ABSTRACT

Implementing biosecurity protocols is necessary to reduce the spread of disease on dairy farms. In Ontario, biosecurity implementation is variable among farms and barriers to biosecurity are unknown. Thirty-five semi-structured interviews were conducted between July 2022 and January 2023 with dairy producers (n = 17) and veterinarians (n = 18). Participants also completed a demographic survey. Thematic analysis was performed with constructivist and grounded theory paradigms. Thematic coding was done inductively using NVivo software. Dairy producers’ understanding of the definition of biosecurity varied, with all understanding that it was to prevent the spread of disease. Furthermore, the most common perception was that biosecurity prevented the spread of disease onto the farm. Both veterinarians and producers stated that closed herds were one of the most important biosecurity protocols. Barriers to biosecurity implementation included a lack of resources, internal and external business influencers, individual perceptions of biosecurity, and a lack of industry initiative. Understanding the barriers producers face provides veterinarians with the chance to tailor their communication to ensure barriers are reduced, or for other industry members to reduce the barriers.

Key words: disease prevention, management practices, farmer perception, veterinarian perception

INTRODUCTION

The Biosecurity for Canadian Dairy Farms: National Standard, provided by the Canadian Food Inspection Agency (CFIA), includes the following definition of biosecurity: “a series of management practices designed to minimize or prevent and control: a) The introduction of infectious disease agents onto a farm; b) Spread within a farm production operation; and c) Export of these disease agents beyond the farm that may have an adverse effect on the economy, environment, and human health” (Canadian Food Inspection Agency, 2013). Biosecurity implementation affects animal health and welfare, production, and public health through reduced spread of disease-causing pathogens (Hoe and Ruegg, 2006; Gates et al., 2013). Welfare is indirectly impacted by biosecurity due to reduced negative affective states caused by disease (Farm Animal Welfare Council, 1993). For example, a cow experiencing symptoms of Salmonella Dublin may be experiencing pain or discomfort, hunger or thirst and exhibiting sickness behaviors, such as changes in feeding and lying behavior (Bowen et al., 2021; Morrison et al., 2022). As many diseases impact milk production, reducing the prevalence of disease can reduce the negative impact disease has on milk production (Van Schaik et al., 2001). Finally, public health is impacted through a reduction in zoonotic disease spread and in antimicrobial resistance (Davies and Wales, 2019; Santin, 2020).

In Canada, biosecurity implementation on dairy farms is variable, which was highlighted in the 2015 National Dairy study (Denis-Robichaud et al., 2019). Implementation of specific biosecurity practices by producers ranged from as low as under 5% (e.g., visitor logbooks) to highly adopted practices (e.g., deadstock management, implemented by 92% of respondents). This trend of variable implementation has been shown across other dairy industries internationally (Brennan and Christley, 2012; Sarrazin et al., 2014; Aleri and Laurence, 2020). There also appears to be a discrepancy between dairy producers’ knowledge and action toward biosecurity (Brennan and Christley, 2013). Producers appear knowledgeable about certain biosecurity practices but continue to report sub-optimal implementation across farms (Brennan and Christley, 2013; Damiaans et al., 2018; Denis-Robichaud et al., 2019a).

In Ontario, biosecurity is required for dairy producers through proAction, a national quality assurance program (Dairy Farmers of Canada [DFC], 2021). In proAction, producers are required to fulfill 7 requirements including a biennial Risk Assessment Question-
nal anti-vivisection movement on dairy farms (Denis-Robichaud et al., 2020). The challenge with these studies is that they do not specifically address the barriers to biosecurity implementation described by producers. The need for more research into the lack of uptake of biosecurity by dairy producers, and veterinarians’ influence on producers’ biosecurity implementation, has been consistently identified (Brennan and Christley, 2013; Denis-Robichaud et al., 2019a; Aleri and Laurence, 2020). Barriers to implementation have not explicitly been described by dairy producers, especially for involuntary programs (i.e., Canada’s pro-Action program). Much of the previous work has sought to quantify or rank biosecurity motivators or deterrents rather than describe the issues in dairies (Aleri and Laurence, 2020; Damiaans et al., 2018; Gunn et al., 2008). The need for more research into the lack of uptake of biosecurity by dairy producers, and veterinarians’ influence on producers’ biosecurity implementation, has been consistently identified (Brennan and Christley, 2013; Denis-Robichaud et al., 2019b; 2020). Without the identification of barriers to biosecurity implementation, sub-optimal biosecurity implementation would continue to be a risk to productivity, animal health and welfare, and public health on dairy farms. Additionally, countries with supply managed systems compared with those without may have different barriers to adopting biosecurity. Finally, much of the Canadian research into dairy producers’ barriers to biosecurity were in relation to voluntary biosecurity programs, as biosecurity protocols are relatively new to inspection.

The objective of this study was to characterize Ontario dairy producers’ and veterinarians’ understanding of biosecurity. We also investigated barriers to biosecurity implementation for producers from both dairy producers’ and veterinarians’ perspectives.

MATERIALS AND METHODS

This study has been approved by the University of Guelph Research Ethics Committee (REB #22–02–025) and is reported using the Consolidated Criteria for Reporting Qualitative Research (COREQ) (Tong et al., 2007).

Positionality statement

The first author (GP) conducted all the interviews and data analysis. She is from an urban background with education in agriculture. She is a M.Sc. student with training in qualitative methods from graduate classes completed during her degree. She has not worked on a dairy farm, nor at a large animal veterinary clinic. Her understanding of the topics of communication and biosecurity comes from an academic perspective. The second author (DR) is a dairy veterinarian, professor and researcher focused on calf health and welfare. The third author (CM) is a veterinarian and dairy specialist working for the government of Ontario. The fourth author (KS) is an epidemiologist and professor specializing in biosecurity. The fifth author (BH) is an epidemiologist specializing in understanding human perception and qualitative research. The sixth author (CW) is a veterinarian, professor, and researcher focused on pain management and welfare in ruminants and is the primary advisor to the first author. The second through sixth authors are advisors to the first author, providing her with guidance and suggestions throughout the entire study.

Participant recruitment

Initially, producer participants were recruited through an advertisement in the late summer edition (June 28, 2022) of “The Milk Producer,” a publication by the Dairy Farmers of Ontario, followed by snowball sampling techniques. Once participants completed their interviews, they were asked if they could provide contact information for other producers, and/or for their herd veterinarian. Veterinary participants were contacted from the information clients provided, either through phone call, text, or email. Veterinarians were also asked to provide contact information for other veterinarians or clients at the end of their interviews if they agreed. Additional recruitment was conducted through the Ontario Association of Bovine Practitioners listerv, a Twitter advertisement, posted advertisements at nearby veterinary clinics, and through an advertisement at the end of a presentation at a producer meeting at a local veterinary clinic. One researcher (GP) contacted respondents to the advertisements by the same method.
they used, either phone call, text, or email. Participants were also provided with a $100 honorarium. There were 11 participants that either withdrew before completing the survey or did not respond after 3 attempts for contact.

