups, please leave the row blank.

Animal	Natural Predation	Improves Soil Health/ Land Productivity	I like seeing this animal/ Aesthetics	Species Protection/ Conservation	Other
Mice and/or Rats					
Raccoon					
Deer, moose, caribou, etc.					
Bats					
Small Mammals					
Large Predatory Mammals					
Crows, ravens, etc.					
Wild turkeys, geese, ducks, pigeons, doves					
Predatory Birds					
Reptiles & amphibians					

Overall, how would you rate the presence of each animal on your farm? Please indicate for ONLY the animal(s) you have identified on your operation. If you have not encountered any of the listed animal groups, please leave the row blank.

	Harmful/ Stressful	Somewhat Harmful/ Stressful	Neutral	Somewhat Beneficial	Beneficial	Not applicable
Mice and/or Rats						
Raccoon						
Deer, moose, caribou, etc.						
Bats						
Small Mammals						
Large Predatory Mammals						
Crows, ravens, etc.						
Wild turkeys, geese, ducks, pigeons, doves						
Predatory Birds						
Reptiles & amphibians						

For animals you have identified on your farm, please indicate which methods you have used for animal control.

Animal	Hunting/ Shooting	Lethal Traps	Non-Lethal Traps/ Relocation	Poison	Physical Barrier (Fences)	Guardian Animals/ Barn cats	Other Deterrent Methods	Other Repellent Methods	Nothing
Mice and/or Rats									
Raccoon									
Deer, moose, caribou, etc.									
Bats									
Small Mammals									
Large Predatory Mammals									
Crows, ravens, etc.									
Wild turkeys, geese, ducks, pigeons, doves									
Predatory Birds									
Reptiles & amphibians									

Which of the following are factors in your decision to use the animal control methods selected above? (Select all that apply)

o Effective in short term
o Effective in long term
o Easy, low labour needed
o Humane for the animal
o Non-lethal method
o Focused on prevention and deterrence
o Neighboring farmers use same or similar methods
o Past owners/operators used these methods
o Other (Please Specify): _____

What would be helpful/needed for you to consider using other wildlife control methods? (Select all that apply)

o More information about the efficacy of prevention and deterrence methods
o More information about the efficacy of non-lethal animal control methods
o More information about the humaneness of different methods
o Cheaper and easier access to other methods
o Information on Wildlife-related control policy
o Government Compensation for Damage
o Other farmers in your area to use other control method(s)
o Other: (Please specify) _____

Have you previously received government compensation for either crop damage or livestock predation?

o Yes
o No
o Not applicable (No noticeable crop damage or livestock predation)