**Study design**

**Consent.** Once a participant responded to an advertisement or agreed to learn more information after initial contact, emails were sent with additional information. This information described the goals and scope of the project and provided preliminary consent documentation. Consent was reconfirmed during multiple steps of the data collection process. The first step of consent was through the submission of the demographic survey. Consent was also verbally confirmed and recorded at the beginning of the interview. Participants were reminded that they had 3 weeks to revoke their consent after their interview time.

**Demographic survey.** The survey was a 5-min-long questionnaire containing basic demographic questions about the participant. The survey for producers included the participant’s personal background, such as their age, gender, education level, and years in the industry, and farm background, such as the size of the farm, location of farm, and type of farm. The veterinary survey included their educational background, years in practice and size of practice, as well as the personal background of age and gender. The surveys were completed using Qualtrics software (SAP, Seattle, USA).

**Interview guide development.** All authors developed the initial interview guides which were revised through test interviews with 3 dairy producers and 3 bovine veterinarians. Following the test interviews, study participants were asked additional questions to seek feedback on the clarity and substance of the interview questions. The interview guides were refined based on this feedback; however, major changes were not suggested so the 6 interviews remained in the study for analysis.

**Interviews.** Phone interviews were conducted between July 2022 and January 2023. Semi-structured, in-depth interviews were conducted with 17 Ontario dairy producers and 18 Ontario bovine veterinarians. Interviews were conducted over Zoom without video connection (Zoom Video Communications, Inc., San Jose, USA). Zoom meetings were held through the toll-free phone or internet link for accessibility. Each interview was audio recorded to the Zoom platform cloud, with automatic transcription. Each participant was interviewed once with only the interviewer (GP) present. Interviews allowed for an in-depth, individual conversation surrounding the topic of biosecurity. We used open-ended, probing questions to investigate personal experiences and sensitive topics privately (Tong et al., 2007). Interviews allow participants to explain their own perspectives without possible feelings of judgement or shame from other participants (Aurini et al., 2016) and allow for a deeper relationship with the interviewer. The open nature of our current study allowed participants to expand on many aspects of biosecurity, primarily barriers to implementation, which can help shape future research and direction on biosecurity. This current research also encouraged producer and veterinarian driven solutions to be described that could be actionable and meaningful to improving biosecurity implementation within their community. Additionally, conducting the interviews over the phone allowed for increased accessibility for participants from across the province. To capture the interviewer’s perception of the participant’s tone, notes were taken during the interview. Participants were not asked for feedback on the transcripts or results, due to the short timeline of this project.

**Data analysis**

Verbatim audio transcriptions were generated during the phone interviews by the Zoom software (Zoom Video Communications Inc., San Jose, USA). Once the Zoom transcripts were completed, one researcher (GP) listened to all the recordings multiple times to increase rigor and read the automatic transcripts to fix any transcription errors (Braun and Clarke, 2006). NVivo (NVivo 1.7.1, QRS International, London, UK) was used to facilitate thematic analysis by one researcher (GP) (Crabtree and Miller, 1999; Creswell, 2014). Analysis was informed through both constructivist and grounded theory paradigms. Since this research sought to understand individual participants' unique experience with barriers to biosecurity, the constructivist worldview was applicable (Creswell, 2014). Constructivism focuses on how the individual constructs their understanding of the world through their subjective perspective (Creswell, 2014). Additionally, due to the aspects of theory generation, or in this case, barriers, both grounded theory and constructivist paradigms were used (Tong et al., 2007; Creswell, 2014). Thematic analysis was used to recognize the patterns within the data, as well as describe the data with rich context for the descriptions of biosecurity (Braun and Clarke, 2006). A codebook was created from the semantic, inductive coding process that compiled common ideas and concepts (Braun and Clarke, 2006). Inductive coding is driven by the information provided by participants and requires the analyst to code without preconceptions, which was beneficial in understanding the participants.

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Power et al.: Ontario perspectives on biosecurity

Journal of Dairy Science Vol. TBC No. TBC, TBC
personal experience with biosecurity with explanations (Braun and Clarke, 2006). Codes were arranged into themes and subthemes. Themes were reviewed, refined, defined, and named further by one researcher (GP). We found that saturation was reached for each population (Saunders et al., 2018). Saturation is reached when no new themes or subthemes are developed from the data (Saunders et al., 2018). No new themes or subthemes were identified from either the last 5 producer or last 5 veterinary interviews conducted; however, these interviews were kept in the analysis. Quotations were edited for conciseness and clarity as indicated by square brackets. Both the Theory of Planned Behavior and the Health Belief Model theoretical frameworks were considered throughout the research process (Rosenstock, 1974; Ajzen, 1991). Participants were identified as either a producer or veterinarian with a “P” for producer or “V” for veterinarian and a number associated with them.

RESULTS

Demographics

Seventeen Ontario dairy producers participated in the survey and interview. Interviews ranged from 22 to 57 min, with an average (±SD) of 37.0 ± 9.03 min. Eighteen Ontario veterinarians participated in the survey and interview. Interviews ranged from 25 to 55 min, with an average (±SD) of 41.5 ± 8.17 min. Demographic information is summarized in Tables 1 and 2. Demographic information was collected to understand the participant base but does not necessarily represent the greater population as the goal was to gather the depth of perspectives instead of quantifying them (Kidder and Fine, 1987).

Descriptions of biosecurity

Producers mainly focused on preventing disease spread when defining biosecurity. Some connected biosecurity to preventing disease from entering the farm, while others also discussed it as disease exiting the farm or spreading within the farm. Producer 14 (P14) said, “Biosecurity is a way that predominantly livestock producers safeguard their animals and their farm environment to outside influences, could be diseases or environmental risks. And it’s a process to eliminate any risk of animals becoming unwell for their well-being.” Producers also connected biosecurity to animal and human safety. Other aspects of biosecurity that producers mentioned were disease containment, food safety, crop health, production, and traceability. When discussing human safety one producer (P4) stated, “I think people need to realize there are zoonotic diseases out there and farmers need to realize there’s zoonotic diseases out there. So, it’s not just about animal safety, it’s about human safety, right.”

Producers also described practices that they implemented on their farms. The most implemented practices included vaccination protocols, visitor protocols such as signage, boot covers and boot washing, disinfection of housing areas and pest management. For instance, P3 stated, “We use vaccinations very heavily here; that would be the number one. If we do have sick animals, I always try to sort them into our special needs pen, for sure.” Other less commonly implemented practices included maintaining closed herds, separating cattle by age and stage of life, quarantining new and sick animals, and specific transportation loading protocols. Of those that had open herds, some tested new cattle before addition to the herd. Record keeping was an important practice to some operations. Other biosecurity practices that were addressed included practices surrounding breeding, feed storage, manure management, milking protocols, and visitor parking. One producer (P11) felt they had no biosecurity practices currently implemented on their farm, saying, “Basically, there are no [biosecurity] approaches at our farm at this point,” but they were interested in learning more, stating, “[Biosecurity’s] something that I would be interested to learn more about.”

Veterinarians had differing opinions on the range of biosecurity implementation on their dairy clients’ farms. In response to providing examples of farms in their practice with excellent and poor biosecurity, some veterinarians agreed they had never seen excellent biosecurity, or that poor biosecurity was more common, while others thought that they mostly saw good biosecurity in their clients’ herds. For veterinarians, good biosecurity was mostly associated with closed herds, or herds that tested and quarantined new or returning cattle additions, whereas others considered good biosecurity to be routine vaccinations, strict visitor protocols with a logbook and boot washing, and general farm cleanliness. Other less frequently mentioned practices of good biosecurity herds included cow-calf separation, maintaining a sick pen, and having transportation protocols. On the other hand, poor biosecurity was commonly attributed to being an open herd, not being strict with visitors, not testing new cattle for disease, and not getting records or quarantining new or returning animals. Poor biosecurity was also described by multiple veterinarians as poor manage-
ment or management with differing priorities on-farm, in general. Veterinarians also perceived that herds with poor biosecurity were lacking interest in biosecurity, and not perceiving problems even if they had experienced outbreaks in the past. Finally, veterinarians tried to be role models for biosecurity to demonstrate proper protocols to help influence their clients.

**Thematic analysis**

Through thematic analysis, the main barriers to biosecurity implementation identified for both dairy producers and veterinarians included a lack of resources, internal and external business influencers, individual perceptions of biosecurity, and a lack of industry initiative. All themes were discussed by both dairy producers and veterinarians, but some subthemes were mentioned by only one group.

**Theme 1: Lack of resources.**

Participants identified several resources lacking for biosecurity implementation, including finances, time, facilities, technology, and knowledge.

**Financial barriers.** Financial barriers were perceived by both veterinarians and producers. Specific practices perceived as expensive by producers included routinely testing new animals, having boot washes or disposable boot covers, and having a closed herd. Some producers also found it more cost-effective to have an open herd and not raise their own replacement heifers, with P5 stating, “I think, as far as the animal movement goes, that’s a big barrier to some farms who rely on buying their replacement animals and buy and sell cattle all the time.” A veterinarian (V15) emulated this thought when stating, “We’ve got herds that have not raised heifers in years because the price of heifers was so low, they could buy them in really easily.” Other aspects of financial barriers included questioning what producers would get out of having a high-level of biosecurity, and if the effort to execute a new practice would benefit the farm financially. One producer (P2) also discussed implementing practices if they would reduce current losses, stating, “I guess, if there was a financial loss due to something that we’re doing currently and implementing something would stop that loss, then that would be the easiest incentive to do it.”

**Time barriers.** Time was also a major barrier to biosecurity for both producers and veterinarians. Time
to complete the practice and the time from implementation until noticeable results are seen were mentioned as concerns. In addition, more paperwork to implement these practices was thought to take time away from other tasks. One producer (P8) discussed other producers’ experiences saying, “If someone is really strapped for time, this maybe isn’t as high on their list of priorities. They just have to get their base chores done, and if they don’t have enough time to do that, then maybe it’s not possible to make these kinds of changes.” Alternatively, a few producers discussed that time could be saved by a preventative mindset compared with a treatment mindset. P7 summed it up by saying, “Prevention is worth a pound of cure.” Veterinarians also agreed that biosecurity may be viewed as more work and ‘one more box to check’ when specifically looking at the tasks to fulfill proAction requirements. While biosecurity implementation relies on many factors, some veterinarian participants did not want to see more biosecurity requirements introduced due to time constraints as exemplified by this veterinarian (V11) who stated, “I’ve often told vet students that ride with me, if you’re giving a farmer another job, you have to tell him what he’s able to give up, so that he has time to accomplish that job. You know we have to give him a reason to do it.”

**Facility barriers.** Facilities were discussed by both dairy producers and veterinarians as a barrier to biosecurity implementation. Facility restrictions were strongly connected to financial restrictions in that modifying or rebuilding a barn to accommodate practices was viewed as expensive. Most participants perceived the layout of the facility as a barrier for multiple reasons. Some stated that dairy barn designs were more open compared with other livestock barns, such as poultry and swine, so it was easy for visitors to just wander in. For example, this producer (P13) said, “It’s hard to keep everything and everyone out with so many open doors. A new barn can certainly accomplish that easier but, that would be the first thing I think of for the biosecurity of our place, so I don’t know how we’d exercise that 12 months of the year, with still having our ventilation and stuff like it is now.” Other barriers were related to space limitations where there was not enough space to maintain an isolation pen, or that separate animals by age and stage of lactation. V6 shared this experience: “I find that the larger farms tend to do a better job than the smaller farms… the milk cows are in one barn, and then you clean your boots before you go to the heifer barn, and before the calf barns, because you’re going into different barns, versus the small tie stall barns I work with where they milk about twenty
cows. Everything’s in that one barn, within five minutes I could walk and touch every animal just because it’s a small, old tie stall, they’re all close together, and that’s just the way it is. So, they still try to have good biosecurity, but there’s just aspects where it’s not going to happen because of what their physical setup is.” Finally, producers discussed that treatment is more practical than changing the design and flow of a dairy barn to implement biosecurity protocols.

**Technological barriers.** Technological barriers were mentioned by a few producers, and not by veterinarians. Their main concerns surrounding biosecurity were being asked to implement technology that was either expensive, not yet available, or was unreasonable to implement. P4 discussed a monitoring protocol they thought had potential but was unreasonable: “[ProAction requirements] say you’re going to have to put up locked gates with 24-hour monitoring or something like that might be financially restrictive.” Another technological barrier was online data recording and computer software, which some producers may struggle with. One producer (P3) reflected on their experience by stating, “I think software is a big issue because well, the general farmer age is what? Sixty-five plus whatever, and like there are younger people often coming into the industry, but it’s really tough for the older producers to really adapt to what we’re doing now.”

**Knowledge barriers.** Both producers and veterinarians discussed knowledge as a barrier to biosecurity implementation. Many producer participants felt that they did not fully understand the purpose of some practices, and that a general lack of knowledge about biosecurity was a barrier to implementation. This producer (P11) candidly stated, “I, quite honestly, I don’t know enough about biosecurity the way it is right now to say what to change.” A couple of other producers mentioned that they were new to the dairy industry and did not know where to start with biosecurity. P10 was worried that increased biosecurity standards in the industry would reduce their access to help, and stated, “If we had a new biosecurity protocol come out that really restricted even [veterinarians and breeders] access to the farm, that would make me a little anxious, because who would you have to breed and preg check?” Other producers stated that they would like to know more about the transmission of disease to help understand how specific diseases spread. Additionally, some producers found that information around diseases and biosecurity practices was always evolving, and keeping up with information was a barrier. Furthermore, some producers wanted to understand how some diseases still entered the herd even when they felt they had strict biosecurity, or what diseases were currently a problem in their herd. For example, P2 said, “In the industry… I think there’s a lot of people that don’t realize what [diseases] they’re up against, so I think there needs to be more testing and that comes with education for producers.”

Commonly occurring diseases that were mentioned during the interviews included *Salmonella* Dublin, bovine leukemia virus, *Cryptosporidium*, mastitis, and digital dermatitis.

Some veterinarian participants agreed that a lack of knowledge was a barrier for their clients, while others disagreed and felt their clients understood biosecurity. One veterinarian (V16) felt as though maybe it was their fault that their clients did not understand biosecurity, stating, “I guess you could also add their understanding. You know, maybe I’m letting them down as a vet by not explaining things clearly enough to them, what risks they face.” Veterinarians also mentioned specific diseases of interest that they would like to spend more time discussing, which included *Mannheimia haemolytica*, pneumonia, mastitis, bovine leukemia virus, *Salmonella* Dublin, calf diarrhea and Johne’s disease.

**Theme 2: Internal and external business influencers.**

The most identified factors that influenced producer decision making included the influence biosecurity had on animal health, cost-benefits, factors influencing change, collective approach, and public perception.

**Animal health.** Animal health was mentioned by both dairy producers and veterinarians. The most important aspects of animal health for decision making included reducing the number of sick animals, reducing the use of antibiotics, increasing longevity of the herd, and improving safety for the animals when chemicals were involved. One producer (P10), when discussing pest control mentioned, “Where we put the bait stations, we didn’t want anything near the cattle, so that’s why they’re enclosed bait stations, they’re mostly around the outside… where there’s really minimal chance for any of that bait to get anywhere near young stock or lactating animals.” Another producer (P3) discussed their thought process surrounding biosecurity protocols stating, “I think [the thoughts behind implementation] are generally about the same, and that the end goal is that you want to prevent disease and make sure that I can maintain the health of my animals.” Other producers mainly focused their biosecurity efforts on calves due to their susceptibility and potential for long-term effects on production. The health status of the national herd (i.e., all the dairy cattle in Canada) was also an important aspect for animal health. Veterinarians also discussed animal health as an important aspect to helping their clients implement biosecurity. Individualized results from recent research investigating diseases in bulk tanks provided veterinarians with an opportunity.
to discuss biosecurity that directly affected their client’s farm. Numerous veterinarians also liked to frame biosecurity in its benefit to cattle health. For instance, V13 stated, “The benefits I tell them is less chance they’re going to have sick animals on the farm if they have tight biosecurity on the farm.”

Cost-benefits. Producers and veterinarians discussed the importance of cost-benefit when implementing biosecurity protocols. Producers discussed cost-benefits as important aspects to decision making for the business as well. These benefits included increased financial gain from more productive animals or better selling quality of the cattle, as well as reduced costs due to reduced negative impacts from disease. Additionally, some participants discussed food safety as an important aspect for profitability. Producers also mentioned that changes take time to show benefits which was important to consider when discussing the cost-benefit of a change, which was also discussed by veterinarians. Other cost-benefits mentioned by producers included the ease and efficacy of the practice. P2 spoke about how calf feedings became easier: “It was actually easier for feeding if we had enough bottles for everybody.”

Veterinarians discussed suggesting easier protocols to implement changes for producers. Some easier practices included combination vaccines or having a box of boot covers on hand. One veterinarian (V9) discussed how inconvenient practices could impact implementation: “Obviously it’s a pain to isolate an animal or test her before she arrives, or potentially not buy her at all.” Efficacy was important to ensure resources were not wasted and improvements to cattle health and production materialized. Veterinarians frequently brought up profit when trying to inform their clients about biosecurity. V15 reflected, saying, “I talk about [biosecurity] in terms of herd health benefits, and economics, for sure… So, a person is wondering what’s the benefit to having a herd that’s lower in leukosis? We can talk about it from an export standpoint… so there might be dollars lost from animals being condemned when they go to slaughter. So, just presenting the advantages from a health standpoint as well an economic standpoint.” Multiple veterinarians also discussed potentially catastrophic losses in animals and finances to try to explain the importance of biosecurity. Additionally, some veterinarians agreed that some practices were unreasonable for their clients to follow due to a perceived disruption to the animals. For example, V11 said, “To sit there and say… we’re going to have plastic booties and stuff for feed company reps. They don’t work, they freak out cows, right. You get a bunch of people traipsing through the barn, and in something different, it makes a different noise, and it upsets the cattle so, I understand why it’s not practiced.”

Factors influencing change. Factors influencing change were also discussed by both producers and veterinarians. Another factor in changing biosecurity practices included forced implementation, either as a reactionary or regulatory change. Reactively implementing biosecurity was common, with multiple participants acknowledging that the value of implementing biosecurity protocols increased after a negative experience with a disease. For instance, P9 said, “I’ll say biosecurity really just popped up in our world about a couple of years ago, right? So, we had an outbreak of some type of ugly virus. Before all of this, we had lots of people coming in and working from other farms, and that was our eye opener because we think we could have picked this up from a beef farm where someone was working, right? So, that was our eye opener.” Some producers said their change in biosecurity was forced by the release of the proAction biosecurity module. Veterinarians also said they tried to outline the efficacy of the practices, but that was not always available, or helpful. Recently, one veterinarian (V1) faced some Mannheimia outbreaks in their clients’ herds and they said, “Those people are getting a harsh reality [check] with bringing new animals on a property. It really does suck for everybody; we’re seeing a lot of loss with farms that are vaccinating and in farms that are not vaccinating. So, it doesn’t even really prove our point that vaccinating is better.”

Collective approach. Producers mentioned that they liked to take a group approach to changing practices on-farm, and veterinarians agreed with the collective approach. They like to include their veterinarians, nutritionist, employees, and other relevant personnel in the decision. When discussing decisions, this producer (P1) said, “We are always talking with our vet, and she keeps us informed if there’s a new disease out there that we should be worried about….I work with my partner, and we’ll sit and talk about this before we make a change….we’ll talk to our feed guy perhaps if it’s required to see what he thinks.” Discussing biosecurity with peers was also beneficial in making business decisions for some producers, with P10 mentioning, “Maybe even seeing some of the top herds or influential herds, implement some of these different biosecurity protocols would probably go a long way for reaching different people.” Veterinarians also discussed other herds as anecdotes, both negatively and positively, to help persuade their clients to implement a new protocol. V9 discussed their approach and said, “In talking about the benefits, I mostly talk about the catastrophes, so I will discuss certain herds, obviously anonymously, but ‘Hey, this herd brought in an animal, and they got mycoplasma mastitis’, and this is why it’s bad. Or ‘They had a pneumonia outbreak, and this is how many animals they lost.’ And so, I outline what the risks are, and hopefully, by
doing that, they can then see the benefit is not going through those animal casualties, the testing expenses, or the additional vaccinations that they wouldn’t have otherwise been doing all those sorts of things.”

**Public perception.** Another aspect of decision making included public perception, which producers discussed. One producer (P1) talked about needing to ensure a positive image of agriculture, stating, “I just think that we have a reputation to keep, and if the public start seeing too many of these poor producers on [the news] at 11 o’clock, that hurts everybody.” Others discussed that the public pushed producers to be better. P4 said, “If I want to produce milk, I need follow my protocols and then, do things the right way and I have to look good to consumers.”

**Theme 3: Individual perceptions of biosecurity.**

The subthemes of personal beliefs fell into 3 main categories: lack of biosecurity value; lack of disease risk; and resistance to change.

**Perceived value.** Veterinarians and producers discussed the importance of producers’ perceived value of biosecurity. There were varying perceived values of biosecurity: some found it important, others said it was not a priority. Some producers mentioned that implementing biosecurity was common sense. P4 stated, “I don’t think there’s anything [to improve] because most things are actually pretty common sense. They’re easy to do. I think it’s just getting everybody on board, thinking the same way, and I think getting farmers to realize how serious it is.” Multiple veterinarians echoed the sentiment that biosecurity was very straightforward. Other producer participants agreed that biosecurity was always important regardless of an outbreak or the age of the cattle. Additional producer participants felt that current biosecurity protocols they implemented were attainable long-term, valuable, and effective. Multiple producers acknowledged that the protocols they do implement take effort, but they believed they are worth the effort. Alternatively, some producers either personally did not believe in the benefit of biosecurity or perceived that other producers did not believe in the benefit of biosecurity. These negative thoughts mostly related to producers’ perception that biosecurity had no benefits or utility, was not a priority, had no value, or was impossible to implement. This sentiment was affirmed by a veterinarian (V6): “Some farmers just don’t think- it’s not that they don’t think it’s important, but if they’ve got three things to do in the day, biosecurity is going to be the least of importance.”

**Lack of perceived risk.** Both producers and veterinarians discussed a lack of perceived risk as a barrier to biosecurity implementation. Multiple producers included COVID-19 in their discussions of risk and value to biosecurity. P3 said, “With Coronavirus for sure, because I think we take for granted how things can be really easy at times, and it can go crazy,” and another (P5) compared it to the fading risk: “… and kind of like CO-VID, people kind of get tired of it, and just take the mask off and go on. So, I think maybe that’s what we’re doing again until the next outbreak comes, I guess.” Some producers and veterinarians felt there was a general lack of perceived risk, while other producers disagreed. One veterinarian (V4) related it back to their experience with bovine spongiform encephalopathy while working in the UK: “I think, because most of our clients haven’t lived through- a lot of them lived through the mad cow stuff, but they didn’t have animals that were euthanized because of it, right? So, I think that they don’t realize, because they haven’t seen it firsthand, how big of a disaster biosecurity could be, so that, I would say is the biggest barrier for sure.” Another veterinarian (V9) discussed their approach due to the varying risk tolerances: “It definitely differs in terms of risk tolerance. I think, regardless of their risk tolerance, I always try and outline truly what the risks are and then at the end of the day it’s their decision.” Veterinarians also based their approach to biosecurity based on if their client’s herd was open or closed due to the differing levels of risk. One veterinarian (V5) said, “…it relates to open and closed herds, the biggest time I would talk about [the lower disease risk] is if they were considering buying in cattle, and that’s not a regular thing that they do. Then I would warn them of the risk of it bringing in new diseases of whatever, because it can be a lot of different diseases.”

**Resistance to change.** Producers’ mindset was also a barrier to biosecurity implementation as perceived by both producers and veterinarians. Multiple producers and veterinarians indicated that they had heard statements along the lines of ‘if it isn’t broken, why fix it’ from others. These stubborn mindsets make it difficult for a producer to want to change. For example, P16 said, “I think the mentality is probably a limiting factor in a lot of places.” This was echoed by another producer (P13) stating, “Some people just don’t want to be told what to do, and they don’t like change, and they think they’re doing it good enough, as is and they don’t have a problem.” Some participants also discussed their pride, interest, and openness to learn about new biosecurity protocols. Producers also mentioned that they have experienced generational differences between acceptance of biosecurity practices. When discussing these differences, P9 stated, “So, in that regards depending on what generation of dairy farmer you’re talking to you might get different responses.” Some producers also liked some of the traditions of the industry. For example, P10 said, “I
A lack of industry initiative covers on-farm initiative from employee compliance, as well as a larger initiative from industry mentality, industry personnel and the biosecurity module of proAction.

**Employee compliance.** A full business effort corresponds to the various comments that producers and veterinarians made that had to do with employees not following the biosecurity protocols laid out, or not choosing to implement new protocols due a lack of employee effort. Some producers touched on having to re-explain the expected biosecurity protocols over time. This was especially important to the producers who had employees that worked at multiple dairies. One producer (P3) discussed how their employees would react to new protocols, stating, “We try to make sure that everybody on the farm has the same standard, and if I think that people might find a protocol to be a little bit ridiculous, that it’s just something that we don’t really see as necessary, we might not add that on. And if I know that some of my employees aren’t going to really keep that enforced, then I would probably just not bother doing it.”

Veterinarians had also noticed that ensuring employee compliance with biosecurity could be difficult. In talking about their clients’ employees, V6 said, “They’ve got a hired hand, and he’s very stubborn, and set in his ways, and so he does most of the vaccinations which is fine, but the big discussion we’ve had with the Leukosis is making sure you change needles in between each animal, and that is one thing that he claims he does but if you actually watch him, he does not.”

**Industry mentality.** Producers and veterinarians agreed that animal movement was one of the most important areas for biosecurity control; however, both groups discussed the frequency and lack of protocols surrounding animal movement in the dairy industry. Human movement was also commonly mentioned. Some producers felt frustrated with neighbors or other producers not doing their part, while others felt that the focus should be shifted to farms struggling the most with biosecurity than focusing on the middle ground farms. As for industry mentality, there was an overall perceived lack of risk in the dairy industry toward disease outbreaks. Producers also commented that the dairy industry was very lax about biosecurity compared with other livestock sectors, such as swine and poultry. Both veterinarians and producers focused on how the dairy industry was lacking behind other industries, specifically the poultry and swine industries; however, they also indicated that cattle were more resistant to disease than swine and poultry, so biosecurity was not as necessary. For instance, P4 stated, “I think the dairy industry has been probably one of the last ones to take it fairly seriously.” Another producer (P8) discussed their thoughts on this a little more, stating, “…kind of how we do things [on a dairy farm], I think is maybe a little bit lax, and when you look at what the other animal agriculture industries do, like chicken, or hogs. What they do for biosecurity, I think, is much more stringent than what most dairy farmers do. And I think in time, as different diseases come down the pipe, dairy farming will get a little bit more restrictive and move more towards what [those industries are] already doing today.” One producer (P13) did not understand why there was a different perception between other livestock industries and dairy biosecurity, stating, “Well, [poultry and pig] barns, you can close them all up... You always hear of diseases, particularly to those two species that can wipe out a barn. I guess, I’m not aware [of] something in this country or province that can do that to a whole dairy or beef herd. Maybe I’m wrong. So, they probably have an extra paranoia or concern about that coming in, wiping out a whole barn. But you know... if you get one problem in a chicken barn, you empty the chicken barn, you disinfect it, and you start again. Whereas a dairy farm can’t do that because you’ve got years invested in those animals until they become profitable... but maybe it was just always easier for them to implement biosecurity early on than it was for dairy guys. I don’t know exactly why.”

**Industry personnel.** As for industry personnel, producers and veterinarians were concerned with the number of visitors they have experienced in the barns. Producers disliked how infrequently industry personnel, which included salespeople, researchers, nutritionists, drovers, milk truck drivers, veterinarians, and hoof-trimmers, follow posted biosecurity protocols for the farm. This came across as frustration in multiple
producer participants, as they felt their biosecurity efforts would never be effective. This was reflected when P7 said, “I feel that everyone should pay close attention, and lots of times people don’t. Salespeople, feed representatives, they just tend to try to walk into your barn, so we have signs up and ‘please do not enter’.” P16 also said, “And visitors I think we do a good job with. It’s a little trickier sometimes to enforce… but still sometimes I find people just like waltz into your barn, and you’re like, ‘oh, excuse me?’” This was echoed in a veterinarian’s (V13) experience: “I guess one of the big barriers is some of the producers are finding it hard to implement that salesmen and other producers or drovers don’t just walk into the barns without letting them know that they’re coming, or making sure that they have clean boots or plastic boots on. That is probably one of the biggest concerns I hear back from farmers is, ‘I want to make sure it’s biosecure, but people are just walking in.’” One producer (P4) discussed the importance of using signage with stronger language for visitors, “The no trespassing signs have been good, some people are like, ‘oh, that kind of turns people off a little bit because you don’t seem like a very nice person.’” A few producers were not comfortable with confronting visitors who did not comply with visitor protocols. While many producers and veterinarians were unimpressed with biosecurity efforts from industry personnel, there were a few who said that industry personnel did do a good job with biosecurity, and V12 said, “We’re not perfect, and I’m not saying that personnel are perfect, but I think that we are a bit more conscientious of the potential spread so, we’re taking steps to try and reduce the risk of it. I’m just not sure that producers are at that same mindset, yet.” When discussing help from industry personnel, some producers felt that producers’ organizations were not helpful in assisting; however, others stated that their provincial producer organization has been great resources in helping with biosecurity.

**proAction.** Participants were directly asked about their opinions on the biosecurity module of the proAction program. Most dairy producer and veterinarian participants found that proAction was mostly beneficial in helping implement biosecurity protocols; however, there were a few who found it less helpful. Producers that had a positive association to proAction felt proAction was easy, flexible, progressive and that the auditors were patient and helpful. Some producers said it was a good time to check in with their veterinarian about biosecurity with one producer (P12) saying, “You have to do [the proAction questionnaire] every two years for proAction… so we always do that with our vet, and it’s a good opportunity to talk about some new practices that we can adopt, and just to evaluate how everything’s been going.” Negative associations to proAction included extra work, forced practices that are not rewarding, and repetition. Several producers also agreed that proAction was ‘just another box to check’. Additionally, they thought proAction was a lot of work for simply improving public perception and consumer relations, especially when they felt it was not being advertised to consumers enough. Multiple producers felt that they or other producers did not like the biosecurity module. For example, P13 said, “I think there’s lots of producers that don’t care. There’s lots of producers that think it’s a waste of time and money.” Furthermore, some producers felt that there was too much warning before proAction audits, or that inspectors were too lenient. Some also felt that proAction requirements were only implemented for the audit, not year-round.

Veterinarians had similar thoughts with regard to positive and negative aspects of the biosecurity module in proAction. Positive aspects included that it opens conversation between veterinarians and producers, it has been helpful in implementing biosecurity to a certain extent, it targets a good number of protocols to implement and was easy to implement. Veterinarians found the proAction RAQ a good opportunity to bring up conversations that have been talked about before or that they know they need to breach. Like some producers, veterinarians found proAction progressive for the industry to initiate a program; however, they thought it could be done better. Both producers and veterinarians agreed that checklists were not the most motivating way to implement a program and veterinarians felt that the module did not motivate producers to implement biosecurity protocols year-round. Other negative aspects included that it was too much work and too repetitive.

Veterinarians had a range of perspectives on what the biosecurity module requires. Some thought requirements were always being added (and not needed), compared with others that would like more requirements added. In discussing the effectiveness of proAction V1 said, “I totally see the good points of having the biosecurity programs… but I think we need to just take a step back and ask what the end game is.” Some veterinarians believe the biosecurity module has helped increase biosecurity implementation or at least introduced producers to biosecurity. Others agreed that proAction had made veterinarians more aware of biosecurity. One veterinarian (V7), while discussing the repetition of the biosecurity questionnaire every 2 years, said, “I think it becomes a bit of a time sink, so to speak, where you’re just going through the motions and asking the questions, and not really getting much out of it on the second and third time through the assessment, because usually things
don’t change that much from year to year on a farm as far as their procedures and whatnot.”

Other areas that veterinarians agreed with producers on was that proAction was a lot of work for public perception, there was no reward, not all practices were applicable to farms and that producers should be more involved in the creation and feedback for proAction. Some suggestions veterinarians had for the biosecurity module included better wording of the RAQ questions and more focus on protocols relating to animal movement. Finally, some veterinarians did not feel that the biosecurity module influenced their relationship with clients.

**Solutions.** Participants were asked to discuss potential solutions to increase biosecurity implementation. Both veterinarians and producers discussed 5 main areas of improvement: funding, incentive/discipline, training/education, peer learning opportunities and research. Funding focused on testing subsidies and facility grants; however, grants need to be more accessible. One producer (P9) felt they were not able to receive grants and said, “There is always funding, but it’s just being able to get the grants. The grants unfortunately, are not easy to obtain. You have to go through a whole lot of righmarole to get them. I feel like on our little farm, we’re just not that dedicated, or we don’t have time slotted to go to these meetings and to get qualified for the grants.” Potential incentive solutions included graduated proAction certifications, manageable requirements tailored to each farm, and monetary incentives. Disciplinary solutions related to additional biosecurity regulations and stricter proAction audits with consequences. Both producers and veterinarians discussed education as a solution for producers, industry personnel and the public. Additionally, opportunities to learn from peers would help producers see good examples of biosecurity and give them a chance to talk to someone in a similar position as them. Producers also recommended biosecurity consultants and listening to the veterinarian’s advice to improve biosecurity knowledge. Finally, research into the economic benefit from biosecurity practices was viewed as a major solution highlighted by several participants. Other suggestions that may require research or additional work included a provincial disease alert system to remind producers of the continued risk. Furthermore, some producers and veterinarians did not have any ideas on how to improve implementation.

Both veterinarians and producers discussed areas that they wanted to see improvements in the industry as well. These areas included improved record keeping, helping with transparency when selling and purchasing new animals and improved transportation protocols, specifically on-farm loading protocols and drover responsibility for trailer cleanliness.

**DISCUSSION**

Many factors in biosecurity implementation revolved around similar themes: a lack of resources, internal and external business influencors, individual perceptions of biosecurity, and a lack of industry initiative. While these are the main themes, there are also concepts that weave between them. Within the broader themes, a general reluctance to change was clear. This general concept differs from the subtheme, resistance to change, as it was an indirect aspect to another barrier. For example, one veterinarian discussed an employee not following protocols, so the direct barrier to the producer was that employee not following biosecurity protocols. The employee’s barrier appeared to be because he was stubborn. Additionally, areas that producers and veterinarians discussed seemed to relate to peer pressure or societal pressure to encourage positive changes. However, there also appears to be a cycle of reinforcement by producers set in the industry standards. Working to reduce some barriers may result in reductions in other barriers as well.

Trustworthiness in qualitative research, like rigor in quantitative research, is determined using in-depth steps to maintain credibility, transferability, dependability, and confirmability (Lincoln and Guba, 1986). These steps include familiarizing yourself with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report (Nowell et al., 2017). Transferability is comparable to external reliability in quantitative research and relies on complete descriptions of the data for others to decide if the content is relevant to their situation (Lincoln and Guba, 1986). It is reasonable to hypothesize that many of the barriers to biosecurity implementation that these participants discussed are relevant to producers in other provinces or countries. Therefore, readers should consider these factors when assessing whether these barriers are likely to apply in other situations.

**Description of biosecurity**

When defining biosecurity, the connection to reducing the spread of disease into a farm has been made in multiple studies. Similar results to this study were found in another Canadian study, where 73% of participants attributed biosecurity to preventing disease spread into and within the herd (Denis-Robichaud et al., 2019a). Furthermore, participants in a British study related biosecurity to keeping disease out more than keeping disease from spreading within the herd (Brennan and Christley, 2013). Alternatively, veterinarians in previous research have defined biosecurity as disease
control and prevention within the farm (Pritchard et al., 2015). Producers in other studies also agreed that animal movement was the most important and riskiest areas of biosecurity (Damiaans et al., 2018, 2020). Further, veterinarians agreed that quarantining sick and new additions and knowing the origin of a new animal were some of the most advantageous biosecurity practices (Kuster et al., 2015). These protocols were mostly consistent with the protocols that veterinarians in this research modeled as good biosecurity measures. Understanding the gaps in producers’ understanding of biosecurity protocol use could help veterinarians target specific areas of improvement. Additionally, veterinarians’ understanding of good and poor biosecurity revolve around practices indicative of animal and human movement, which are areas of concern. This focus may help veterinarians discern which practices are most beneficial to their clients.

**Theme 1: Lack of resources**

The lack of resources identified in this research (financial, time, facility, and knowledge) has also been identified in previous work. The financial barrier of initial costs was discussed in studies conducted in Great Britain (Gunn et al., 2008; Richens et al., 2018) and Sweden (Svensson et al., 2019). In Ontario, research investigating Johne’s control also found that money was a barrier, especially in connection with time and facilities from both producer and veterinarian perspectives (Roche et al., 2019). Multiple British studies with veterinarians found similar barriers that producers may not be able to afford biosecurity (Gunn et al., 2008; Shortall et al., 2016). Alternatively, other barriers were related to producers’ willingness to spend money on biosecurity and the lack of understanding that biosecurity would save money in the long run (Shortall et al., 2016). Time was also mentioned as a barrier in previous research with both producers and veterinarians, consistent with this study (Richens et al., 2018; Roche et al., 2019; Svensson et al., 2019). Gunn et al. (2008) also indicated that producers felt biosecurity was too much work. Additionally, while technology may not be necessary for biosecurity, Canadian producers are required to record SOPs, product use and disease events in their animals (DFC, 2021). These deficits in understanding how to use technology may increase time spent hand recording events or trying to learn new software.

Facility barriers have also been connected to preventative measure implementation. These other studies identified barn design and farm layout as a constraint for improving biosecurity (Lehenbauer, 2014; Damiaans et al., 2018; Oliveira et al., 2018). Participants in a Danish study felt that producers with newer facilities had an easier time with biosecurity (Oliveira et al., 2018). Facility size was also identified by Ontario producers and veterinarians as a factor in implementing preventive measures against Johne’s disease (Roche et al., 2019). Barn design and space was identified as a barrier in a Swedish study (Svensson et al., 2019). Veterinarians also agree that facility design was restrictive in producers’ ability to implement biosecurity (Shortall et al., 2016).

Other work has identified a knowledge gap in producers understanding of biosecurity and that it may relate to inadequate communication from veterinarians (Gunn et al., 2008). In a behavioral economics analysis study in Great Britain, knowledge about biosecurity measures was significantly associated with behavioral change (Toma et al., 2013). Additionally, other research has indicated that veterinarians believe their clients have enough information, they just choose not to apply it (Shortall et al., 2016). Conversely, other veterinarians agree that producers need more education on disease and biosecurity (Sayers et al., 2014). This discrepancy could be due to the variation between clients’ or veterinarians’ value placed in biosecurity. Additionally, some veterinarians may have a better relationship with their clients and provide them with more information, reducing clients’ needs to find information elsewhere.

The resource barriers are external factors that impede producers’ ability to implement biosecurity. Time is one of the more challenging barriers to overcome because producers are busy with many different aspects on the farm. Additionally, if they are unable to afford help, they may not be able to find time for biosecurity without giving something else up. Understanding biosecurity protocols could help producers determine how to manage their time. Additionally, facility improvements cost money, time, and knowledge. Producers need to understand biosecurity to design a biosecure facility. Furthermore, producers need to find an alternative, suitable housing situation for their herd while facility improvements are underway.

**Theme 2: Internal and external business influencers**

Other studies have investigated motivators for producers to implement biosecurity and prevention. Common motivations have included animal health benefits (Gunn et al., 2008). In an Australian study, animal health was consistently scored highly as the reason to implement biosecurity (Aleri and Laurence, 2020). British producers also felt that biosecurity improved animal health (Richens et al., 2018). When implementing Johne’s disease prevention, Ontario producers agreed that animal health was an important aspect as well (Roche et al., 2019). In a Swedish study, animal
health was a main factor in implementing a preventive measure (Svensson et al., 2019). Furthermore, producers that associate biosecurity with a healthy herd were more likely to implement more biosecurity (Toma et al., 2013).

Some producers in England thought that biosecurity was cost-effective and time-effective (Brennan and Christley, 2013). Participants in an Ontario study also mentioned that highlighting the benefits of reducing a disease can have a positive impact (Roche et al., 2019). Another study in Sweden identified that improving the businesses profitability helps to motivate change in producers (Svensson et al., 2019). Veterinarians have also seen the impact of peer learning for producer clients for Johne’s disease control (Roche et al., 2019). Veterinarians also regard group discussion as important in motivating change (Roche et al., 2019). The benefits of peer learning have been seen in the international literature as well (Brennan and Christley, 2013; Damiaans et al., 2020; Ritter et al., 2020). Peer learning allows producers to discuss topics with someone who has had similar experiences, first-hand. More producer meetings could be beneficial for veterinarians to address multiple clients or provide them with another resource by bringing in an expert on the topic.

Understanding how producers make large business decisions may help veterinarians or other industry sources, such as government and producer organizations inform producers of the importance of biosecurity. Animal health is important for producers to consider as their animals are the basis of their business. Additionally, cost-benefits are also necessary to maintain an effectively run business. While none of the participants in this current study mentioned Canada’s supply management system as a barrier, for some producers it may affect how they make financial decisions on farm. Supply management was discussed as a barrier for participants in research about implementing bovine leukosis virus strategies in Canada (Kuczewski et al., 2022). Some changes are forced, for various reasons, which may not be as motivating for producers. Producers changing due to a poor outcome seemed to be more motivating than changing for proAction requirements. Furthermore, most producers liked to have multiple perspectives to help them make a big decision, especially those who liked to be informed when making decisions.

**Theme 3: Individual perceptions of biosecurity**

A Swedish study found that producers perceived biosecurity as ineffective (Svensson et al., 2019). Veterinarians also believed they needed to convince their clients of the value of biosecurity in reducing disease (Shortall et al., 2016). In addition to value and ease of biosecurity, efficacy was important, and previous research has found that producers that have tried to implement protocols with no benefit were more hesitant to try other biosecurity protocols (Svensson et al., 2020). Literature exploring preventive practices in livestock producers found that producers feel more invested in biosecurity if they feel they have control and can see improvements in their animals (Ritter et al., 2017). Veterinarians from Great Britain felt that their clients did not have an interest in biosecurity or that they were unwilling to change (Gunn et al., 2008). These results were consistent with other research (Pritchard et al., 2015; Denis-Robichaud et al., 2020). Further research into efficacy of practices could persuade producers to believe in the impacts of biosecurity. Additionally, veterinarians or other farm advisors could try and target areas that producers find valuable to discuss biosecurity. However, if veterinarians perceive their clients are disinterested, they may stop discussing biosecurity with them.

Other studies have also identified a perceived lack of risk as a barrier to biosecurity implementation (Svensson et al., 2019). A behavioral economic analysis showed that when producers perceived an effect of disease outbreak on their business were more likely to apply more biosecurity protocols (Toma et al., 2013). One UK study found that producers were aware of their herd’s disease risks with and without biosecurity practices (Brennan and Christley, 2013). Producers that do not perceive a risk of disease may benefit from peer learning or additional conversations with their veterinarians. Additionally, further information about the current disease spread in the region and routes of transmission may alter their understanding and perceived risk.

**Theme 4: Lack of industry initiative**

The frustration that participants in this study felt within the industry was also echoed in another study in Canada (Ritter et al., 2020). This study highlighted the need for all producers and industry personnel to work together to improve dairies instead of the ‘good’ producers working to keep the dairy industry relevant on their own (Ritter et al., 2020). In a UK study, there was a general lack of trust between all participants (producers, veterinarians, and industry personnel) that farm-level biosecurity protocols would be ignored (Gunn et al., 2008). In another Great Britain study, over 60% of participants agreed that biosecurity needs to improve in the entire dairy industry (Richens et al., 2018). Many other barriers focused on reasons why producers did not think they can do biosecurity, but when discussing visitors, participants seemed worried about their effect on biosecurity. This difference may be due to feelings of control; producers can control their implementation of biosecurity protocols.
but struggle to control outside forces. As for proAction, work looking at another module has found that the disbudding and dehorning requirements were also variably perceived, with some producers thinking they were easy and fair, and others feeling forced (Saraceni et al., 2022). These results are consistent with this research; however, in the disbudding and dehorning research participants said that proAction saved time and was good for public perception (Saraceni et al., 2022). The difference in regard to public perception between the studies may be due to the direct human-inflicted effect disbudding and dehorning pain management has on the animals compared with biosecurity measures. As an industry, more education should be provided for everyone to develop a basic understanding of biosecurity and protocols that should be followed on every farm regardless of what the producer expects. Ensuring that any industry personnel, researchers, and veterinarians have biosecurity training could improve visitor protocols.

Solutions

Suggestions for solutions in previous research related to preventive management practices on dairies included free testing, financial compensation, financial penalties, and refusal to collect milk (Roche et al., 2019; Ritter et al., 2020). These are like the solutions that participants suggested in this work around incentives and disciplines. Targeting research to focus on economic benefits of biosecurity implementation was also identified as a solution, which is consistent with a Flemish study (Damiaans et al., 2018). Education could also provide all stakeholders in the industry with knowledge on how to conduct themselves on farms. Education could be in the form of work training, producer meetings, continuing education programs or professional development. Participatory and experiential learning for producers showed to be effective for improving management practices specific to Johne’s disease (Roche et al., 2015). Additional research in the USA, also showed that interactive education was beneficial in changing producers’ attitudes around biosecurity (Moore and Payne, 2007). There is emerging research into the effectiveness of biosecurity training for other industry personnel (McDonald et al., 2020; Smith and Cummings, 2020), but further research is warranted. Further focus on biosecurity and large-animal communication in veterinary colleges could also improve veterinarians’ ability to promote biosecurity implementation.

CONCLUSIONS

Biosecurity practices are important to many aspects of dairy production. Ontario producers and veterinarians mostly understood the importance and impact of biosecurity protocols on farms. While there were varying perspectives on barriers to biosecurity implementation, some key themes were identified including lack of resources and industry initiative, internal and external business influencers, and individual perceptions of biosecurity. Veterinarians are in a unique situation where they have access to and the relationship with producers to be changemakers in biosecurity implementation. With this situation, increased motivation and skills of veterinarians would be beneficial to help make these changes. Additionally, understanding the general thoughts and ideas around biosecurity provides researchers and industry members with future directions on effective biosecurity and effective solutions to barriers discussed by participants. Solutions to reduce these barriers, such as incentives, education, and further research, may help producers implement more complete biosecurity measures.

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REFERENCES


